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AMBIGUOUS WINDS OF CHANGE – OR FIGHTING AGAINST WINDMILLS IN CHINESE WIND POWER

PhD Series 05-2015

Julia Kirch Kirkegaard

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A CONSTRUCTIVIST INQUIRY INTO CHINA'S PRAGMATICS OF GREEN MARKETISATION - MAPPING CONTROVERSIES OVER A POTENTIAL TURN TO QUALITY IN CHINESE WIND POWER

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The Doctoral School of Organisation and Management Studies (OMS) is an interdisciplinary research environment at Copenhagen Business School for PhD students working on theoretical and empirical themes related to the organisation and management of private, public and voluntary organizations.

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Til min elskede far, der lærte mig livets, krimiens og plottets kunst

*

*

To see a World in a Grain of Sand
And a Heaven in a Wild Flower,
Hold Infinity in the palm of your hand
And Eternity in an hour.

William Blake (1757-1827) "Auguries of Innocence"

*

Give me one matter of concern and I will show you the whole earth and heavens that have to be gathered to hold it firmly in place.

Bruno Latour, “Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern”

*

Mærk det lige – vi er endelig med

Marie Key, “Uden Forsvar”

Acknowledgements and Preface

”We say, ’The wind is blowing’, as if the wind were actually a thing at rest, which, at a given point in time, begins to move and blow. We speak as if the wind were separate from its blowing, as if a wind could exist which did not blow’” (Elias, 1978: 112)

This thesis marks the end of a long journey. However difficult the journey has been at times, and however much my life seemed to become intertwined with the project, as I engaged in mapping controversies in Chinese wind power, it has been a tremendous learning experience. And hopefully, not only have I learned something about wind power in China as well as about life in general, but readers of the thesis will hopefully also find their understanding of China enriched. This, despite of the fact that “*next year, if you come out here again, we would probably tell you a completely different story”*, as one of my many informants warned me. Indeed, China - and the thesis, reflect entangled stories of paradoxical and ambiguous transformation. Acknowledging that the controversy mapping is just one ’fractal’ amongst many, the story offered in the thesis has been formed based on extensive fieldwork in China. Further, it is informed by a ‘promiscuous’ coupling of heterogenous fields, i.a. of organisation studies, political economy, economic geography, international business, development, China, and culture studies, software and mechanical engineering, and mathematics. The thesis is the result of a long research journey, where the landscape to be encountered remained a riddle for a long time, and which has involved encounters with unexpected actors and issues, many of which turned out (often surprisingly) as central to the story. I guess, though, that one of my respondent’s comments still holds true:
”It’s quite a task that you have embarked on! […] Well, that’s cool! I think it’s really great that you have taken upon yourself such a challenge. But it requires that you keep it straight!”

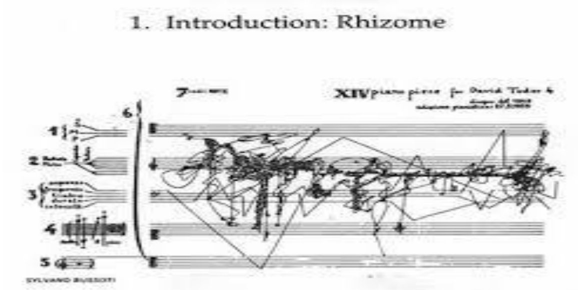
To - hopefully - form a ‘straight’ and coherent story of the myriads of stories encountered in the field has involved ongoing work on emplotment. Maybe this has been inspired by my father’s lifelong research in narratives and, in particular, in the well-plotted crime fiction (Kirkegaard, 2013; 2014). The structure of the thesis may, therefore, in many ways resemble a crime plot or, to be more precise, the crime plot of the *rhizomatic maze* (Eco, 1983; Kirkegaard, 2013; 2014), which is the plot of conjecture. Through the botanical metaphor of the rhizome, Deleuze

and Guattari (1980-1987) write that the rhizome constitutes a net of entangled roots that grow under the soil in lateral directions, without any centre point, beginning or end, and no middle point (Deleuze and Guattari, 2011[1980]). While the rhizome and rhizomatic maze has inspired emplotment of crime fiction and related literature streams, it has also inspired the thesis, which presents a story with myriads of plots within plots, i.e., with no clear beginning or ending.

In the process of tracing and disentangling the thick mesh of the emerging rhizomatic fractal, certain people have been particularly important to me. First of all, I should not forget to thank my many helpful respondents who have taught me so much, and have always been willing to explain and draw, also when I asked the same questions again and again, as I was slowly getting acquainted with wind power, software algorithms, aeroelastic codes, and many other pecularities (in English and Danish, but also in Chinese!). Many of these fields have been completely alien to me with my background in organisation and China studies. In addition to my respondents, without whom there would be no thesis today, I am forever grateful to all of my (many!) supervisors. Placed between and within heterogeneous fields, it has been an ongoing work and challenge to put the 'pieces' together and to find 'my own voice' and story, and to couple fields that have not been coupled before, and which are evidently not easy to synthesise. Each of my supervisors have – with their particular expertise within one or several of the fields that my thesis touches upon – been of invaluable assistance. First, Professor Peer Hull Kristensen has been a generous, supportive discussant, and an immense help to me with his consistent trust in my work. Without his ability to follow my traces and the emerging story from the chaotic early drafts, I would have stopped many times halfway. Also Professor Susse Georg has displayed such immense empowering trust in my ability to work out the knots myself. Without her always being ready to discuss, read, draw, and offer words of support and wisdom during the progressings of my work, and on life in general, I would never have made it. The assistance from Associate Professor Stine Jessen Haakonsson who made everything possible at the outset, and with whom I have gone 'GIN hunting' many times – in China, Germany, and in Denmark – has been invaluable, involving so many fruitful and insightful discussions on Chinese wind power and GINs over the years. Last but not least, my Chinese supervisor, Professor Liu Xielin has been a great assistance and support for my work while conducting fieldwork in China. Overall, the Sino-Danish University Centre for Research and

Education (SDC) has, apart from supporting my work financially, also been a tremendous help, i.a. through my participation in joint SDC field trips to China.

And then, of course, without a doubt, the most important support has come from my family, my friends, and my beloved ones, without whom I would never have applied for a PhD scholarship, nor would I have survived or completed it. Also, I want to thank my Chinese friends Yuhua, who helped my life in China in so many ways, and my friends at the Chinese Academy of Sciences in Beijing. I will never forget. Without these people in my life, there would never have been the birth of my thesis. Read it and hear it. Maybe you will find it a baroque fugue with many voices. Or maybe it's a 'China blues'. I look forward to hearing what you have found and heard!



Source: Sylvano Bussotti, Rhizome, 1959 (Via MaryAnn Reilly);
http://bryanjack.ca/tag/ds106radio/

Abstract

The thesis inquires into dynamics and controversies of constructing a market for wind power in China. Inquiring into what the thesis dubs a quality crisis in Chinese wind power after years of high growth rates, and into a potential turn to quality, the thesis traces such current ambiguous winds of change with point of departure in the notion of global innovation networks (GINs). Thus, it looks into how international collaborations on critical components, such as software programmes, play a critical role in the qualification of wind power as a 'sustainable' renewable energy source.

However, with a structural rather than micro-relational or processual lens, the existing GIN literature is claimed to be ill-equipped to grasp the *genesis*, *dynamics*, and *agency* of GINs. To fill this gap, the thesis develops a situational, constructivist framework based in Science and Technology Studies, which renders a processual and relational understanding of GINs as part and parcel of market construction. It does this by initially 'looking away' from the original metaphor of GINs, with the result of effectively reconceptualising it. This is done by illustrating the dynamics and the agency of GIN genesis through a mapping of controversies over issues of Intellectual Property Rights, standardisation, money, and cost and price calculations, entangled in a Chinese 'system problem' of state-owned actors and a Chinese experimental pragmatism of market construction, which has had unintended effects.

Tracing one potential GIN taking shape around a critical component, the thesis also contributes to the GIN literature through a new methodological approach. Illustrating the potentially disruptive dynamics of GIN construction, and how the emerging GIN around software programmes possesses disruptive agency in regard to the framing of the emerging Chinese wind power market, the thesis sheds light on some of the socio-material work needed to construct and maintain GINs and the markets it co-constitutes and is co-constituted by, as well as the negotiated roles, identities, and positions of actors in a developmental context of China. The thesis coins the seemingly particular Chinese mode of market construction within wind power a fragmented and experimental 'pragmatics of (green) market construction', with its agile responses to emerging issues.

Last, to overcome the dualism between structural and processual accounts, the thesis draws on the pragmatist notion of *figuration* (Elias, 1978). After demonstrating a potential figurational change reflected in the ongoing turn to quality, the thesis also considers the implications that the inquiry has for other related literatures, hereunder proposing a new research agenda for New Economic Sociology to understand market and GIN construction in a developmental context, which holds a promise for inquiring into China’s self- and other-disruptive, yet potentially path-creating modes of development and upgrading.

English Summary

This thesis conducts a market construction *('marketisation')* analysis of China's wind power market, founded in the Anthropology of Markets and its performativity programme (Callon and Çalişkan, 2009; 2010a; 2010b). The thesis demonstrates how the construction of a market for wind power in China can be seen as constituting a particular Chinese fragmented and experimental 'pragmatics of green marketisation'. The sustainability of this pragmatics of green marketisation is, however, being contested, with the result of producing controversy as it has not only contributed to unprecedented high growth rates of installed wind power capacity, but also to extensive quality problems. These problems now, paradoxically, threaten to destabilise China's emerging wind power market and its framing as a viable and sustainable renewable energy source in terms of development. That is, sustainability in China is linked to concerns for Scientific Development, which emphasise upgrading and development of indigenous innovation capabilities within core technologies. Facing a quality crisis, i.a. resulting in vast amounts of underperforming wind farms and lost generation of wind power, the framing of wind power as technically, scientifically, economically, environmentally, and even politically and developmentally sustainable has been destabilised. In addition to jeopardising the emerging wind power market in China, concerns are increasingly voiced that the quality crisis may threaten the reputation of wind power on a global scale. As China risks 'fighting its own windmills' in its pursuit of rapid catch-up, the thesis inquires into the ongoing struggle to qualify wind power as sustainable. The thesis argues that while it is China's 'pragmatics of green marketisation' that has produced a quality crisis, it is also the same pragmatics of green marketisation that is likely to enable an agile turn to quality, which i.a. opens up a contested and hybrid space of simultaneous collaboration and competition between Chinese and foreign actors.

By inquiring into the particular mode of marketisation in Chinese wind power, the thesis also offers a contribution to the literature on global innovation networks (GINs) within economic geography. In the struggle to qualify wind power as sustainable, certain 'core' components such as software programmes in control systems, simulation tools, and prediction tools for wind turbines, have been framed as 'critical'. While China's wind power industry has emerged with

unprecedented growth rates and has upgraded capabilities rapidly, the legacy of technology sourcing and licensing in China's wind turbine industry still plays a prevalent role in terms of core technologies such as software, and Chinese manufacturers are still largely dependent on sourcing of foreign core technologies and software. Thus, while Chinese actors actively strive towards independence from foreign technologies and towards developing indigenous innovation capabilities, in alignment with the doctrine of Scientific Development, they are, nevertheless, simultaneously engaging heavily in technology sourcing and collaborations with foreign suppliers. This strategy of leveraging foreign knowledge and technology is – along with China's upgrading – taking place i.a. through the gradual global dispersion of R&D activities, the hiring of foreign experts, joint design agreements, and mergers and acquisitions. While predecessors such as the Global Value Chain and Global Production Network literatures within economic geography (e.g. Gereffi 1994a; 1994b; Bair, 2005; Gereffi et al., 2005; Gibbon and Ponte, 2008; Ponte, 2009; Dicken et al., 2001; Coe et al., 2008a; Hess and Yeung, 2006), have sought to explain the global dispersion of production activities, the GIN literature has been concerned with the global dispersion of R&D and innovation activities through the metaphor of GINs (e.g. Ernst, 2006; 2008; INGINEUS, 2011; Cooke, 2012; Parrilli et al., 2013; Barnard and Chaminade, 2012). According to recent empirical studies of the Chinese wind turbine industry, different GINs (Silva and Klagge, 2013) and global learning networks and collaborative innovation networks (Lewis, 2013; Chen et al., 2014) can be detected in the Chinese wind turbine industry in the shape of Chinese wind turbine manufacturers, who have engaged in these globalised innovation activities. Based on the argument that integration into GINs, centred around core technologies such as software, can be seen as a mode of re-qualifying wind power as sustainable in developmental terms, the thesis is motivated to explore how and whether such GINs take shape around software, and how they may play a role in marketisation.

Through a literature review, the thesis claims that the GIN literature, despite its proposals of having detected the emergence of GINs, i.a. in Chinese wind power, has not yet rendered insight into *how* these GINs emerge in the first place. This claim is based on the argument that the GIN literature does not look into the socio-material micro-processes of relationship-building, but instead tends to look at GIN structures 'from the outside' and to identify their emergence 'after the fact', instead of tracing their progressive construction. While having provided valuable insights into the structures and effects of GINs, treating them as globally organised webs of complex interactions between firms and non-firm organisations engaged in knowledge production related to and resulting in innovation (Barnard and Chaminade, 2012), the positivistic and structuralistic GIN literature does not put emphasis on the micro-processes of building and maintaining relations, nor on aspects of genesis, dynamics, and agency. Interested in how and whether GINs emerge around core technologies such as software, as well as in their dynamics in the current quality crisis of wind power, and how they may play a role in the qualification of wind power as sustainable, the thesis turns towards a constructivist lens, which offers an integral relational and processual perspective. In this way, the thesis argues that it initially must, somewhat paradoxically, 'look away' from GINs, i.e. it must avoid adopting the GIN metaphor in what in the thesis is termed its 'marketisation analysis', in order to open the black box of 'the relational' in the GIN construction, and thereby render insight into the genesis, dynamics, and agency of GINs. Consequently, with an empirical interest in how a *turn to quality may take place in Chinese wind power – potentially reflecting a Chinese mode of green market construction – and how this turn to quality may de- and reconfigure relations between Chinese and foreign actors around software*, the thesis explores how and whether an *constructivist perspective may qualify the understanding of GIN genesis, dynamics, and agency in a Chinese developmental context*.

The thesis in this way takes up the challenge of connecting the ontological and epistemological divides between the constructivist Anthropology of Markets approach and the positivist GIN literature, which is suggested in the above dual-pronged research question. This connection is undertaken through what thesis coins 'a pragmatist tunnel'. On the one hand, the constructivist perspective (e.g. Latour, 2005a; Muniesa, 2013; Law, 1994) has explicit roots in the micro-relational and processual philosophy of American pragmatism (e.g. Dewey, 1927; Whitehead, 1978; Elias, 1978; Mead, 1934) and the GIN literature is, on the other hand, founded on i.a. economic geography, which within certain streams has opened up towards a more relational and even constructivist perspective. On this basis, the thesis argues that cross-fertilisation between the constructivist and GIN literature is possible, and can take place through a pragmatist connection and their common concern for the 'relational'. With this ambition of cross-fertilisation, the thesis develops a situational and 'grounded' theoretical and methodological framework founded in constructivist streams within Science and Technology Studies (STS). The theoretical framework of the thesis is in particular drawing on Actor Network Theory (e.g. Callon, 1986a; 1998; Law, 1994; Latour, 2005a; 2005b), the Anthropology of Markets and its *performativity programme* and *pragmatics of valuation* (Callon and Çalişkan, 2009; 2010a; 2010b), as well as drawing on the *sociology of associations* (Latour, 2005a).

The particular network construct used in the thesis to initially 'look away' from GINs, namely the concept of Techno-Economic Networks (TENs), is thus adopted from Callon (1998) and adapted to the present inquiry. Treating the ongoing quality crisis in Chinese wind power as a qualification struggle, the thesis subsequently dives into a number of overlapping TENs and the related processes of framing wind power, and some of the potential struggles such framing attempts may produce in collaborative relations around the core technology of software. To inquire into these struggles, the thesis also draws on the constructivist and ethnographically inspired method of 'Mapping Controversies' (Latour, 2005a; Yaneva, 2012; Venturini, 2009). To conduct a marketisation analysis of wind power in China, the thesis is based empirically on extensive, iterative processes of fieldwork in China (as well as Denmark and Germany) from the period September 2011- September 2013 (amounting to 95 interviews).

On this basis, the analysis first provides an historical account of how an ambiguous shift in policy priorities and means from a focus on quantity towards quality is taking place in Chinese wind power, which, as mentioned previously, i.a. positions upgrading and development of indigenous innovation capabilities in software as critical. To inquire further into what seems to be 'winds of ambiguous change' in Chinese wind power, and how these may be de- and reconfiguring relations between Chinese and foreign actors around software, the thesis maps four controversies. First, two controversies over the role of Intellectual Property Rights (IPRs) and standards in the framing of wind power as sustainable are analysed. These studies zoom in on collaborative Sino-foreign relations around control system technologies for the optimisation of the regulation of the wind turbine as well as simulation tools for the optimisation and certification of turbine designs. The two studies illustrate some of the myriads of power struggles taking shape around software algorithms in the software tools, e,g. because they are often black-boxed. To render a more fine-grained and situational understanding of the controversies taking place around control systems and simulation tools, the thesis also studies controversies unfolding over money and cost and price calculations, which are entangled in wider controversies over what is being seen as a Chinese 'system problem' of Chinese state-owned actors, as well as in a controversy over the sustainability of what seems to be a Chinese experimental and fragmented mode of marketisation.

The thesis concludes that only by 'looking away' from GINs, does it become possible to 'see' them and to capture their progressive socio-material construction, their dynamics, and their agency. While the GIN literature has already concluded that there are GINs in China's wind turbine industry, the thesis illustrates that when 'diving deeper', and looking into a specific core technology of software, there are no stabilised GIN(s) to be found. Rather, technology and knowledge tend to be commodified, leaving software to remain part of the value chain. As capabilities of Chinese actors are improving rapidly, there are, however, characteristics of GIN emergence, but not without continuous power struggles. The overly volatile nature of collaborations, which seem to unravel even before they are configured, is argued to bear resemblance to so-called 'sustained contingent relations' (Herrigel, 2010), which due to an extensive role ambiguity are being consistently destabilised and require ongoing maintenance. This instability can, in turn, be linked to shifting ambitions and agendas of Chinese actors, who grope their way forward in marketisation, as they build capabilities. Further, Chinese actors seek, somewhat ambiguously, to become part of GINs in order to build capabilities that can help upgrading, while they in the pursuit of indigenous innovation simultaneously seek to move beyond GINs, i.e. to become autonomous and independent from foreign technologies. While rendering Sino-foreign collaborations in Chinese wind power overly volatile, the thesis also points towards a possible shift from an overall competitive space towards more collaborative spaces.

The thesis makes a number of contributions. Firstly and primarily, it contributes to the GIN literature by adopting a constructivist marketisation perspective, which allows for shedding light on genesis, dynamics and agency in the emergence of GINs. The perspective offers insights into some of the controversies, exclusion mechanisms, and power struggles which GIN construction can engender, as well as into the many human and non-human actors that this construction involves. The thesis further illustrates how GINs and, amongst other things, software algorithms can disrupt (as well as spur) marketisation. The thesis has done this by ‘looking away’ from the GIN construct, and by reconceptualising GINs, treating them as part of marketisation. Further, it has disassembled the wind turbine and zoomed in on the socio-material construction of relations around a particular core component. The thesis is, thereby, able to show how the socio-material resistance to obtaining access to algorithms has produced an intense power struggle and multiple matters of concern for i.a. indigenous innovation, leapfrogging, and catch-up, as well as concerns by Western actors as to how to simultaneously manage their relations with Chinese partners and protect their own core competencies and market shares. In future studies on GIN construction, it is recommended that studies attempt to ‘dive deeper’, e.g. through ethnographic studies and by tracing processes of relationship-building around specific components.

Secondly, the thesis renders an account of an extensive creative and agile experimentation in the marketisation of wind power, in which disruptive upgrading and governance relations is made possible. This contributes to the understanding of the potentially multiple alternative modes of marketisation. Overall, by cross-fertilising the GIN literature and constructivist perspectives through a pragmatist tunnel, the thesis also extends the marketisation lens and shows a particular mode of Chinese marketisation in China.

Thirdly, in order to render further insight into the volatile dynamics of marketisation and the consistent de- and reconfiguring of relations between Chinese and foreign actors, the thesis also discusses how Elias’s (1978) pragmatist figurational sociology may contribute to the findings. It is here demonstrated that a gradual move from *figuration I* to *figuration II,* namely from a focus on speedy low cost production and installed capacity towards a focus on quality and generated electricity, can be seen in Chinese wind power. In this move towards *figuration II,* a new strategic and more complex game between Chinese and foreign actors has emerged, in which dynamics of collaboration and competition coexist and collide. In these paradoxical relations of *figuration II*, software programmes have become the centre stage of contestation.

Lastly, the thesis contributes to a number of other literature streams, i.a. to China studies, related literatures on China’s specific variety of capitalism(s), upgrading and governance studies, as well as to perspectives on industrial policy and Chinese prospects for innovative manufacturing. Having displayed how the structuralist perspective of GINs and the constructivist perspective of the Anthropology of Markets can cross-fertilise each other through a pragmatist bridging, the thesis proposes a new research agenda for New Economic Sociology to inquire into the construction of GINs and markets in a developmental context. Although there are limits to generalisation from the focus of the present inquiry into other countries and industries, the thesis nevertheless suggests that wider lessons on the nature of market construction in China within other strategic, i.a. green, industries in China can be drawn.

Dansk Referat

Baseret på Callon og Çalişkans (2009; 2010a; 2010b) markedsantropologi og dets ’performativitetsprogram’ analyserer afhandlingen konstruktionen af et marked (’*marketisation*’) for vindkraft i Kina. Afhandlingen viser, hvordan markedsskabelsen inden for kinesisk vindkraft ser ud til at repræsentere en særligt kinesisk ’grøn markedskonstruktionspragmatisme’, der er karakteriseret ved en fragmentarisk og eksperimenterende tilgang. Da denne pragmatiske tilgang til markedskonstruktion ikke kun har resulteret i hastig vækst i installeret vindkraft, men også i et væld af kvalitetsproblemer, illustrerer afhandlingen, hvordan selve bæredygtigheden af den pragmatiske tilgang til grøn markedskonstruktion har ført til debat, og at dette afspejles i forskellige kontroverser i markedskonstruktionsprocessen. De utilsigtede kvalitetsproblemer truer på paradoksal vis med at destabilisere Kinas spirende vindmarked. Dette skyldes blandt andet, at kvalitetsproblemerne truer med at skade vindkraftens ’framing’ som en bæredygtig vedvarende energikilde i overensstemmelse med et kinesisk udviklingsperspektiv. Dette hænger sammen med, at bæredygtighed i en kinesisk kontekst bliver koblet til såkaldt Videnskabelig Udvikling (*Scientific Development*), der lægger stor vægt på muligheden for industriel opgradering og udvikling af indenlandske innovationsevner – særligt inden for kerneteknologier. Eftersom det kinesiske vindmarked står overfor en kvalitetskrise, som blandt andet ses i det store antal vindparker, der leverer langt under den forventelige mængde elektricitet, samt i den store mængde tabt vindkraft på grund af mange og forskelligartede udfordringer med tilkoblingen til elnettet, er framingen af vindkraft som eksempelvis teknisk, videnskabeligt, økonomisk, miljømæssigt samt politisk og udviklingsmæssigt bæredygtig blevet destabiliseret. Udover at dette truer med at destabilisere det kinesiske vindmarked, betyder det også, at der er stigende grad af bekymring over, at kvalitetskrisen påvirker vindkraftens generelle rygte på globalt plan. Da Kina ser ud til at risikere at ’kæmpe mod dets egne vindmøller’ i jagten på hurtig catch-up, er afhandlingen interesseret i at undersøge den nuværende kamp for at frame vindkraft som bæredygtig i Kina. Afhandlingen argumenterer for, at den kinesiske ’grønne markedskonstruktionspragmatisme’, som på mange måder har været med til at afføde en kvalitetskrise, samtidig også er det, der potentielt muliggør et fleksibelt skifte til kvalitet i kinesisk vindkraft. På samme tid åbner det mulige kvalitetsskifte op for et anfægtet 'hybridrum' karakteriseret ved simultant samarbejde og konkurrence mellem kinesiske og udenlandske aktører.

Ved at undersøge den partikulære måde at skabe et vindmarked på i Kina leverer afhandlingen også et bidrag til litteraturen vedrørende globale innovationsnetværk (*global innovation networks* (GINs)) indenfor økonomisk geografi. I forbindelse med kvalitetskrisen bliver særlige kerneteknologier i vindmøllen, såsom software-programmer i kontrolsystemer, simuleringsprogrammer og prognoseværktøjer, konstitueret som særligt kritiske for at kunne rekvalificere vindkraft som bæredygtig. Da Kinas vindmarked i høj grad er blevet etableret på grundlag af teknologi-sourcing og køb af udenlandske teknologi-licenser, er mange kinesiske vindmølleproducenter afhængige af udenlandske kerneteknologier og software til trods for, at de har opgraderet med meget stor hastighed i takt med en eksplosiv vækst i det kinesiske vindmarked. Mens kinesiske aktører arbejder sig hen mod at blive uafhængige af udenlandske teknologier og mod at udvikle egne indenlandske innovationsfærdigheder i overensstemmelse med doktrinen om Videnskabelig Udvikling, er de stadigt aktivt engagerede i teknologi-sourcing og samarbejder med udenlandske leverandører. Strategien om at tilegne sig udenlandsk viden og teknologi – som led i Kinas opgradering – forfølges blandt andet igennem en gradvis geografisk spredning af Forsknings- og Udviklingsaktiviteter (FoU), ansættelse af udenlandske eksperter, fælles designaftaler samt fusioner og overtagelser. Mens tidligere litteraturstrømninger vedrørende globale værdikæder og globale produktionsnetværk indenfor økonomisk geografi (f.eks. Gereffi 1994a; 1994b; Bair, 2005; Gereffi et al., 2005; Gibbon og Ponte, 2008; Ponte, 2009; Dicken et al., 2001; Coe et al., 2008a; Hess og Yeung, 2006) har forsøgt at forklare den geografiske spredning af produktionsaktiviteter, bruger GIN-litteraturen metaforen om GINs til at forklare en sådan global spredning af FoU- og innovationsaktiviteter (f.eks. Ernst, 2006; 2008; INGINEUS, 2011; Cooke, 2012; Parrilli et al., 2013; Barnard og Chaminade, 2012). Ifølge nylige empiriske studier af den kinesiske vindmølleindustri findes der allerede forskellige GINs (Silva og Klagge, 2013) og globale læringsnetværk eller samarbejdsinnovationsnetværk (Lewis, 2013; Chen et al., 2014) i den kinesiske vindmølleindustri, hvilket ses i form af kinesiske vindmøllefabrikanter, der har engageret sig i globaliserede innovationsaktiviteter på forskellig vis.

Baseret på argumentet om, at integration i GINs, der er centreret om kerneteknologier såsom software, kan ses som en mulig måde at rekvalificere vindkraft som bæredygtig i en udviklingsmæssig forstand, forsøger afhandlingen af undersøge, hvorledes GINs potentielt tager form omkring software, og hvorledes de kan spille en rolle i markedskonstruktionsprocesser. Ved en litteraturgennemgang finder afhandlingen frem til, at GIN-litteraturen - til trods for dets fund af spirende GINs i kinesisk vindkraft – ikke har vist, *hvordan* disse GINs er opstået. Dette argument er baseret på, at GIN-litteraturen ikke undersøger selve den socio-materielle mikro-proces med at skabe relationer, men i stedet har en tendens til at se på GIN-strukturer ’udefra’ og til at identificere fremkomsten af GINs ’efter det er sket’ fremfor at følge deres gradvise konstruktionsproces. Selvom den positivistisk og strukturalistisk orienterede GIN-litteratur har bidraget med værdifuld indsigt i GIN-strukturer og –effekter ved at følge dem som globalt organiserede net af komplekse interaktioner mellem virksomheder og ikke-virksomheder, der er engagerede i innovationsrelateret eller innoverende videnproduktion (Barnard og Chaminade, 2012), sætter GIN-litteraturen ikke fokus på processerne med at skabe og vedligeholde relationerne. Eftersom afhandlingens afsæt er en interesse i, hvorledes GINs vokser frem omkring kerneteknologier såsom software, samt i GIN-dynamikker under den nuværende kvalitetskrise og i den potentielle rolle, som de måtte spille for kvalificeringen af vindkraft som bæredygtig, åbner afhandlingen sig imod en konstruktivistisk optik, som tilbyder et relationelt og processuelt perspektiv. Det vil sige, at afhandlingen argumenterer for, at det er nødvendigt først at ‘se væk’ fra GINs og undlade brugen af GIN-metaforen i markedskonstruktionsanalysen for at kunne åbne ’det (’mikro’-)relationelle’, der udgør en ’sort boks’ (*black box*) i GIN-konstruktionsprocessen, hvilket kan gøre det muligt at følge aspekter af GIN-genese, dynamikker og agens. Med en empirisk erkendelsesinteresse i, *hvordan et kvalitetsskifte potentielt finder sted i kinesisk vindkraft – og at dette potentielt repræsenterer en særlig kinesisk måde at skabe grønne markeder på – samt i, hvordan dette potentielle kvalitetsskifte de- og rekonfigurerer relationer mellem kinesiske og udenlandske aktører omkring software* undersøger afhandlingen *hvorledes et konstruktivistisk perspektiv kan hjælpe med at kvalificere forståelsen af genese, dynamikker og agens i GINs i en udviklingskontekst.*

Afhandlingen tager herved udfordringen om at overvinde de ontologiske og epistemologiske forskelle mellem det konstruktivistiske perspektiv i markedsantropologien og den positivistiske GIN-litteratur op, hvilket afspejles i det ovenfor nævnte dobbelte forskningsspørgsmål. Denne kobling muliggøres igennem det, afhandlingen kalder en ’pragmatisk tunnel’. På den ene side har det konstruktiviske perspektiv (f.eks Latour, 2005a; Muniesa, 2013; Law, 1994) eksplicitte rødder i amerikansk pragmatisk filosofi og dennes mikro-relationelle og –processuelle perspektiv (f.eks. Dewey, 1927; Whitehead, 1978; Elias, 1978; Mead, 1934). På den anden side er GIN-litteraturen funderet i bl.a. økonomisk geografi, hvor nogle strømninger har åbnet op for et mere relationelt og endda til tider konstruktivisk perspektiv. På denne baggrund argumenterer afhandlingen for, at en krydsbefrugtning mellem det konstruktivistiske perspektiv og GIN-litteraturen er muligt igennem en pragmatisk kobling og den delvist fælles voksende interesse i ’det relationelle’. Med en ambition om en krydsbefrugtning mellem perspektiver udvikler afhandlingen en situationelt specifik og empirisk funderet (’grounded’) teoretisk og metodisk ramme, der er baseret på strømninger indenfor den konstruktivistiske Science and Technology Studies (STS)-litteratur. Afhandlingen bygger således primært på aktør-netværksteorien (f.eks. Callon, 1986a; 1998; Law, 1994; Latour, 2005a; 2005b), markedsantropologien og dets performativitetsprogram og valueringspragmatisme (*pragmatics of valuation*) (Callon og Çalişkan, 2009; 2010a; 2010b), såvel som på en associations-sociologi (*sociology of associations*) (Latour, 2005a).

Det specifikke netværksbegreb, som afhandlingen benytter sig af for at kunne ‘se væk fra’ GINs, er begrebet Techno-Economic Networks (TENs), der er lånt fra Callon (1998) og er blevet tilpasset afhandlingens specifikke undersøgelsesfelt. Afhandlingen behandler den nuværende kvalitetskrise i kinesisk vindkraft som en kvalificeringskamp, og i den forbindelse dykker den ned i en række overlappende og sammenflettede TENs og de relaterede processer med at ’frame’ vindkraft og nogle af de potentielle magtkampe, som sådanne framing-forsøg kan skabe i samarbejdsrelationer omkring kerneteknologien software. For at undersøge disse magtkampe trækker afhandlingen også på den konstruktivistiske og etnografisk inspirerede metode ’kontroverskortlægning’ (’*Mapping Controversies*’) (Latour, 2005a; Yaneva, 2012; Venturini, 2009). Til gennemførsel af en kontroverskortlægning inden for markedsskabelsen af vindkraft i Kina er afhandlingen baseret empirisk på omfattende og gentagne feltstudier i Kina (såvel som i Danmark og Tyskland) i perioden september 2011 til september 2013 (i alt 95 interviews).

På denne baggrund giver afhandlingen først en historisk redegørelse for et tvetydigt skifte fra et fokus på kvantitet til kvalitet i kinesisk vindkraft i de kinesiske politiske prioriteringer og politikker, hvilket – som tidligere nævnt – positionerer opgradering og udvikling af indenlandske innovationsfærdigheder indenfor software som værende af kritisk betydning. Afhandlingen kortlægger fire kontroverser i forsøget på nærmere at undersøge det, der ser ud som tvetydige transformationsstendenser i kinesisk vindkraft, samt for at se nærmere på, hvordan disse forandringer eventuelt medfører en de- og rekonfigurering af relationerme mellem kinesiske og udenlandske aktører omkring software. Først kortlægges to kontroverser i framingen af vindkraft som bæredygtig over henholdsvis intellektuelle ejendomsrettigheder og standarder. Disse to studier zoomer ind på kinesisk-udenlandske samarbejdsrelationer omkring kontrolsystemteknologier for optimeringen af vindmøllens regulering samt omkring simulationsværktøjer for optimeringen og certificeringen af vindmølledesigns. De to studier illustrerer nogle af de myriader af magtkampe, som finder sted omkring software-algoritmer i disse software-værktøjer, blandt andet fordi disse ofte er 'black-boxed'. For at kunne give en dybere og mere situational forståelse af de to kontroverser omkring kontrolsystemteknologier og simulationsværktøjer undersøger afhandlingen også to kontroverser, der udfolder sig over penge samt omkostnings- og prisudregninger. Disse kontroverser er sammenflettet med andre kontroverser over det, der bliver kaldt et kinesisk 'system-problem' centreret omkring kinesiske statsejede aktører, samt en kontrovers over bæredygtigheden af det, der ser ud som en kinesisk eksperimenterende og fragmenteret måde at skabe nye markeder på.

Afhandlingen konkluderer, at kun ved at 'se væk' fra GINs bliver det muligt at 'se dem' og indfange deres progressive socio-materielle konstruktion, deres dynamikker og deres agens. Mens GIN-litteraturen allerede har konkluderet, at der eksisterer GINs i den kinesiske vindmølleindustri, viser afhandlingen, at når man 'dykker dybere', og når man kigger på en enkelt kerneteknologi som software, er der ingen GIN(s) at finde. I stedet bliver teknologi og viden snarere kommodificeret, det vil sige gjort til en vare, hvilket efterlader software som en del af værdikæden. Samtidigt er der dog tegn på GIN-emergens i takt med at kinesiske aktørers færdigheder hurtigt bliver forbedret. Men dette sker ikke uden kontinuerlige magtkampe. Afhandlingen argumenterer for, at samarbejdsrelationernes stærkt flygtige karakter, hvor relationerne ser ud til at blive brudt op, næsten før de er blevet etableret, har karaktertræk tilfælles med såkaldte ’vedvarende betingede relationer’ (Herrigel, 2010), hvilket skyldes den høje grad af rolletvetydighed, som kontinuerligt destabiliserer relationerne og nødvendiggør vedvarende vedligeholdelsesarbejde. Denne grad af ustabilitet kan desuden forstås ud fra den måde, hvorpå kinesiske aktørers ambitioner og agendaer også skifter, efterhånden som kinesiske aktører ’famler sig frem’ i opbygningen af et marked, samtidigt med at de forbedrer deres færdigheder. Desuden forsøger kinesiske aktører at blive en del af GINs for at kunne forbedre egne evner til opgradering, mens de samtidig forfølger målet om indenlandsk innovation. Denne tvetydighed medfører, at kinesiske aktører på sin vis søger videre end GINs, for at blive autonome og uafhængige af udenlandske teknologier. Mens dette gør kinesisk-udenlandske samarbejder i det kinesiske vindmarked meget flygtige, peger afhandlingen også på, at det potentielle kvalitetsskifte kan transformere det primært konkurrenceprægede rum (’*space*’) til et mere samarbejdsorienteret rum.

Afhandlingen kommer afslutningsvist med en række bidrag til litteraturen. Først og fremmest bidrager den til GIN-litteraturen ved at anvende et konstruktivistisk markedskonstruktionsperspektiv. Overordnet åbner dette perspektiv for en belysning af genese, dynamikker og agens i forbindelse med GIN-emergens. Perspektivet giver indblik i nogle af de kontroverser, eksklusionsmekanismer og magtkampe, som GIN-konstruktion kan forårsage, samt i de mange menneskelige og ikke-menneskelige aktører, som disse processer involverer. Afhandlingen illustrerer desuden, hvorledes GINs og – blandt andre ting også software-algoritmer – kan virke forstyrrende (såvel som fremmende) for markedskonstruktionsprocesserne. Afhandlingen har gjort dette ved at ’se væk’ fra GIN-metaforen og ved at rekonceptualisere GINs, dvs. ved at behandle dem som en del af markedskonstruktionsprocesserne. GIN-begrebet bliver således rekonceptualiseret ved at splitte vindmøllen ad i dets komponenter og ved at zoome ind på den socio-materielle konstruktion af relationer omkring en specifik kernekomponent. Herved er afhandlingen blevet i stand til at påvise, hvordan der blandt andet findes socio-materiel modstand mod adgang til algoritmer, samt hvordan dette har skabt en intens magtkamp og anledning til utallige bekymringer blandt kinesiske aktører om blandt andet indenlandsk innovation, leapfrogging og catch-up, samt bekymringer blandt vestlige aktører om, hvordan man bedst håndterer relationer til kinesiske partnere samtidig med, at ens kernekompetencer og markedsandel søges bevaret. Afhandlingen anbefaler, at fremtidige GIN-studier undersøger GINs ved at 'dykke dybere', eksempelvis igennem etnografiske studier og ved forfølge processen med at etablere relationer omkring specifikke komponenter.

For det andet viser afhandlingen en høj grad af kreativ og agil kinesisk eksperimentering i markedskonstruktionen af vindkraft, som muliggør 'forstyrrende' brud i opgradering og i governance-relationer. Studiet bidrager til en forståelse af de potentielt multiple mulige former for markedskonstruktion, der findes. Afhandlingen udvider herved også markedskonstruktionsperspektivet og bidrager med at kortlægge en særligt kinesisk måde at skabe markeder på i Kina, hvilket er muliggjort ved at krydsbefrugte GIN-litteraturen med det konstruktivistiske perspektiv via en pragmatisk tunnel.

For det tredje, ved at sikre en dybere forståelse af de forstyrrende dynamikker i markedskonstruktionen og den kontinuerlige de- og rekonfigurering af relationer mellem kinesiske og udenlandske aktører diskuterer afhandlingen også Elias' (1978) pragmatiske figurationssociologi. Her demonstreres det, at et gradvist skifte er ved at indfinde sig fra *figuration I* til *figuration II,* nemlig fra et fokus på hastig vækst og lave produktionsomkostninger og installeret kapacitet til kvalitet og genereret elektricitet. I dette skifte henimod *figuration II* indfinder der sig et nyt strategisk og mere komplekst spil mellem kinesiske og udenlandske aktører, hvor samarbejds- og konkurrencedynamikkerne både sameksisterer og kolliderer. I de paradoksale relationer i *figuration II*, der er præget af både konkurrence- og samarbejdsdynamikker, er software-programmer kommet i magtkampens centrum.

Til sidst bidrager afhandlingen også til en række andre litteraturstrømninger, herunder blandt andet Kina-studier, relaterede litteraturer vedrørende Kinas specifikke 'variety of capitalism(s), opgradering og governance-litteraturerne samt til perspektiver på industriudvikling og kinesiske udsigter til innovativ fremstillingsvirksomhed. Efter at have vist, hvordan det strukturalistiske perspektiv på GINs og det konstruktivistiske markedsantropologiske perspektiv kan krydsbefrugte hinanden igennem en pragmatisk tunnel fremlægger afhandlingen et forslag til en ny forskningsagenda for Ny Økonomisk Sociologi (*New Economic Sociology*) for at kunne undersøge konstruktionen af GINs og markeder i en udviklingskontekst. Selvom der er grænser for mulighederne for at generalisere fra det indeværende forskningsfokus til andre lande og industrier, indikerer afhandlingen, at resultaterne om markedskonstruktion ikke detso mindre også kan relateres til andre strategiske, evt. grønne, industrier i Kina.

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List of Abbreviations

5YP	Five-Year-Plan
5YP S&T Wind Power (2012*)	Five-Year-Plan for the Scientific and Technological Development of Wind Power (2012*)
AMSC	American Superconductor Corporation
ANT	Actor-Network Theory
AoM	Anthropology of Markets
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine of China
BELC	Business Ecosystem Lifecycle-model
CAS	Chinese Academy of Sciences
CASTED	Chinese Academy of Science and Technology for Development
CCC	China Compulsory Certification
Ch.	Chapter
CME	Coordinated Market Economy
CNAS	China National Accreditation Service for Conformity Assessment
CNCA	China National Certification and Accreditation Administration/ Certification and Accreditation Administration of China
CPC (CCP)	Communist Party of China (Chinese Communist Party)
CEPRI	Chinese Electrical Power Research Institute
CGC	China General Certification
CNREC	China's National Renewable Energy Centre
CREIA	China Renewable Energy Industry Association
CRESP	China Renewable Energy Scale up Programme
CWEA	China Wind Energy Association
CWEEA	Chinese Wind Energy Equipment Association
DNV	Det Norske Veritas (now merged into DNV GL)
DNV GL	Det Norske Veritas Germanischer Lloyd
DRC	Development and Reform Commission
DTU	Technical University of Denmark/Risø
EU	European Union
FBI	Federal Bureau of Intelligence
FDI	Foreign Direct Investment

FIT	Feed-in Tariff
GATT	General Agreement on Tariffs and Trade
GCC	Global Commodity Chain
GDP	Gross Domestic Product
GH	Garrad Hassan (now merged into DNV GL)
GL	Germaninischer Lloyd (now merged into DNV GL)
GIN	Global Innovation Network
GPN	Global Production Network
GVC	Global Value Chain
GW	Gigawatt
GWEC	Global Wind Energy Council
GWh	Gigawatt per hour
HDD	Hard-Disk-Drive
ICT	Information and Communication Technologies
IEC	International Electro-Technical Commission
Int.	Interview
IPRs	Intellectual Property (Rights)
kWh	Kilowatt per hour
LAC	Loads, Aerodynamics, Control
LME	Liberal Market Economy
LoRD	Local and Regional Development
LVRT	Low-Voltage-Ride-Through
M&A	Mergers and Acquisitions
MIIT	Ministry of Industry and Information Technology of the People's Republic of China
MLP RE (2007)	Medium and Long Term Development Plan for Renewable Energies (2007)
MMS	Mandatory Market Share
MLP S&T	15-year National Plan for the Development of Science and Technology in the Medium and Long Term (2006-2020)
MMS	Mandatory Market Shares
MNC	Multinational Corporation
MOST	Ministry of Science and Technology
mSTA	Market Socio-Technical Agencement
MW	Megawatt
MWh	Megawatt per hour

NDA	Non-Disclosure Agreement
NEA	National Energy Administration
NES	New Economic Sociology
NDRC	National Development and Reform Commission
NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
OPP	Obligatory Passage Point
PLA	People’s Liberation Army
PLC	Programmable Logic Controller
PPA	Power Purchase Agreement
PRC	People’s Republic of China
REC	Renewable Energy Credit
RED	Sino-Danish Renewable Energy Development Programme
REL (2005)	Renewable Energy Law (2005)
RIS	Regional Innovation System
R&D	Research & Development
S&T	Science & Technology
SAC	The Standard Administration of China / Standardisation Administration of China
SASAC	State Owned Assets Supervision and Administration Commission of the People’s Republic of China
SCADA	Supervisory, Control, and Data Acquisition
SDC	Sino-Danish University Centre for Research and Education
SME	Small-and-Medium-Sized Enterprise
SOE	State-Owned Enterprise
STA	Socio-Technical Agencement
STS	Science and Technology Studies
TBT	Technical Barriers to Trade agreement (WTO)
TEN	Techno-Economic Network
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
US	United States
VoC	Varieties of Capitalism
WED	Sino-Danish Wind Energy Development Programme
WIPO	World Intellectual Property Organisation
WTM	Wind Turbine Manufacturer
WTO	World Trade Organisation

PART I: Introduction and Positioning the Inquiry

We have struggled our ways in different directions for quite a while, surrounded by thousands of people and Chinese kites in the air, before we finally manage to spot each other – the only other Western-looking person here around the Olympic Park metro-station in Beijing. The meeting has been set up at short notice, a couple of days after the China Wind Power Conference, which is held every year in Beijing in grandiose settings at the outskirts of Beijing. During the conference this year, I had wandered around for several days along the booths, approaching and talking with dozens of people – European and Chinese wind turbine manufacturers, component suppliers, consultants, diplomats, researchers, experts, and everything in-between. The hard work of introducing myself and my research has resulted in dozens of business cards in return for mine. While I had already written an introductory email to some of the people I have met in order to set up interviews, I had not yet reached this particular person on my endless contact list. However, he had now written me, keen to follow up on the brief talk we managed to have at the conference. It turns out that he is interested in learning more about my research.

With a tightly packed schedule before I return to Denmark, we set up the meeting right away. I live near the Olympic City, which is known for somewhat brighter skies compared to the heavily smogged centre of Beijing, and as I am familiar with the area I take us to my favourite work café. After having been served our coffee, we find a quiet, dark spot in the back of the room and sit down to talk. I turn on the recorder and for more than two hours the talk almost takes off by itself. Although strangers, we have several things in common. Apart from being the only Westerners, we are both – me as a researcher and he as a control system supplier in the wind power field – struggling to understand exactly the same thing: How to understand the ’Chinese spiderweb’ that seems to constitute the Chinese wind power market, and how to deal with the complex relations between Chinese and foreign actors. Talking for a couple of hours, all the bricks in the puzzle begin to fall into their proper places. What he tells me is an intriguingly complex story of the challenges of trying to manage the thick mesh of the Chinese ’spiderweb’. In this story, software algorithms of the main control seem to take centre-stage, as they are seen as critical in ensuring the quality of the turbine, its reliability, and performance. Functioning as the ’spine’ of the wind turbine, the ’core algorithm’, positioned at the bottom of all the different source codes, binds together all information from the different components to regulate the wind turbine in the most efficient and safe way. However, while being critical to the upgrading of Chinese wind power, which has stumbled upon a severe quality crisis in recent years, these software codes are being ”locked, sealed, and protected in every possible and impossible way”. While the Chinese customers ”try in every possible manner” to get access to these codes, none have succeeded yet. Yet, if or when they do, “then the rest of us have to quit, I’m sure”, he says. Biking home to my flat from the café, I sense that the talk has set a direction for my journey through the algorithmic rhizome of the Chinese wind power market and the relations between Chinese and Western actors.

And so the journey begins…

Chapter 1. Emergence or Collapse of China's Wind Power Market?

In less than a decade, the global wind power market has undergone a remarkable shift in geographical locus. Whereas Europe (in particular Denmark and Germany) and the US since the 1970s and 1980s represented the geographical locus of the global wind energy market (Karnøe and Garud, 2012), today China is the "world's clean energy leader", leading the global "Clean Energy Race" (PEW, 2012: 14). As the Chinese wind power market has experienced a "velocity of capacity development never before witnessed" (Korsnes, 2014: 176), China now constitutes a leading wind turbine player (Chen et al., 2014: 264). In less than a decade, China's wind power market has grown from almost nothing, with 0.8 Gigawatt (GW) installed capacity in 2004, to constitute the world's biggest market (in terms of annual capacity installations/GW) in 2014, when China's total accumulative installed capacity reached 91 GW (GWEC, 2014)[1]. Hereby, it has taken China

"less than ten years to go from having no turbine manufacturing experience to having the ability to manufacture complete, state-of-the-art wind turbine systems that are either already available or soon to be available on the global market" (Lewis, 2013: 166).

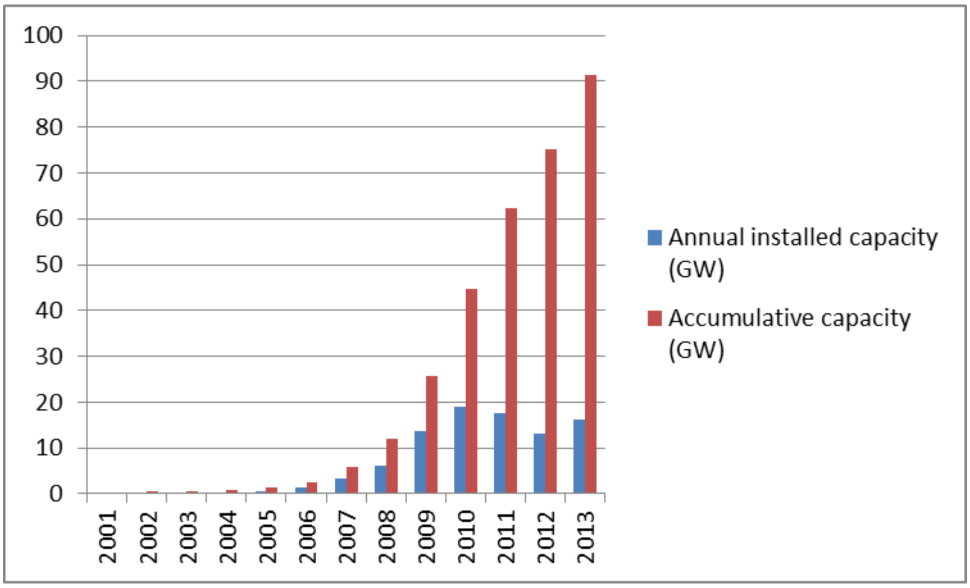
The rapid growth of China's wind power market in the last decade can to a large extent be explained by a comprehensive, supportive Chinese policy framework for clean energy and related technologies, and specifically for wind power, in particular since 2005 (Lewis, 2013: 23). Facing issues of power shortage, environmental degradation, and holding the position as the global number one emitter of CO_2 (e.g. Cherni and Kentish, 2007; Li, 2010; Liao et al., 2010; Yu et al., 2009; Liu and Kokko, 2010), the Chinese Government "has made the commitment that by 2020 non-fossil energy will account for 15 percent of its total primary energy consumption" (Energy Policy 2012, II. Policies and Goals of Energy Development). China's policy framework on renewable energies has been introduced in accordance with the overall aim of the Chinese political leadership of constructing a so-called *'Harmonious Socialist Society'* (*shehui zhuyi hexie shehui*) (社会主义和谐社会) (Fan, 2006), which primarily is to be reached through the "portmanteau term of 'scientific developmentalism' (*kexue fazhanguan*)" (科学发展观) (Naughton, 2011). In turn, Scientific Development is to be achieved in large part by the construction of indigenous ('home-grown') innovation capabilities within core technologies (Fan, 2006: 709-717; Christensen, 2013).

[1] For list of abbreviations, please refer to pages 39-41.

The current consolidation phase – materialisation of a quality crisis after the golden period

After a 'golden growth period' in the years from 2006 till 2010 and following nearly a decade of explosive growth in China's wind power market, however, a slowdown and consolidation phase came around the year 2011 (GWEC, 2014; Korsnes, 2014; REN 2013: 49, IEA, Oct. 14, 2010). In addition, despite the impressive numbers in installed capacity, wind power, still, only makes up a minor proportion of China's total electricity output and consumption (GWEC, 2013: 18). This is claimed to reflect China's 'schizophrenic energy revolution', in which coal is still reigning (International Business Times, 2014). Nevertheless, despite the consolidation, by 2013, China again represented the largest wind power market in the world, and growth rates were rising (Børsen, Sep. 10, 2014a; GlobalData, Jun. 10, 2014). In *figure 1* below, the development in accumulative capacity and annual installed capacity (GW) is depicted for the period 2001 to 2013.

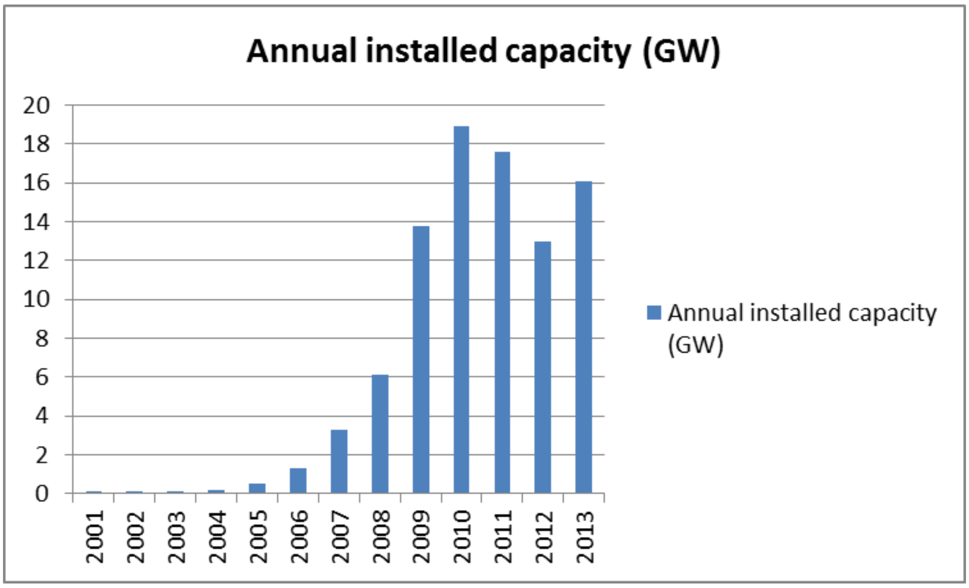
Figure 1: Annual installed capacity and accumulative capacity



Source: GWEC 2014: 43.

If zooming in on annual installed capacity, it becomes visible that these have been marked by slowdown and fluctuations since 2010, as illustrated in *figure 2*.

Figure 2: Annual installed capacity (GW) 2001-2013



Source: Calculations based on figures of accumulated installed capacity, GWEC 2014.

As growth in annual installed capacity seems to have started to pick up again in 2013, some industry reports argue that the consolidation phase in China's wind power market, which began after the peak year of 2010, is over (GWEC, 2014). Yet, the consolidation phase has not only initiated a shake-out process amongst wind turbine manufacturers (WTMs) and component suppliers in the Chinese wind turbine industry (EnergiWatch, Jun. 10, 2013), but has also revealed deeper quality issues (Interviews; Korsnes, 2014; China Wind Power Conference, 2013; Klagge et al., 2012; Silva and Klagge, 2013; Bloomberg/Bizweek, Mar. 15, 2012)[2]. Whereas China is able to "engineer wind turbines that cost as little as 75 per cent of the least expensive models offered by their foreign competitors" (Nahm and Steinfeld, 2012: 14), China's Central Government's "preference of industry creation, and hence quantity before quality" (Korsnes, 2014: 192) has resulted in

"massive quality problems. Massive grid break downs. Enormous problems. And you see that because you have been installing gigawatt by gigawatt of very poor quality. […] Without any of the key things you need to make a sustainable market...That's the direct consequence of that policy" (Interview 1 (hereafter, Int. 1)).

[2] Part of the slowdown can of course also be linked to the global recession following the financial crisis in 2007/2008, as well as a lack of efficiency in China's fund for renewable energies and the competition with coal prices (Ecobusiness.com, Jan. 22, 2014).

With a focus on the lowest price bids for wind farm concession projects (interviews; Korsnes, 2014), on upfront investments in turbines, and on installation of GW capacity, rather than focusing on generated electricity through gigawatt per hour (GWh), the quality of wind turbines and the grid system in general, has suffered severely (Korsnes, 2014; Bloomberg/Bizweek, Mar. 15, 2012). Consequently, already

"[b]y late 2010 there were visible flaws in China's wind power industry. The first was the production quality of the turbines. Since the government planners demanded quantity, and not performance, wind farm developers tended to cut corners. Thousands of China's turbines lack the more expensive technology that keeps them operating when there is a disturbance on the power grid" (Bloomberg/Bizweek, Mar. 15, 2012).

The resulting unstable power output from wind turbines and wind farms, i.a. due to poor quality, lack of certification, control system technologies, and forecasting tools, in combination with China's weak electrical grid infrastructure, has resulted in vast amounts of potential wind power being wasted. That is, between one fourth and one third of installed wind power is reported to be disconnected from the electrical grid (interviews; Lewis, 2013; Bloomberg, 2012; Klagge et al., 2012). This reflects existing challenges associated with integrating large amounts of wind power rapidly into a poor quality power system (Lewis, 2013: 186). Further, rapid integration of wind power of a relatively poor quality has created resistance against wind power amongst various actors (e.g. grid companies), as wind power threatens grid stability. Overall, quality issues are increasingly claimed to threaten the global reputation of Chinese wind turbines as well as of wind power in general (Interviews). Indeed, realising a 'sustainable transition' to meet environmental concerns in China still seems far ahead.

The role of critical core components for quality and the role of software

To solve what the thesis frames as the 'quality crisis' in Chinese wind power, certain component technologies have become constituted as particularly 'critical'. For instance, software tools in a wind turbine's various control system technologies, as well as in simulation tools for testing, documenting, and certifying new turbine designs, are being constituted as 'core' for developing high-performing, reliable, and intelligent wind turbines and for ensuring a stable output from wind farms. First of all, the wind turbine's main control system (henceforth 'main control', unless otherwise noted) – including both hardware and software – helps to ensure the systemic interaction of the thousands of components that constitute a wind turbine. That is, the main control regulates the communication between the various sub-control systems, which in turn regulate different turbine components. As what, by some, is coined the 'spine' and 'central nervous system' of the wind turbine, the main control's software part contains a core algorithm, which ensures the optimal regulation and systemic interaction of the wind wind turbine's thousands of components (Interviews). Second, aeroelastic software codes in simulation tools play a critical role for the standardisation and certification of new and adapted wind turbine designs. Acknowledging the strategic importance of advanced technologies such as software programmes, the development of capabilities for developing such critical software tools has become a strategic priority of the Chinese Government's development plans for achieving the 'Scientific and Technological Development' of the Chinese wind power market (12th Five-Year Plan for the Scientific and Technological Development of Wind Power, 2012) (hereafter, 5YP S&T Wind Power, 2012*) (asterix marking that the plan is in Chinese).

As a relative latecomer in wind power, the development of China's wind turbine industry has been based largely on foreign technology licenses, financial and technical support from donors, engagement in joint ventures with foreign companies, imitation, reverse engineering and backward design, as well as on technical assistance by foreign consultants (Lewis, 2007; Lema et al., 2013; Kristinsson and Rao, 2008; Lewis, 2013; Nahm and Steinfeld, 2013/forthcoming; Chen et al., 2014; Silva and Klagge, 2013; Klagge et al., 2012). These strategic knowledge- and technology-seeking investments resemble an upgrading strategy of so-called *linkage-leverage-and-learning,* which is typical of multinational companies (MNCs) from newly industrialised countries (Mathews, 2002; 2006). While Chinese WTMs and component suppliers have developed manufacturing capabilities with tremendous speed from such technology- and technology seeking investments, it is widely acknowledged that in terms of the most advanced core technologies and indigenous wind turbine design, China is still dependent on technology transfer from foreign (i.e. Western) firms. As regards software programmes, for instance, these are still largely acquired from foreign companies on the basis of technology licenses (Interviews; Lewis, 2013). As core algorithms of software tools are locked by foreign companies as a matter of intellectual property (IP) protection, there is increasing Chinese concern that there may be barriers to China's strategy of reverse engineering and upgrading (Interviews). For instance, without capabilities of developing advanced, indigenous simulation tools, there might be limits to the international certification of new Chinese turbine designs. Overall, while China's wind power industry has made impressive progress in terms of wind turbine manufacturing and installments, it is confronted with various challenges and problems regarding the development of indigenous innovation capabilities (Klagge et al., 2012).

Emerging global innovation networks (GINs) in China's wind power industry?

Facing severe quality issues, or what the thesis, as mentioned, frames as a 'quality crisis', and so far not having created the necessary environment for catching up with global technology leaders (Silva and Klagge, 2013: 1353), conventional technology transfer such as licensing agreements may turn out to have self-undermining effects. That is, positive outcomes of a linkage-leverage-learning strategy (Mathews, 2002; 2006) are not automatic. Accordingly, Chinese WTMs have realised that "it is necessary to link [its] own resources more closely with external knowledge and innovation capacities" (Stamm and Altenburg, 2007 and Altenburg et al., 2008 in Silva and Klagge, 2013: 1351), not only through conventional technology transfer, but by engaging in codevelopment and learning and innovation networks with foreign partners (Interviews). Accordingly, China's leading WTMs have recently been claimed to have embarked on a new approach, which fits into the general trend of globalising knowledge production through the development of so-called global innovation networks (Silva and Klagge, 2013: 1353). That is,

"[w]hile global production networks [GPNs] have been a common feature in various industries including the wind industry, the internationalization of R&D [Research & Development] and specifically the emergence of global innovation networks [GINs] is a more recent trend" (Silva and Klagge, 2013: 1351).

Such global innovation networks have in the economic geography literature recently been abbreviated into and dubbed 'GINs' (e.g. Ernst, 2006; 2008; INGINEUS, 2011; Cooke, 2012; Parrilli et al., 2013; Barnard and Chaminade, 2012). GINs denote "*[a] globally organized web of complex interactions between firms and non-firm organizations engaged in knowledge production related to and resulting in innovation*" (Chaminade (2009) in Barnard and Chaminade, 2012: 2-3). Such 'GINs' within Chinese wind power, or what other scholars have more or less interchangeably dubbed international networks for learning and innovation (Lewis, 2013) and collaborative innovation networks (Chen et al., 2014), are claimed to play a rarely examined but crucial role in the development of China's wind industry (Lewis, 2013: 3).

Chinese navigational skills – and the debated sustainability of China's growth path

The volatile development of China's wind power market – and the potential emergence of GINs – has been marked by the Chinese Government's "policy flexibility and institutional adaptability" (Korsnes, 2014: 175). For instance, as the Chinese wind power market undergoes its quality crisis, the Chinese Government has gradually centralised approvals of new wind farms in order to slow down and coordinate growth and raise focus on quality

(Korsnes, 2014: 196). Further, higher standards have gradually been introduced in order to raise quality (Lewis, 2013; Korsnes, 2014; Børsen, Sep. 19, 2014b; Børsen, Oct. 20, 2014; Børsen, Oct., 21, 2014). This is claimed to reflect specific ”navigational skills” (Korsnes, 2014: 196) of the Chinese State and an “impressive ingenuity in nurturing new industries”, as challenges emerge (Korsnes, 2014: 195).

While rapid growth and a focus on price competitiveness has produced unforeseen effects, or so-called ‘externalities’ (Coase, 1960; 1988; also in Callon 1998), i.a. in terms quality issues and spilled wind, China is often argued to have achieved its competitive advantage by combining three variables, namely those of tempo, production volume, and cost (Nahm and Steinfeld, 2013/forthcoming; Lema et al., 2013: 65). This is deemed to constitute a unique competitive challenge for the developed West (Breznitz and Murphree, n.d.: 29), since

”China’s industries are not competing with Western ones to lead at the cusp of novel-product innovation. Rather they are competing by successfully mastering all other stages of innovation and production. In so doing, although the largest shares of profits continue to be reaped overseas, the Chinese gain greater broad-based employment and economic growth. They also gain an intimate understanding of a wide variety of technologies, exactly the sort of understanding necessary for an eventual leap into ’higher’ forms of innovation. Thus the China challenge is whether or not the modern economic model in the developed West which relies on specialization at only the top of the innovation pyramid is sustainable when the remainder of the pyramid, with its skills and jobs has moved elsewhere” (Breznitz and Murphree, n.d.: 29-30).

The ability of China to emerge as, what some term, a ‘scale-up nation’ (Nahm and Steinfeld, 2012; 2013/forthcoming) is linked to today’s general global decomposition of production activities, which has led to increased modularisation and specialisation (Breznitz and Murphree, 2011; 2013; Lema et al., 2013). Currently, there is much debate amongst commentators as to the long-term sustainability of this Chinese scale up strategy. In terms of wind power, scholars are debating ”[w]hether the ability to sell turbines at competitive prices in the Chinese market requires quality shortcuts that will affect their long-term reliability” (Nahm and Steinfeld, 2012: 14). Overall, some scholars argue that China “is doomed to remain mostly an assembler and processor of foreign technologies, forever trapped in lowest value-added activities” (Steinfeld, 2004 in Breznitz and Murphree, 2011: 18). Conversely, others are more optimistic in regard to China’s development, arguing that the global decomposition of production can induce *innovative manufacturing* (Nahm and Steinfeld, 2012; 2013/forthcoming; Herrigel et al., 2013). Together, while many agree that China’s economic ’miracle’ is significantly transforming the global economy, there is uncertainty over its long-term sustainability (Breznitz and Murphree, 2011; 2013) as well as

“uncertainty over innovation. Can China come up with new technologies that create new avenues for green transformation and reduce costs substantially?” (Lema et al., 2013: 65).

While China's strategy of not competing at the cusp of novel-product innovation seems to constitute a competitive challenge for Western companies, Western companies may gradually come to acknowledge that there are prospects for interfirm collaboration all along the global value chain (GVC) for wind power. That is, there may be synergistic, mutual learning potentials for both Chinese and foreign WTMs to "drive down costs, improve quality, and make wind power a more effective energy option for the world" (Lema et al., 2013: 65). Such international collaboration is increasingly important for both Chinese and foreign actors. For China, collaboration to improve quality and make wind power a more effective energy option has become more important than ever, as China's wind power market suffers from a reputation of technical and economical 'unsustainability'. In addition, Western companies can learn from China's ability to lower costs, i.e., from what by some is called China's 'cost out' strategy (Interviews). The space for collaboration may in addition by expanded with the recent introduction of stricter quality standards in China. That is, as 'new winds [of quality] are blowing' in China's wind power market (Børsen, Sep. 19, 2014b), the potential turn to quality in China's wind power market is predicted to ease business in China for Western WTMs, such as the Danish WTM, Vestas, which compete on quality and innovation rather than low prices (Børsen, Oct. 20, 2014; Børsen, Oct., 21, 2014). However, such collaboration in the midst of a competitive game may not be simple, but may engender paradoxes, conflict, and controversy.

Introducing the dual research question of the thesis – a 'fight against windmills'?

Interested in the potential turn to quality, taking place within China's wind power market in order to qualify wind power as a technically and economically viable and sustainable renewable energy source to overcome the current quality crisis, the thesis inquires into the potentially unique Chinese mode of constructing 'green' markets[3] as a matter of qualification. Whether the ambiguous winds of change, which seem to blow over China's wind power market, will transform the Chinese wind power market, and result in an actual shift in focus from price and quantity towards quality, remains to be seen. Rephrasing Cervantes' (1705/1615) famous novel on Don Quixote's vainful 'fight against windmills', the thesis asks rhetorically whether China might be *'fighting against (its own) windmills (wind turbines)'*, or whether the seemingly self-disruptive behaviour may turn out as a creative, pragmatic industrial policy that re-shapes dynamics and governance modes within the global value chain (GVC) for wind power. With an interest in how the ongoing quality

[3] 'Green markets' and 'green market construction' are in the thesis treated as a matter of the establishment of renewable energy markets such as the wind power market, overall reflecting a concern for 'sustainable transition'.

crisis unfolds, in the role of collaborative and competitive relations between Chinese and foreign actors around the core technology of software in the requalification of wind power as sustainable, and in the potential controversies these relations may produce, the thesis, firstly, inquires into an *empirically* motivated research question:

How may a 'turn to quality' in Chinese wind power - reflecting a Chinese mode of green market construction - be de- and reconfiguring relations between Chinese and foreign actors around software?

Interested in the potential requalification of China's wind power market, and interested in whether and how collaborative relations between Chinese and foreign actors around software take shape in this qualification process, and the potential(ly disruptive) controversies they may produce, the thesis takes its outset in the emerging literature on GINs. In the GIN literature, integration into GINs is claimed to possess a "developmental potential" (Cooke, 2013: 1081). In regard to China's wind power market, integration into GINs is further claimed to constitute a strategy to overcome the technical and quality issues in China's wind industry (Silva and Klagge, 2013: 1351). The thesis is thus concerned with how GIN integration may play a role in the current qualification struggle of China's wind power market, be it in terms of upgrading and/or stabilising or disrupting the market. Hereby, the thesis is interested in how GIN relations are formed between Chinese and foreign actors in the first place, and by whom how they are constituted and maintained. Acknowledging that GINs may constitute both collaborative and competitive forces, the thesis is interested in the quality and dynamics of these relations, and the potential controversies they may produce. For instance, in a developmental context of China, controversies may unfold over access and intellectual property rights (IPRs) to core algorithms, their implications for certification and standardisation, as well as controversies over money and liquidity in a crisis-ridden wind power market as well as over contested and negotiated cost and price calculations. Set into a Chinese context of protectionism of state-owned-enterprises (SOEs), such entangled controversies are likely to engender wider struggles over what constitutes 'sustainable development', and what does not, with myriads of heterogeneous, socio-material actors taking part. Hereby, the thesis inquires into GIN genesis[4], dynamics, and agency in China's wind power market.

[4] The thesis treats genesis and emergence as two sides of the same coin, yet when employing the notion of emergence, emphasis is put on the 'process' of genesis, while the notion of genesis more points to the 'event'.

The existing GIN literature has already provided valuable insights into the existence and structure of GINs (e.g. Cooke, 2013; Ernst, 2006; Barnard and Chaminade, 2012; INGINEUS, 2011; Silva and Klagge, 2013), e.g. within a developmental context of Chinese wind power (Silva and Klagge, 2013). Yet, primarily looking into the 'geography and structure' of GINs (Liu et al., 2014), largely adopting a lens 'from the outside', the thesis finds, in the review of the GIN-literature, that the GIN framework does not possess the tools to inquire into the very microprocesses of relationship-building and –maintenance, into the potentially shifting quality of relations, the potential controversies they may produce, or their potential role in qualifying the markets they coconstitute. Instead, the GIN literature tends to assume GIN existence based on formal structures, i.e., looking at the 'result' of GINs instead of looking at GINs as 'processes' of relationship-building. Risking to miss out on how relations are established, the GIN literature misses the conceptual tools to inquire into issues of genesis. That is, GIN emergence and genesis cannot take place without the establishment of relations; yet, how these relations are built and maintained remains largely obscure in the literature as it does not provide a microprocessual account of 'the relational'. Further, tending to focus on MNCs and their collaboration partners, the innovation system, and the institutional embedding context, the list of potential actors playing a role in GIN construction remains largely limited to humans, embedding institutions, and (innovation) systems, while the potential constructive or disruptive roles and agency of technologies, algorithms, discourses and narratives, grid codes, standards, IPRs, money, cost and price calculations, and other non-humans in the construction of GINs are largely left aside. In order to open the 'black box' of the relational in the dynamic socio-material network*ing* of GINs, the thesis suggests that it is necessary to explore whether another theoretical perspective can help shed light on issues of GIN genesis, dynamics, and agency in a developmental context of China. Due to its inherently 'micro'-relational, processual, and socio-material lens, the thesis therefore proposes an exploration of how a constructivist lens can help shed light on this issue. This sets the foundation for a *theoretically* motivated research question:

As the GIN literature generally does not pay much attention to the question of genesis, dynamics, or agency, how may a constructivist perspective qualify the understanding of GIN genesis, dynamics, and agency in a Chinese developmental context?

The thesis thus aims to explore how and to what extent a constructivist perspective can fill the identified gap in the existing GIN literature on ‘the relational’ and microprocessual, in turn hopefully rendering insight into the potential emergence and dynamics of GINs, and their potential role in the construction of a market for wind power. To do this, the thesis zooms in on the seemingly hidden dynamics of the consolidation phase (around 2011-2013), which has revealed an underlying quality crisis within Chinese wind power, and looks into collaborative relations between Chinese and foreign actors around software technologies. By inquiring into the genesis of GINs, as entangled processes of market construction, the thesis aims at providing an account of *“*how a play comes to be performed, or why this particular story is being staged instead of some other one*”* (Powell et al. 2012: 434), rather than resembling *“*a play that begins with the second act, taking both plot and narrative as an accomplished fact” (Powell et al. 2012: 434).

Structuring the account

To trace the potential genesis of a GIN configuring around software in China’s wind power market, the thesis is structured as follows: First, *Part I* ‘sets the stage’ through the introduction and a critical literature review of the GIN literature and a brief summary of how the GIN literature has emerged from other streams within economic geography. This draws the line for *Part II*, which outlines the theoretical and methodological premises of a constructivist perspective, adapted to look into market construction in China, and concluding with a situational ‘model’ for tracing GIN construction as part and parcel of market construction processes in a developmental context of China (*Chapters 3-5*). In *Part III (Chapters 6-12)*, each chapter of the constructivist analysis constitutes an empirical (and ethnographically inspired) narrative, together forming a story on GIN construction in Chinese wind power. Whilst *Chapters 6, 7, and 8* serve as an historical background for understanding the rapid growth, quality crisis, and role of software programmes for the survival of the industry, *Chapters 9-12* offer more in-depth ‘microprocessual’ accounts, or so-called ‘controversy mappings’, of GIN construction. First, *Chapter 9* provides an in-depth analysis of a controversy unfolding over intellectual property rights (IPRs)[5] in Sino-

[5] The thesis looks into controversies over ‘IPRs’, as a practical matter of concern for protection of Intellectual Property (IP), in particular in terms of software algorithms. The thesis is not as such interested in the legal and/or formal understanding of the term as defined in the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organisation (WTO), but rather as a matter of tracing how relations between actors are de- and reconfigured around the potentially controversial issue of IPRs. In this way, while acknowledging the relevance of the debate, the thesis is not concerned with discussions

foreign collaborations around control system technologies. Second, *Chapter 10* dives into a controversy over international certification and standardisation, configuring around simulation tools. Third, *Chapter 11* dives into a controversy over money (liquidity) and trust, entangled in a so-called Chinese 'system problem' of state-owned enterprises (SOEs) in a highly state-controlled power sector. Last, *Chapter 12* presents a controversy mapping over price and cost calculations in a struggle i.a. between wind power and fossil fuels, which is entangled in a controversy over the sustainability of China's seemingly experimental mode of market construction. The last two controversy mappings (*Chapter 11* and *12*) serve to shed further light on the 'algorithmic' controversies (*Chapter 9 and 10),* by setting them into a wider context of China's power sector and a seemingly specific Chinese mode of industrial policy. Upon summing up on the findings of *Part III,* in terms of a constructivist perspective, the foundation for the final *Part IV* (*Chapters 13-15*) has been laid out. In *Chapter 13,* the contributions of the constructivist approach to the GIN literature are in turn elaborated on. On this basis, the thesis provides a conclusion in *Chapter 14* on the dually motivated research question. Finally, this leads to a discussion in *Chapter 15* on some of the wider implications of the findings, suggestions for further research, and a reflexive critique on the limitations of the study. The structure of the thesis is outlined below.

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revolving around finer legal, definitional or ideological distinctions that seek to draw a line between IP, IPR and intellectual rights (IR).

Table 1: Structure of thesis

Structure of thesis		
	Abstract and summaries	*Part I. Positioning the thesis*
Chapter 1	Introduction	
Chapter 2	Critical literature review on GIN and neighbouring literatures	
Chapter 3	Theoretical framing – basic assumptions of a constructivist marketisation perspective	*Part II. Theoretical and methodological tools – developing a situational model*
Chapter 4	Methodological and analytical tool set	
Chapter 5	Situational model for studying green marketisation in China	
Chapter 6	Rapid growth of the Chinese wind power – and rapid overflowing (background)	*Part III. Analysis: Background and controversy mapping*
Chapter 7	Potential turn to quality in Chinese wind power (background)	
Chapter 8	Emergence of a network for software tools in Chinese wind power (background)	
Chapter 9	Controversy over intellectual property	
Chapter 10	Controversy over standardisation and certification	
Chapter 11	Controversy over money entangled in a Chinese system problem	
Chapter 12 (and summarising)	Controversy over cost and price calculations entangled in a Chinese pragmatics of green marketisation. *Summing up on findings (Part III) – based in constructivist perspective*	
Chapter 13	Discussion across chapters of contributions	*Part IV. Discussion and conclusion*
Chapter 14	Conclusion	
Chapter 15	Wider implications and critique	

Against this backdrop, the thesis moves on to *Chapter 2,* which renders a critical review of the GIN literature and parts of the economic geography literature, with an explicit focus on the conceptualisation of ‘the relational’ in order to inquire into the issue of genesis, dynamics, and agency.

Chapter 2. Positioning the Thesis – a Critical and Explorative Review of (Missing) Relations in the GIN Literature – and a first pragmatist tunnel

Interested in how and whether GINs are emerging in China's wind power market, *Chapter 2* conducts a literature review of the GIN literature. The review relates the GIN literature to central streams within economic geography[6], which lie at the foundation of the GIN literature[7]. These streams within economic geography include the global commodity chains (GCC), global value chain (GVC), and global production network (GPN) frameworks[8]. All concerned with the global fragmentation of production activities, the relatively young GIN literature has added to these three streams by pointing to how innovation activities are also being dispersed globally. To different degrees and with different emphases, these streams are all interested in the probability to (and limits to) industrial upgrading and local development from integration into GCCs, GVCs, GPNs, and GINs. Over the years, the different streams have converged, and in a recent comparative review of the GVC, GPN, and GIN frameworks, for instance, Parrilli et al. (2013) recommend the synthesisation of the GVC, GPN, and GIN literatures to provide a full account of implications for 'local and regional development' (LoRD) (Parrilli et al., 2013: 967). In this way, the latest stream within the reviewed literature streams within economic geography, the GIN literature, can

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[6] E.g. Gereffi 1994a; 1994b; Bair, 2005; 2008a; 2008b; Gereffi et al., 2005; Gibbon and Ponte, 2008; Ponte, 2007; 2009; Sturgeon, 2002; 2004; 2008; Dicken et al., 2001; Dicken, 2007; Coe et al., 2008a; 2008b; Hess and Yeung, 2006.

[7] Apart from economic geography, the relatively young GIN literature builds somewhat eclectically on ideas and concepts from innovation studies (e.g. Lundvall, 2010; Pavitt and Patel, 2003; Fagerberg et al., 2005; Lee and von Tunzelmann, 2005; Chesbrough et al., 2008; Kristinsson and Rao, 2008), international business studies, in particular within a developmental context of technological capabilities (e.g. Vernon, 1966; Dunning, 1980; Meyer, 2004; Peng, 2002; Chen, 2007; Archibugi and Iammarino, 2003; Mathews, 2002; 2006; 2008; 2009; Altenburg et al., 2008; Figeuiredo, 2002a; Fu et al., 2011; Morrison et al., 2008), and alliance and network studies (e.g. Powell, 1990; 1998; Powell et al., 1996; Powell and Grodal, 2005; Owen-Smith and Powell, 2004; Padgett and Powell; 2012; Koza and Lewin, 1998; March, 1991; Brown and Duguid, 1991; Wenger, 2009; Lave, 2009; Yasuda, 2005).

[8] In addition to the GCC, GVC, and GPN (and GIN) frameworks, economic geography also includes the industrial cluster literature (e.g. Malmberg and Maskell, 2006; Giuliani and Bell, 2005; Krugman, 1991; Arthur, 1989; 1996; Cantwell and Piscitello, 2005; Saxenian, 2006). While industrial clusters can be seen as localised/concentrated constellations of different configurations of GPNs (Parrilli et al., 2013: 970), the GPN, GVC, and GIN frameworks are rather based on a rationale of globalised/decentralised phenomena (Parrilli et al., 2013: 970). In the literature review, the cluster literature is only touched upon briefly.

be seen as the latest add-on to the current synthesisation, in particular to the GVC and GPN frameworks.

Concerned with how GINs emerge and are maintained, i.e. the genesis, dynamics, and agency of GINs, the literature review focuses on how 'the relational' has been conceptualised in the existing literature. Hereby, the literature review first renders a review of the GIN literature, including GIN studies, conducted within the Chinese wind turbine industry. Second, the way in which the GIN literature relates to economic geography is outlined briefly. Third, this leads to an outline of how relations are conceptualised in the existing literature. Fourth, the chapter then renders a critique on an identified 'gap' within the literature in regard to 'the relational', and thus in terms of genesis, dynamics, and agency of GINs. This leads to the next section, which illustrates how the gap on 'the relational' has already been acknowledged in parts of the existing literature (Dicken et al., 2001; Coe et al., 2008a; 2008b; Grabher, 2005). Concerned with the potential global reconfiguring of the wind turbine industry and China's potential industrial upgrading during the current potential requalification of China's wind power market, and with the potential role of GINs in qualifying wind power as sustainable, the thesis suggests that it is relevant to explore how and whether another 'relational' perspective can shed more light on these aspects, and thus inquire into genesis, dynamics, and agency of GINs.

Pointing to the need for attention to 'the relational', parts of economic geography have already opened up for potential inspiration from a constructivist perspective, which in turn is founded in a relational pragmatist perspective. Hereby, *Chapter 2* concludes by suggesting that a constructivist perspective may be helpful in terms of shedding light on issues of GIN genesis, dynamics, and agency. The move from the GIN perspective to a constructivist perspective is made possible through the construction of what the thesis dubs a 'pragmatist tunnel'. That is, the concern for the relational in economic geography shares characteristics with American pragmatism. Likewise, the proposed constructivist perspective employed by the thesis is founded in and born out of American pragmatism. In the hope of cross-fertilising and extending the GIN and constructivist perspectives, *Chapter 2* links up to the following *Part III* (*Chapters 3, 4, and 5)*, which lays out a constructivist theoretical and methodological framework and proposed model for the analysis in *Part III*. While the analysis in *Part III* leaves the GIN metaphor all together, the GIN construct is revisited in *Part IV*, where potential contributions to the GIN literature and related literatures as well as to the constructivist perspective are discussed.

Review of the GIN literature

First, the chapter provides a brief review of the GIN literature. This is done by looking into 'what a GIN looks like', 'who is involved', 'how and why GINs emerge', and 'how to find GINs'. This leads to a review of GIN studies conducted within wind power in China, and the types of questions that the GIN literature has addressed.

What does a GIN look like?

The GIN framework is concerned with how new knowledge is created across national and firm boundaries, how innovations emerge at a global level, and how it is no longer confined to the Triad of the US, Europe, and Japan, but is expanding to emerging economies such as China and India (e.g. Barnard and Chaminade, 2012; Cooke, 2013; Silva and Klagge, 2013; Ernst, 2006; Chen and Wen, 2011; Chen and Wen, 2013; INGINEUS 2.2; 4.1; 5.1, 2011; www.ingineus.eu). As "globally organised webs of complex interactions between firms and non-firm organisations engaged in knowledge production related to and resulting in innovation" (Barnard and Chaminade, 2012: 2), GINs are sometimes defined as globalised networks of innovation, which cross firm, sector, and country borders (Ernst, 2006: 12). A taxonomy of different types of GINs has been developed, based on different dimensions and degrees of 'globalness', 'innovativeness', and 'networkedness' (span and depth) (Barnard and Chaminade, 2012). This classification has been based on data from an EU-sponsored firm-level survey amongst 1,215 responding MNCs in seven European countries, plus Brazil, China, India, and South Africa, within different low-, medium-, and high-tech sectors (INGINEUS-project 2009-2011; 7th Framework Programme (www.ingineus.eu); INGINEUS, 2.2. in Barnard and Chaminade, 2012). Based on these data, six main GIN types have been identified, namely (1) balanced GINs (GIN and gin), (2) global asset exploiters (Gin), (3) innovators (gIn), (4) networkers (giN), (5) global networkers (GiN), and (6) domestics (*in) (Barnard and Chaminade, 2012: 20). In addition, GINs have sometimes been classified as either complex inter-firm GINs or intra-firm GINs (e.g. Ernst, 2006). In this classification, inter-firm GINs constitute a "set of relations among the case company (headquarters and subsidiaries) and the outside collaborators" (Liu et al., 2013: 1462), reflecting innovation outsourcing of R&D activities of the focal firm (Ernst, 2006: 3, 12). Conversely, intra-firm GINs constitute a "set of relations among the functional departments or groups within a company's headquarters and its subsidiaries" (Liu et al., 2013: 1462). In this way, intra-firm GINs reflect the internalisation of R&D activities, i.e. innovation offshoring, of the focal firm (Ernst, 2006: 3, 12). Over time, broader and more loosely defined GIN conceptualisations have emerged, taking into account the institutional, co-evolving and embedding context and looking beyond the lead firm. That is, as globalised *networks of innovation,* which cross firm, sector, and country borders, the GIN framework represents a methodological dualism (Parrilli et al., 2013: 975). That is, the ”unit of analysis is both the firm (and the R&D department within the firm) and the industry to which it belongs” (Parrilli et al., 2013: 974). In other words, the GIN framework represents a

”very special approach to inter-firm industry relationships that goes beyond firm boundaries and national borders to take into account homogeneous or integrated groups and networks of firms and industries that shape technology and competition features of any industry and market on a global scale” (Parrilli et al., 2013: 974-5).

With such methodological dualism, the GIN literature is based on an assumption of embeddedness into the institutional context (Granovetter, 1985). In turn, the conceptualisation of the institutional embedding context is often seen through the lens of innovation systems (e.g. Lundvall, 2010; Lee and von Tunzelmann, 2005; Kristinsson and Rao, 2008). As a still young and emergent research field, there is a certain lack of consensus, as to how to treat and conceptualise GINs, however. Apart from treating GINs as MNCs and/or as a ”GIN arrangement of interlocking businesses and, to some extent, TISs [technological innovation systems]” (Cooke, 2013: 1092), GINs are also treated as “a strategic framework for the analysis of current and future trends and leaderships in the globalized economy” (Parrilli et al., 2013: 974). Simultaneously, the GIN construct is sometimes treated as a somewhat normative and prescriptive tool for local development, with potentially performative and political effects. For instance, the relative advantage of GPNs and GINs as a ‘developmental model’ is being analysed by Cooke (2012: 1083), as ”the GIN offers more opportunities to extend and upgrade the overall production pattern cultivated in any region” (Parrilli et al., 2013: 974). In this way, the GIN is treated as a prescriptive means of evolving and upgrading from GPNs (Cooke, 2013). At other times, the GIN is constituted as an embedding context for MNCs, regional economies, and clusters. That is, ”firms gradually embed in global innovation networks”, as they adapt their routines and change (Herstad et al., 2013: 26). At the same time, GINs are sometimes constituted as an embedding context of regions and clusters (Herstad et al., 2013: 26). That is, regions have become knowledge hubs in GINs (Chaminade and Vang, 2008; Liu et al., 2013: 1457).

Who is involved in GINs?

While pursuing a methodological dualism, and often being interested in the embedding institutional context, many GIN studies have tended to take as their starting point large focal firms, i.e. MNCs (OECD, 2008; Parilli et al., 2013; Ernst, 2006, Ernst, 2008; Barnard and

Chaminade, 2012; Chen and Vang, 2008; Chen, 2007; Liu et al., 2013), who have dispersed their R&D activities globally. For instance, in their analysis of the ”geography and structure of global innovation networks (GINs) of two multinational companies belonging to industries with different knowledge bases” (Liu et al., 2013: 1456), Liu et al. (2013) treat GINs as “a set of relationships of the case company aiming at technological innovation, both product and process innovation” (Liu et al., 2013: 1462). Likewise, Chen (2007) treats GINs as a matter of the dispersed R&D of MNCs (Chen, 2007: 394), inquiring into the interaction between the subsidiary innovation centres of the Western MNCs and local institutions (Chen, 2007: 373). Conducting a comparative study of what is termed ‘two MNC’s Regional Innovation Networks’ in China, the study illustrates how a developing country such as China has become integrated into ’[foreign] MNC global innovation networks’ (Chen, 2007: 375). While Chen (2007) compares intra-firm GINs of two different MNCs, Liu et al. (2013) study both intra-firm and inter-firm GINs (Liu et al., 2013: 1456). Along the same lines, Chen and Vang (2008) conduct a case study on a single MNC (Motorola) and its dispersion of R&D activities, inquiring into the role of developing countries in MNC’s GINs (Chen and Vang, 2008: 11). Conducting a case study on GINs in China’s wind power industry, Silva and Klagge (2013) find that leading Chinese WTMs ”are trying a new approach which fits into the general trend of globalizing knowledge production through the development of global innovation networks (Silva and Klagge, 2013: 1353). This is illustrated by the way in which turbine manufacturers are increasingly aiming

”at integrating cutting-edge technology and the related innovation capabilities into their firms via acquisitions and the establishment of R&D units in developed countries in order to catch up with the technologically advanced and mature turbines by firms from these countries” (Silva and Klagge, 2013: 1353).

A somewhat alternative approach, than that of following GINs as constituted by MNCs, has been employed by Cooke (2013), who looks into the transition and evolution from GPNs to GINs in the Singaporean ICT sector. Cooke does this by focusing on a core ICT technological subsystem, namely hard disk drives (HDDs). The HDD subsector is less dynamic and innovative than other parts of the ICT industry, and is still primarily characterised by GPNs and a dominance of large MNCs. In contrast, GINs have emerged in the more dynamic and innovative parts of the ICT industry (Cooke, 2013: 1082). Cooke finds that

“GPN set-ups are not particularly innovation-inducing, tend to stabilizing over the long term and firm growth is largely by acquisition. The contemporary global ICT system is, by contrast, endogeneously innovative, far from stable and has greater developmental potential because of its GIN characteristic, which is its capacity for novelty” (Cooke, 2013: 1081).

In addition, Linden et al. (2009) have taken as their starting point the product (Apple's iPod) by looking into "who actually benefits from innovation", i.e. inquiring into who captures value in a GIN (Linden et al., 2009: 140). Cooke's (2013) and Linden et al.'s (2009) studies illustrate how the analysis instead can take as its starting point a particular technology/industrial subsector or product, and how the GIN literature generally experiments with other approaches to GINs, which do not have MNC strategies as their starting points as those illustrated above. In addition, the GIN literature has gradually shifted focus from GINs in Western countries, formed by Western MNCs exclusively, to GINs in emerging economies, sometimes also formed and shaped by MNCs from developing countries. This reflects that GINs are no longer a phenomenon exclusive to developed countries (e.g. Silva and Klagge, 2013; Barnard and Chaminade, 2012; Ernst, 2006; Ernst, 2008; EU, 2009; Chen, 2007; Chen and Vang, 2008; Parrilli et al., 2013; Cooke, 2013). Overall, the GIN framework emphasizes the role of new emerging powers and how they are joining globalised R&D activities, e.g. in the form of specialised R&D departments within foreign MNCs and/or within own MNCs (Parrilli et al., 2013: 971). The rise of developing countries as central actors in GIN formations is linked to the increasing use of *innovation offshoring* by Western MNCs (Ernst, 2006; Ernst, 2008), which has led to an increasingly central role of firms from developing countries (INGINEUS, 4.1., 2011; Silva and Klagge, 2013; Lewis, 2013; Barnard and Chaminade, 2012; Chen, 2007; Chen and Vang, 2009).

How and why do GINs emerge?

In the GIN literature, there are different accounts of how and why GINs are emerging. These accounts point to an enabling institutional context, evolution from GPNs to GINs, MNC strategies[9], and industrial knowledge bases.

First, with the methodological dualism of the GIN framework, the co-evolving institutional context embedding GINs is often used as an explanatory factor for GIN emergence, as already indicated above (e.g. Chaminade and Vang, 2008; Barnard and Chaminade, 2012; Silva and Klagge, 2013; Cooke, 2013; Ernst, 2006; INGINEUS, 4.1., 2011). These studies particularly emphasise the role of supportive government policies and of the innovation system (Cooke, 2013; Ernst, 2006; Barnard and Chaminade, 2012; INGINEUS, 4.1; Silva and Klagge, 2013). For instance, Cooke (2013) finds that

[9] For instance, MNCs may adopt a strategy of either home-based knowledge exploiting or – augmenting/exploring R&D labs (e.g. Ernst, 2006; INGINEUS, 5.1.; Chen, 2007; Chen and Vang, 2008). This distinction is founded on March' (1991) distinction between explorative and exploitative innovation (March, 1991).

”TIS [technological innovation system] locations where capable innovation agencies, research institutes and economic governance bodies created a valued developmental infrastructure for indigenous and inward investing companies, innovation became possible for local companies that had started life as members of MNC supply chains. This presaged the rise of what some saw as a GIN” (Cooke, 2012: 1092).

Overall, changes in geographical organisation are often seen through evolutionary approaches in the economic geography literature (Martin, 2010; Boschma and Martin, 2007; Cooke, 2012; Silva and Klagge, 2013; Giuliani and Bell, 2005). For instance, Chaminade and Vang (2008) have looked at the role of regional innovation systems (RIS) for the emergence of GINs (Chaminade and Vang, 2008: 1688). To do this, they look at the co-evolution of indigenous small and medium-sized enterprises (SMEs) in Bangalore and the emerging RIS (Chaminade and Vang, 2008: 1684), in order to answer the question whether the emerging Bangalore RIS is evolving into a mature RIS that can provide the kind of support needed by upgrading firms (Chaminade and Vang, 2008: 1691). Further, Barnard and Chaminade (2012) have presented what, at first sight, might seem like counter-intuitive results, as they display how primarily institutionally *dis*advantaged and maybe even geographically distanced regions are more prone to the emergence of strong-form GINs. According to the authors, this indicates how scarcity of skills and locational (and institutional) disadvantages can induce firms to engage in GINs, as they start to exploit the potential of leveraging rich and globally dispersed networks (GINs) (Barnard and Chaminade, 2012: 32). Along the same lines, another study displays that GINs may emerge in regions, which are neither institutionally too thick or too thin, but where an interactive regional innovation system holds both the incentive and the capability to engage in GINs (INGINEUS, 4.1.: 3). These studies confront conventional wisdom of the institutional innovation system literature that institutionally thick regions with a well-established innovation system are more prone to be involved in GINs. Accordingly, these GIN studies emphasise the need to shed further light on the institutional infrastructure of regions (Barnard and Chaminade, 2012; INGINEUS, 4.1.), e.g. including universities, technological centres, and funding organisations (INGINEUS, 4.1.: 7).

Second, a prevalent argument in the GIN literature is that GINs are evolving from GPNs, constituting a new and somewhat ‘higher-level’ form of cross-border relations, as they do not only take place within production, but also within innovation activities. Thus, the GIN literature inquires into the

”shift from global production networks [GPNs], driven by the search for markets and lower cost production sites, to global innovation networks (GINs), driven by the search for knowledge” (Herstad et al., 2014: 495).

As touched upon briefly in *Chapter 1*, the seeming emergence of GINs is thus seen as marking a new stage of economic globalisation, namely reflecting how it is not sectors or industries, which are being geographically disintegrated, but stages of production including R&D and innovation, due to the global modularisation and disintegration of production (Chen and Wen, 2013: 1). The global decomposition of production, reflected in offshoring and outsourcing as well as in increased specialisation of production activities and services, has ”brought about prevailing cross-border production schemes” of GVCs and/or GPNs. Hereby, cross-border networking does not only take place within manufacturing, but increasingly also within services and even design and R&D activities (Chen and Wen, 2013: 1). As different layers of industrial players within GVCs increasingly need to interact closely for innovation, this has caused a rise in GINs (Chen, 2004; Ernst, 2006 in Chen and Wen, 2013: 1).

Third, the emergence of GINs is linked to strategic responses of MNCs to competitive pressures. That is, through access to GINs, MNCs are able to get access to valuable (and maybe even cost-efficient) resources and innovative capabilities of a lower-cost talent pool (Ernst, 2006: 3, 23; OECD, 2008). The turn towards low-cost talent pools is often explained through exogenous, macroeconomic competitive pressures. These exogenous pressures are claimed to have changed corporate innovation management procedures towards a more open innovation model (Ernst, 2006; OECD, 2008; EU, 2009: 1). This indicates an implicit assumption in some GIN studies of the paradigm of open innovation (Chesbrough, 2008), which denotes that firms increasingly (must) cooperate with suppliers, customers, knowledge institutions (universities, laboratories etc.), and sometimes even with competitors, to stay innovative and competitive. Importantly, however, open innovation does not refer to free knowledge or technology (such as ‘open source’), but to the collaborative methods applied (OECD, 2008: 2). Accordingly, an OECD study on GINs argues that “the innovation model stays relatively more open for non-core technologies and markets” (OECD, 2008: 5). While these arguments often refer to MNCs from developed countries, the GIN literature argues that, from the perspective of emerging economies like China, integration into GINs can help these countries ”to link own resources more closely with external knowledge and innovation capacities” (Stamm and Altenburg, 2007; Altenburg et al., 2008 in Silva and Klagge, 2013: 1351). Accordingly, within Chinese wind power,

”[i]t is against this background that leading Chinese turbine manufacturers have recently started to pursue the establishment of and integration into global innovation networks [GINs]” (Silva and Klagge, 2013: 1351).

Along these lines, as regards China's wind power industry, "[a]ccess to global learning networks can be highly valuable for assimilating technological expertise, which can be done through international research, development of demonstration partnerships, or even something as simple as hiring specialized workers from abroad" (Lewis, 2013: 167) [10]. In these studies, GINs (or interchangeably 'global learning networks') are treated as an alternative to conventional technology transfer with its limits in regard to building indigenous innovation capabilities (Silva and Klagge, 2013: 1351). With its "developmental potential" (Cooke, 2013: 1081), GINs are being constituted as a strategic means of industrial upgrading and regional development (Parrilli et al., 2013; Cooke, 2013), which can induce local governments to play an interventionist role in nurturing the transformation of GPNs into GINs (Cooke, 2013).

Finally, the GIN literature has recently looked into the issue of why GINs emerge in particular industries. This has been done by inquiring into the specific knowledge base, constituted as either analytical or synthetic in nature, of the industry(-ies) in question (Herstad et al., 2014; Herstad et al., 2013; Liu et al., 2014). As analytic knowledge is found to be more easily codified, and thus being less tacit and 'sticky' (Gertler, 2003; Gertler and Levitte, 2007; INGINEUS, 4.1., 2011: 5), industries with an analytical knowledge base will result in more GINs to be formed than within industries with more sticky, synthetic knowledge (Herstad et al., 2014; Herstad et al., 2013; Liu et al., 2014). Liu et al. (2013), for instance, map a so-called globally organised model of a particular MNC embedded in an analytical knowledge-based industry (telecommunication), comparing it to a locally organised model of an MNC within a synthetic knowledge-based industry (automobile) (Liu et al., 2013: 1456, 1468). Such analyses of industrial knowledge bases and technological regimes (Herstad et al., 2014: 495), which seek to explain sources of firm-level behavioural differentiation and understand how and why GINs evolve, can provide insight into how specific determinants nurture or constrain network linkages maintained by firms (Herstad et al., 2014: 496).

How to find GINs?

The methodological dualism of the GIN framework (Parrilli et al., 2013: 975), i.e. the way in which both firms and their embedding industries constitute the unit of analysis, has been

[10] Lewis (2013) does not subscribe directly to the GIN framework, but instead adopts the notion of global learning networks. However, the thesis argues that the conceptualisation of GINs and global learning networks overlap to the extent that it makes sense to treat Lewis's work within the GIN framework. This is elaborated later in the chapter.

”tackled with nested case studies that offer the opportunity to collect and discuss critical information on two sets of actors as well as to maintain and to manage a very open approach to innovation dynamics derived from such agent’s multiplicity” (Parrilli et al., 2013: 975).

To detect and find GINs, many GIN studies have conducted case studies of single MNCs or comparative studies of different MNCs (primarily within relatively high-tech industries)[11] and their strategies, treating them more or less as embedded in the institutional context. In GIN studies on MNC GINs, the literature detects GINs by mapping the global dispersion of R&D labs and innovation centres, and/or mapping links between actors of the GINs in terms of contractual R&D collaborations, technology sourcing agreements, M&As, hiring of specialised workers, and/or joint design agreements with external partners, which may be other companies, universities, and/or research institutes (Ernst, 2006, 2008; Chen, 2007; Chen and Vang, 2008; Liu et al., 2013; Chen, 2007; Silva and Klagge, 2013; Lewis, 2013). Mapping the geographical spread of innovation and technology sourcing models, GIN studies offer an

”analysis of private sector objectives, plans and strategies of lead firms and less well-known specialized suppliers. In this endeavor, the GIN maps out the relationships that are being built up to develop higher-level capabilities used to discover new technologies, formats and products that open the way for new industry segments in which significant market shares can be developed” (Parrilli et al., 2013: 982).

Overall, inquiring into MNC innovation and technology sourcing strategies, GIN studies tend to focus on formal, i.e. contractual networks, adhering to the conception that ”[c]ollaboration can be governed contractually, monitored administratively and adjusted according to project progression” (Adams, 2002 in Herstad et al., 2014: 496). The detection of GINs is, in addition, sometimes done through adoption of social network analysis (involving key connection analysis and structural equivalence analysis) and visual mapping tools (Liu et al., 2013: 1463; Chen et al., 2014)[12]. Sometimes inquiring into different innovation roles played by actors in the network, GIN studies also rely on different innovation typologies, e.g. distinguishing between incremental, radical, modular, and architectural innovation (Henderson and Clark, 1990; Ernst, 2009 in Parrilli et al., 2013). In order to render a nested case study and adhere to the methodological dualism, many GIN

[11] E.g. electronics, IT/ICT (and software), telecommunication, automobile sectors, and lately also wind power (Ernst, 2006: 4; Cooke, 2013; Ernst, 2008; Chen, 2007; Chen and Vang, 2008; Liu et al., 2013; Chen, 2004; Chen and Wen, 2011; Silva and Klagge, 2013).

[12] Chen et al. (2014) have conducted a study on ’global collaborative networks’ in China’s wind turbine industry. The study has extensive overlaps with the GIN literature, while it does not position itself directly into the GIN framework. However, the thesis treats the notion of global collaborative networks as more or less synonymous with GINs, which is to be elaborated further later in the chapter.

studies include an analysis of the embedding institutional context (e.g. Chaminade and Vang, 2008; Barnard and Chaminade, 2012; Silva and Klagge, 2013; Cooke, 2013; Ernst, 2006; INGINEUS, 4.1., 2011). Finally, while most GIN studies are qualitative case studies (e.g. Cooke, 2013; Chen, 2007; Chen and Vang, 2008; Ernst, 2006; Silva and Klagge, 2013; Liu et al., 2013), GIN studies also often rely on quantitative methods and data, e.g. employing aggregated trade statistics, surveys, and descriptive statistical data (e.g. OECD, 2008b, EU, 2009; INGINEUS 2.2; 4.1, 2011; Barnard and Chaminade, 2012), and sometimes even conducting hypothesis testing in regression analyses, as seen in the case of studies on sources of behavioural differentiation (e.g. Herstad et al., 2014: 496; Herstad et al., 2013).

GIN studies on Chinese wind power

In recent years, a few studies have been conducted within China's wind industry, which look into GINs or into other neighbouring constructs for global collaborative networks for learning and innovation. Looking both into as well as beyond China's interventionist policies within wind power, a study by Silva and Klagge (2013) has illustrated the emergence of GINs in the shape of Chinese WTMs (Silva and Klagge, 2013). Constituting a means of "the development of indigenous innovation and learning capabilities in a so far very successful process of catching up with market and technology leaders from developed countries" (Silva and Klagge, 2013: 1342), "[t]he most recent development in China's wind industry is its increasing and deep integration into global knowledge networks" (Silva and Klagge, 2013: 1351). While Silva and Klagge's study is the only one conducted so far, to the knowledge of the author, on GINs (interchangeably referred to as 'global knowledge networks') in Chinese wind power (Silva and Klagge, 2013), related studies have looked at Chinese wind power through a lens which, arguably, to a large extent resembles the GIN framework.

Such neighbouring accounts are e.g. seen in Chen et al.'s (2014) study on the evolution of what they term a 'collaborative innovation network' in China's wind turbine manufacturing industry. They define collaborative innovation networks as a team of self-motivated organisations with a collective vision to collaborate in achieving a common goal by sharing ideas, information, and work (Gloor, 2005; Gloor and Cooper, 2007; Silvestre and Dalcol, 2009 in Chen et al., 2014: 264). Hereby, their approach is relatively narrow, compared to the GIN construction, which includes more actors and a broader approach due to its methodological dualism. Aiming at uncovering the co-evolutionary dynamics of collaborative innovation networks in China's emerging wind turbine manufacturing ecosystem and sub-ecosystems of the leading WTMs in China (Chen et al., 2014: 265), the study adopts a so-called business ecosystem lifecycle model (BELC) (Rong, 2011; based on Moore, 1996). Adopting software to visually map social network relations between two leading WTMs and their domestic and foreign suppliers of core components (blades, gearboxes, generators and control systems), detected through identification of formal contracts (Chen et al., 2014: 266), Chen et al. (2014) identify five pathways of technology accumulation strategies of Chinese WTMs over the past 30 years, along the BELC life cycle model (Chen et al., 2014: 264, 267). The study illustrates how the Chinese wind turbine manufacturing industry have undergone different evolutionary stages along the BELC (*emerging, diversifying, converging, consolidating, and renewing*) (Chen et al., 2014: 268, 293)[13], and how Chinese MNC strategies of technology accumulation have shifted accordingly. That is, China's wind turbine manufacturing industry has engaged in strategies of importing, in-licensing, joint R&D/co-designing, outbound M&As, and increasingly engaging in industry-university/research institution collaboration (Chen et al., 2014: 267, 269). The authors conclude that China' wind turbine manufacturing industry has followed a pathway of tentative experimentation and preliminary domestic co-development, reverse engineering and development, in-licensing and domestic co-development, international co-designing/co-R&D and domestic co-development, and finally global innovation, i.e. working with domestic and international partners in cross-border M&As and domestic-international co-designing (Chen et al., 2014: 293). Indeed, the latter stages on this path-way resemble what in the GIN framework is coined as GINs.

Another related approach has been adopted by Lewis (2007; 2011; 2013), who has conducted a number of studies on Chinese wind power. In a couple of comparative case studies on leading WTMs, Lewis (2007) compares technology sourcing strategies of India and China (2007), among others adding South Korea (2011) to these in other studies. Having illustrated the technology and knowledge sourcing strategy of Chinese wind turbine companies (Lewis, 2007; 2011), as also illustrated in the studies by Silva and Klagge (2013) and Chen et al. (2014), Lewis (2013) demonstrates in her book, 'Green Innovation in China', a shift in China's mode of technology transfer (Lewis, 2013: 35). That is, Lewis also demonstrates a gradual move from conventional means of technology transfer towards joint design and M&As, largely enabled through "[a]ccess to networks for learning and innovation" (Lewis, 2013: 3), which constitutes "a new model for innovation through the global generation of technology" (Lewis, 2013: 33). Access to such "global learning

[13] Chen et al. add a 'diversifying phase' to the framework to cover the diversified nature of innovation during an industry's early and chaotic stages (Chen et al., 2014: 293).

networks" of Chinese WTMs has "played a rarely examined but crucial role in the development of China's wind industry" (Lewis, 2013: 3), and has contributed to Chinese "technological leapfrogging" within wind power technologies (Lewis, 2013: 2).

Lastly, a study by Lema et al. (2013), although not employing a GIN framework, but relying instead on a GVC perspective, has provided insight into not only the global recomposition of the wind power value chain (Lema et al., 2013: 43), but also the organisational decomposition of the innovation process (Schmitz and Strambach 2009 in Lema et al., 2013: 60-61). Focusing on the manufacturing value chain (and not the deployment-services chain) within wind power, Lema et al. (2013) illustrate how Chinese WTMs have modularised their supply chain, offering considerable cost and time reductions (Lema et al., 2013: 39, 44). This has been accomplished through cooperation with foreign partners:

"Inter-company relationships are central to the Chinese model: Lead firm supplier relations buttress a flexible low-cost industry structure, and links to technology suppliers complement in-house expertise. Chinese firms do not seek to "go it alone" in technology development. Instead, Chinese lead firms seek to develop turbine technology in cooperation with foreign partners" (Lema et al., 2013: 63).

By emphasising the Chinese strategy of 'not going it alone', as expressed in the quote above, the study by Lema et al. (2013) bears resemblance to the GIN studies briefly outlined above, e.g. through its analysis of shifting mechanisms of technology transfer (from conventional technology transfer modes such as foreign direct investments (FDI), trade, and licensing to non-traditional technology transfer such as joint design, R&D collaboration and overseas R&D units) (Lema and Lema, 2012 in Lema et al., 2013: 60). Overall, Lema et al. (2013) find that China's process of "catching up with the old leaders in wind power" (Lema et al., 2013: 60) reflects innovation strategies that combine internal development with heavy reliance on external knowledge sourcing (Lema and Lema, 2012 in Lema et al., 2013: 60).

What questions does the GIN literature address?

Having inquired into *'what a GIN looks like', 'who is involved'*, *'how and why GINs emerge', 'how to find GINs',* and looking at how GINs have been conceptualised in Chinese wind power, the review of the GIN literature concludes by rendering an account of the type of questions that the GIN literature addresses. As illustrated, the GIN literature has made a valuable contribution to the understanding of the "changing global geography of knowledge and innovation" (Ernst, 2009; Barnard and Chaminade, 2011 in Silva and Klagge, 2013: 1353). Concerned with the geographical dispersion of innovation (Parrilli et al., 2013: 972), the GIN literature looks into what has become a politically sensitive issue, as it touches upon the presumed "hollowing out" of Western economies (Ernst, 2006: 2, 3), as knowledge intensive activity and knowledge creation seem to be spreading to developing countries outside of the EU in different sectors (INGINEUS, 2.2, 2011: 2). Countering some of these fears, other studies emphasise the potential mutual benefit from GIN integration (Ernst, 2006; OECD-report, 2008; INGINEUS, 5.1., 2011: 7). As somewhat normative studies, the GIN literature often provides policy recommendations, e.g. in terms of adjustments to the innovation system and the institutional framework in general (OECD, 2008b; EU, 2009: 2; Ernst, 2006: 4; Liu et al., 2013: 1470). Overall, this reflects how the GIN literature is preoccupied with the effect of GINs on upgrading and regional development, not only for developed, but also for developing countries. In particular, often treated as a potential means for upgrading and catch-up (Ernst, 2006; Parilli et al., 2013; Cooke, 2013; Silva and Klagge, 2013; Herstad et al., 2013), the GIN literature tends to assume that MNCs from developing countries can rise up the so-called ”smiling curve” of value appropriation, when they enter ”near the bottom of the curve but with aspirations and potential to rise along it” (Chen, 2004; Chen et al., 2010 [2011] in Cooke, 2013: 1089-1090). This “implies a catching up in R&D and innovation capabilities that are likely to change the global balance of power even more strongly over the next decade” (Parrilli et al., 2013: 971). In a comparative review of the GIN, GPN, and GVC approaches, Parrilli et al. (2013) argue that the

”GIN framework delivers a third strategic asset [apart from global value chain (GVC) and global production network (GPN) frameworks] in the analysis of LoRD [Local and Regional Development]: innovation networks and strategies. This is distinct from ”innovation systems” as it takes into account the fast modifications that occur worldwide in the leading business activity, R&D&I [Research & Development & Innovation], which affects any country, region and locality, and in which any of these territories can upgrade through appropriate dynamics and strategies in order to catch up with, and consolidate, a more competitive position in global markets” (Parrilli et al., 2013: 982).

At times, GIN studies claim to provide a “theoretical framework within which to situate case studies systematically so as to construct cumulative evidence of the genesis, performance, and implications of decentralized knowledge-intensive activities” (INGINEUS, 2.2.: 7). Yet, although the GIN literature “emphasizes the emergence of GINs, and their implications for local-global production inter-relationships” (Parrilli et al., 2013: 971), the literature does not provide an insight into the micro-processes of establishing relations, which lie at the foundation of their proclaimed genesis. Instead, formal, contractual relations for R&D collaboration and geographical mappings of R&D locations are treated as evidence of GINs, i.e. looking at GINs and their genesis as a *result* rather than as a *process* and potential *outcome* of specific dynamics and requiring ongoing work of maintenance. Overall, GINs tend to be seen from the outside, instead of inquiring into processes of relationship-building and dynamics of relationship maintenance. In addition, GIN studies do not look at how GINs may take part in the re-qualification of markets and *vice versa*. In the following, the chapter briefly looks into how the GIN literature has evolved from the GCC, GVC, and GPN frameworks, which may render an explanation of why GINs and their genesis tend to be looked at from the outside.

The intellectual heritage of GINs – on GCC, GVCs, GPNs

As indicated in the above review of the GIN literature, the GIN framework has emerged from the GCC, GVC, and GPN literatures within economic geography. In the following, the chapter briefly looks into the foundational GCC, GVC-, and GPN literatures, which focus on the globalisation of production rather than innovation activities[14].

Conceptualising economic activities through chains and networks of production

Overall, ”[c]onceptualizing economic activities as being organized functionally into a *chain* of interconnected elements has a lengthy history” (Dicken cited in Dicken et al., 2001: 97). The GCC framework, which evolved in the early 1990s (Gereffi and Korzeniewics, 1994; Gereffi, 1994a; 1994b; 1999; Bair, 2005; 2008a; 2008b; Bair and Gereffi, 2007; Bair and Peters, 2006; Sturgeon, 2008), is founded in earlier world-systems theory, which divides the world into core, semi-peripheries, and peripheries of the so-called ‘global North’ and ‘global South’ (e.g. Hopkins and Wallerstein, 1977). Preoccupied with how economic globalisation influences the restructuring of international production, the GCC framework looks at GCCs as structures that connect actors across space, often in unequal ways (Gereffi and Korzeniewics, 1994; Gereffi, 1994a; 1999). Constituting the infrastructure of international trade, GCCs are “rooted in transnational production systems that give rise to particular patterns of coordinated international trade” (Gereffi, 1994b: 215).

While the GCC framework does point to opportunities for upgrading through integration into GCCs, the later and still dominant GVC framework (Humphrey and Schmitz, 2000; 2001; 2002; Ponte, 2007; 2009; Sturgeon, 2008; Sturgeon et al., 2008; Sturgeon and Gereffi, 2009; Gereffi and Fernandez-Stark, 2011; Gereffi and Kaplinsky, 2001; Gereffi and Memedovic, 2003; Pietrobello and Rabellotti, 2007; Morrison et al., 2008), which has evolved from the GCC framework since the late 1990s, offers a relatively optimistic account (with less focus on exploitation), of the possibility for upgrading for developing countries by integration into GVCs. The GVC framework is concerned with the cost-efficient

[14] Parrilli et al. (2013) position the GVC framework within sociology, economy and developmental studies, while they position the GPN and GIN frameworks within economic geography and innovation studies respectively. However, the thesis still treats the reviewed literature as part of the broader field of economic geography, as they are all concerned with the global dispersion of economic activities, interchangeably including production and innovation (Parrilli et al., 2013).

coordination of customer-supplier relations (based on a transaction cost calculus) (e.g. Coase, 1988, Williamson, 1981, 2002), and with how value appropriation and power is distributed and exerted in customer-supplier relations. In addition, the GVC framework is preoccupied with implications for the potential for industrial upgrading (Parrilli et al., 2013; e.g. Humphrey and Schmitz, 2002). In terms of cost-minimising coordination and distribution of power in customer-supplier relations, this is seen through the lens of value chain governance. Overall, the GVC framework has developed an elaborate "tool to trace the shifting patterns of global production, link geographically dispersed activities and actors of a single industry, and determine the roles they play in developed and developing countries alike" (Gereffi and Fernandez-Stark, 2011: 2).

Not adopting a chain construct, but a network construct to conceptualise the globalisation of economic activities, the GPN framework (Ernst and Kim, 2002; Henderson et al., 2002; Coe et al., 2008a; 2008b; Yeung, 2009; Dicken, 2007; Sturgeon, 2002; 2004; Hess and Yeung, 2006) represents a more multidisciplinary framework (mainly within the economic and political fields), which feeds into economic geography (Parrilli et al., 2013: 972). While the GVC framework tends to overstate the role of MNCs, but understating the power of developing state organisations in "both moderating and moulding those forms to suit their own territorial interests" (Cooke, 2013: 1082), the GPN framework takes a broader sector and/or industry approach (Parilli et al., 2013: 972, 974) and attaches more power to developing state organisations. Thus, the GPN literature takes

"into account more widely the institutional and cultural features and constraints of different territorial ensembles, as well as the explicit policy approach taken by states and institutions, which seek to develop their own competitive positions" (Ernst and Kim 2002; Yeung, 2008, 2009; Coe et al., 2008 in Parrilli et al., 2013: 968).

Hereby, conceptualising GPNs as "networks embedded within networks, with varying degrees of imbrications and interconnection", the GPN framework allows for a more explicit analysis of the geographical and institutional context 'embedding' the GPN, and for a so-called multi-scalar conception of levels and territorialities (Coe et al., 2008a: 277). Further, compared to the GVC framework, which took its outset in the analysis of the global textile industry, gaving rise to the GVC idea in the first place, the GPN construct has moved its focus to industries, which are more deeply based in science and technology (Cooke, 2013: 1082). The GPN construct denotes the interconnectedness of nodes (MNCs) and their links, which extend spatially across national boundaries, integrating parts of disparate national and subnational territories (Coe et al., 2008a: 274)[15].

Overall, the GIN framework bears most directly resemblance to the GPN framework, due to their network metaphors, the concern for more high-tech and science and technology-based sectors, the inclusion of more diverse actors, and the concern for the institutional context. Yet, in recent years, the GVC and GPN frameworks have converged, as they complement each other well. Accordingly, the GIN framework also draws on concerns of the GVC framework, in particular in regard to issues of governance and upgrading, which illustrates the potential for cross-fertilisation between the GVC, GPN, and GIN frameworks (Parrilli et al., 2013). In the following, it is briefly reviewed how issues of governance and upgrading are treated in the existing literature.

Governing chains and networks

Concerned with implications for local and regional development ('LoRD'), e.g. in terms of the emergence of innovative clusters, integration into GCCs, GVCs, GPNs, and/or GINs, and transition from GPNs to GINs (ingineus.eu; Cooke, 2013; Parrilli et al., 2013), the economic geography literature is generally concerned with issues of power distribution or what is termed 'governance'. Governance denotes "the process of organising activities with the purpose of achieving a certain functional division of labour along a value chain – resulting in specific allocations of resources and distributions of gains" (Ponte, 2007: 3). Gibbon et al. (2008) have developed a typology of different conceptualisations of governance in the existing literature, namely *governance as driving*, *governance as coordinating*, and *governance as normalisation* (Gibbon et al., 2008), which will be briefly reviewed in the following.

First, the GCC literature treats governance as a matter of chain driving by so-called 'chain drivers'/'lead firms' (Bair, 2005; Gibbon et al., 2008). Based on this concept, the GCC literature identifies producer-driven versus buyer-driven GCCs (Gereffi, 1994a; 1994b; Appelbaum and Gereffi, 1994 in Bair, 2005). Though this lens, governance is a function of lead firm type (Gibbon et al., 2008: 320), which determines the ability of particular firms to make decisions about which other actors will be able to access the chain and under what

[15] Another definition of GPNs has been developed concurrently by Ernst (2002) and Ernst and Kim (2002), conceiving GPNs as the concentrated dispersion of the value chain across firm and national boundaries, with a parallel process of integration of hierarchical, systemic layers of network participants.

circumstances (Bair, 2008a: 351). Second, the GVC literature has developed the most elaborate theory for predicting governance modes, representing governance as coordination of relations. This refers specifically to the theoretical framework developed by Gereffi et al. (2005) for predicting GVC governance in dyadic buyer-supplier relations between economic actors in the global economy (Gereffi et al., 2005: 82). Based on a rationale of transaction cost minimisation, Gereffi et al. (2005) identify five different modes of governance, namely hierarchical, captive (network), relational (network), modular (network), and market coordination. Where there are low transaction costs, relations will be *market-based*, and where transactions costs are high, relations tend instead to be internalised through vertical integration, that is, through corporate hierarchical control *(hierarchy)* (Gereffi et al., 2005: 83-84). In between these two ideal types of the continuum, i.e., between the governance modes of the market and hierarchy, three different *network* types of governance are identified, namely *modular, relational,* and *captive*. In turn, the specific choice of governance mode depends on the level of transaction costs associated with the specific buyer-supplier relations, which in turn relies on the level of supplier competencies, knowledge codification, and transaction complexity (Gereffi et al., 2005: 83-84). Third, governance in GVCs may also be treated as *normalisation*, which reflects an analytical focus on the discursive dimension of the value chain, as discourses produce rules, institutions, and norms, which frame buyer-supplier relations (Ponte, 2007; 2009; Gibbon and Ponte 2005; Ponte and Cheyns, 2013). The notion of normalisation denotes the ”project of re-aligning a given practice so that it mirrors or materialises a standard or norm” (Ponte, 2009: 237). Most of these studies inquire into how standards and processes of standardisation influence the governance of industrial relations in GVCs, in particular the governance and role of quality, as they produce and are founded in normative systems[16]. Governance as normalisation is a mode of hands-off governance by lead firms, as standards rule and govern by setting norms and quality conventions, which work at a distance, making market coordination more cost-efficient (Gibbon and Ponte, 2005: 11; Ponte 2009). Along the same social constructivist lines, Gibbon and Ponte (2008) have looked further into the role of norms and narratives for GVC governance, adopting a *governmentality* lens, or rather, a so-called ‘programme of government’ approach (Gibbon and Ponte, 2008: 367). Inquiring into the potential shift ‘from governance to governmentality’, this approach dives deeper into the broader normative frameworks in which quality conventions operate, and the tools applied. Through the programme of government lens, the governance of the chain is

[16] Early work on governance as normalisation borrowed from convention theory (e.g. Boltanski and Thévenot, 2006; Thévenot, 2009) to situate and analyse the dynamics of buyer-seller relations in wider normative contexts (in Ponte, 2009).

co-determined not only by economic characteristics, but also by the diffusion of a variety of broader normative paradigms and narratives circulating within society (Gibbon and Ponte, 2008).

Upgrading through chains and networks

In addition to being preoccupied with issues of governance, the existing literature to various degrees also inquires into implications for industrial upgrading (e.g. Humphrey and Schmitz, 2002; Gereffi, 2005; Ponte, 2007: 2; Morrison et al., 2008). Thus, economic geography looks into how international linkages and integration into global chains and/or networks of production and innovation can play a role in accessing technological knowledge and enhancing learning and innovation. While the earliest frameworks with a background in world systems theory tended to offer a somewhat bleak picture for developing countries, later frameworks have emphasised the potential for upgrading. In regard to the GCC literature (Gereffi, 1994a; 1994b; 1999), upgrading is treated as a matter of a dynamic movement from assembly towards becoming original equipment manufacturers, brand manufacturers, and finally design manufacturers (Gereffi, 1999: 51). Later, the GVC framework argued that the specific governance mode of the chain determines, not only the process of adding and distributing value along the chain, but also upgrading possibilities, and thus the potential for transforming and upgrading within the GVC (Humphrey and Schmitz, 2002: 1017; Schmitz, 2004: 1; Parrilli et al., 2013: 970). The different ways in which countries and industrial clusters are inserted into GVCs, and particularly the GVC governance mode and the position of developing country firms selling to large, global buyers, thus have consequences for upgrading (Humphrey and Schmitz, 2002: 1017). In parts of the GVC literature, upgrading is treated as a matter of process, product, functional, and chain- or inter-sectoral upgrading (Humphrey and Schmitz, 2002).

While not having developed a comprehensive approach to governance or upgrading, the GPN framework instead focuses on the role of the institutional context for upgrading. In addition, GPNs may evolve into GINs, as innovative and potentially disruptive technologies enter the industry, and the power of incumbent MNCs is reduced (Cooke, 2013). Hereby, the GPN framework clarifies the margins for upgrading processes (Parilli et al., 2013: 976), e.g. by displaying how a specific GPN architecture of ICT globalisation is transitioning (or not transitioning) to a GIN (Cooke, 2012: 1082). For instance, in Cooke’s study on GINs and GPNs in the Singaporean ICT sector, the rise of GINs is taking place in only the most dynamic parts of the global ICT industry, while the less dynamic and innovative parts are still dominated by concentration of power in MNCs in a GPN (Chen, 2004; Chen et al., , 2010 [2011] in Cooke, 2012: 1089). Overall, these literatures (in particular the GVC framework) have also inquired into barriers to upgrading, i.a. seen as effects of particular governance modes and/or technological capabilities of suppliers (e.g. Humphrey and Schmitz, 2002; Fu et al., 2011; Figueiredo, 2002; Morrison et al., 2008).

Moves towards synthesising frameworks within economic geography

While the GVC literature has the most developed framework for upgrading and governance, the GIN literature offers a lens for regional upgrading processes in terms of innovation types and the position of the firm in the GIN (Parrilli et al., 2013: 972). Like the GPN framework, the GIN framework tends to look at regional upgrading processes as a matter of ’linking up’ with external resources, i.e. as a matter of ’strategic coupling’ (Parrilli et al., 2013: 970). With the gradual convergence of the GVC and GPN frameworks, and the emergence of the GIN framework, the GIN literature extends and adds to the coupling of the GVC and GPN literatures. With their respective strengths and weaknesses in terms of their insights into aspects of i.a. governance and upgrading, Parrilli et al. (2013) recommend that the contributions of the GVC, GPN, and GIN frameworks should be synthesised into a “more complete and dynamic territorial perspective on regional development in the context of globalization” (Parrilli et al., 2013: 967). With a concern for developing a framework for understanding the impact of integration into GVCs, GPNs, and/or GINs on local and regional development (LoRD), e.g. in terms of impact on industrial clusters[17], Parrilli et al. (2013) argue that

“we can think of GVCs and production-innovation networks as organizational clusters that produce foot-prints in local locations. In each of these locations, there are territorially based clusters constituted through overlapping footprints of similar chains and networks” (Parrilli et al., 2013: 985).

Consequently, “[w]e need to understand their [the clusters’] position in GVCs, GPN and GIN that are mediated through non-local links such as firm-specific organization of value-chain activities” (Parrilli et al., 2013: 985). Having conducted a brief review of the GIN literature and its neighbouring literatures within economic geography from which it has

[17] The cluster literature (Malmberg and Maskell, 2006; Cantwell and Piscitello, 2005; Sturgeon, 2004; Tödtling and Trippl, 2012; Tödtling et al. 2008; Giuliani, 2013; Giuliani and Bell, 2005; Herstad et al., 2014; Herstad et al., 2013; Liu et al., 2014; Altenburg et al., 2008; Chaminade and Vang, 2008) is generally based on assumptions of agglomeration effects and increased returns to specific technologies, and thus embracing the notion of a ‘lock-in’ (Arthur, 1989, 1996; Krugman, 1991) into certain technological trajectories (Dosi, 1982), which in turn indicates assumptions of path dependence in the cluster literature (Martin, 2010).

evolved, the chapter inquires in the following into how the existing literature has sought to conceive '*the relational'*.

Relations in the GVC, GPN, and GIN literatures

In the above, the thesis has illustrated many of the valuable insights provided by the GIN literature and related literatures within economic geography into the globalisation of production and innovation, governance relations and value distribution, institutional and other contextual factors, as well as into development prospects in terms of upgrading. In the following, the chapter reviews the literatures, by critically looking into their structuralist and rather static conceptualisations of 'the relational'. As already indicated earlier, the GIN literature looks into GIN genesis by looking at structures as evidence of GIN genesis, i.e. it looks at GINs from the outside and as a manifest result. Perceiving of relations in a network/systemic perspective (Parrilli et al., 2013: 972), the GIN literature tends to render a somewhat structuralist account, which does not put emphasis on the dynamics and/or potentially shifting quality of relations:

"The interaction between the intra-firm and inter-firm networks influences the geographic pattern of a GIN as well as its structure. Structure is defined here as the pattern of relations in the network. The structure of a network reflects how the network is organized and suggests 'possible ways in which we could exploit it to achieve certain aims'" (Newman, 2003: 180 in Liu et al., 2013: 1457).

Yet, no insight is provided into micro-processes of establishing relations at the outset, or of maintaining them over time. Without an insight into how relations are established at the outset, a micro-processual understanding of genesis is missing, as well as an understanding of the dynamics and agency of GIN construction. Overall, interested in "the geography and structure of GINs" (Coe et al., 2008 in Liu et al., 2013: 1457), GINs tend to be seen from the outside. The structural, meso-level, and exogenous lens on GINs can be linked largely to the way in which the GIN literature is positioned within economic geography, and thus is a science of the meso-level, which is primarily offering a structural, systemic lens. Thus, GIN studies do not inquire into 'micro'-processes of building relations or their potentially shifting quality, but tend to assume that relations are being built somewhat automatically, based on calculations of cost-minimising coordination of transaction costs, considerations of geographical scale and nearness, knowledge bases, and/or protection of core competencies.

Assuming relationship-building away – on implicit foundations of different paradigms

In the above, it has been indicated how the existing literature to a large extent, although to various degrees, builds on, – often implicit – assumptions of different overarching meta-theoretical paradigms. First of all, the literature (in particular, the GVC framework) draws on the institutional theory of the firm, namely transaction cost economics (e.g. Coase, 1988, Williamson, 1981, 2002), which treats relations as a matter of cost-minimising coordination. Second, the existing literature is informed by the resource-based view of the firm (e.g. Barney, 1991; Wernerfelt, 1984; Peteraf, 1993) and its dynamic capabilities view (Teece et al., 1997), which treat relations as strategic resources which can generate economic rents. This is e.g. seen in studies on the strategic considerations of firms to engage in GINs or not. Lastly, concerned with understanding the reorganisation of economic and social phenomena, the reviewed literature, in particular the frameworks which draw on more sociological and institutional perspectives, are also grounded in the paradigm of New Economic Sociology (NES) (e.g. Dobbin, 2004; Granovetter; 1985; Beckert and Zafirovski, 2011; Powell, 1998, Powell et al., 1996, Powell, 1990, Powell and Grodal, 2005; Padgett and Powell, 2012; Owen-Smith and Powell, 2004). At the intersection between economy and sociology and launched largely as a critique of neoclassical views of perfectly competitive markets, strains within NES emphasise the structuring of production, or what can be termed a sociology of markets (Fligstein, 2001: 6). With overlapping interests in evolutionary economics (Nelson and Winter, 2002; Penrose, 1959), the embedding institutional context, and in the implications for path dependency and lock-in (Granovetter, 1985), parts of the reviewed literature have its roots in NES. The foundations of the paradigms of transaction cost economics, the resource-based view, and/or in NES however imply that the existing literature of the GIN and other economic geography frameworks to different degrees 'assume away' the very *micro-dynamics* and potential socio-material resistances to relationship-building. The thesis argues that to open the black box of the GIN, and to render an account of GIN genesis, dynamics, and agency, it may help to set aside the very GIN metaphor in the analysis to avoid being 'misled' and 'seduced' by it. That is, the thesis argues that GIN studies must paradoxically 'look away' from the 'GIN' construct, instead treating GINs as a relational, emergent effect. In the following, the chapter ventures further into a critique of the 'relational gap' in the existing literature.

Critique – rich in structure, impoverished in 'the relational'

It may be noted, though, that some GIN studies do inquire into the emergence of GINs, e.g. (as earlier indicated) treating it as a matter of the industrial knowledge base, the institutional context, or as a matter of transformation from GPNs into GINs. Indeed, the reviewed GIN and economic geography frameworks reviewed are strong in their structural accounts, and in the detection of patterns of ties. As a science of the meso-scale (Grabher, 2005: 13), the narrative of economic geography is one of scales and spaces at a relatively high level of spatial aggregation. Thus, the geographical and locational argument plays an important role for the emergence of clusters, global chains and networks (Parrilli et al., 2013; Dicken et al., 2001). However, to the knowledge of the author, there exist no in-depth, endogenous studies on intra-firm and inter-firm micro-processes of relationship-building, or on the shifting quality of relations. Rich in topographic structure, but impoverished in processes of relationship-building, the thesis argues that network genesis risks to be 'assumed away'. That is, by 'looking away' from processes of building relations, the GIN literature tends to miss out on the *emergence, activation, and durability* of GINs. The thesis claims that by looking at GINs mainly through an exogenous lens from 'above' and 'the outside', as a 'fact' and a 'result', and basing it largely on formal, geographical structures, implies a risk of overlooking the very *networking* (GIN-ing) of the network, i.e. GINs as an emergent effect. That is, the relational aspect of how the network must be actively constructed and maintained through various socio-material means is put aside.

Critique: Dynamics in the GIN literature

Having inquired into the conceptualisation of 'the relational' in the GIN framework and economic geography, the following section critically reviews the conceptualisation of dynamics in the existing literature. While the chain constructs within economic geography offer a somewhat static, linear, and hierarchical account of economic globalisation, network studies (e.g. GIN and GPN frameworks) tend to adopt a more dynamic and holistic lens. This is e.g. done by adopting an evolutionary perspective or even what is coined a lens of 'dynamic path dependence', in order to account for 'on path' development/evolution without lock-in and de-locking (Martin, 2010 in Silva and Klagge, 2013: 1342). This is e.g. seen in Silva and Klagge's (2013) GIN study within China's wind power market, which illustrates how the accumulation of small and incremental changes has led to fundamentally new structures, such as the construction of GINs (Silva and Klagge, 2013: 1341, 1352). Also, the GPN framework with its interest in the institutional context is more likely to be used to describe product network dynamics and changing regional and national landscapes of industries (Parilli et al., 2013: 974), as it adopts a more geographically sensitive network analysis of the global economy (Coe et al., 2008b: 269). Some of these studies inquire directly into dynamic "change processes" in an interplay between GPNs and GINs (Liu et al., 2013: 1470), as GPNs are sometimes transformed into GINs (Cooke, 2012: 1091). Accordingly, and as indicated earlier, Parrilli et al. (2013) argue that the integration of GIN, GVC, and GPN frameworks can render an explanation of "the dynamic transformation of industrial clusters in LoRD [Local and Regional Development]" (Parrilli et al., 2013: 985). However, still looking at MNCs and other types of organisations 'from the outside', these units of analysis still tend to be black-boxed, which renders little insight into how they and their relations may shift in *quality*. Hereby, a more fine-grained understanding of changing micro-dynamics of network configurations and transforming governance structures is still missing.

Critique: Agency in the GIN literature

Chain and network constructs and their constituting parts are, to a large extent, assumed to have a fixed ontology, as also indicated above. Thus, studies are seldom opening up micro-processes and –relations of lead firms or other constituting parts, or of GCCs, GVCs, GPNs, GINs, clusters, or the institutional contexts embedding them. Instead, they tend to be treated as black-boxed entities, without rendering an insight into the heterogeneous actors and entities inhabiting them, and their potential ongoing transformations. Further, developing countries in the economic geography literature are often treated as relatively passive actors, without much leverage on the constitution of their networks. However, by inquiring into a sub-sector within the Singaporean ICT industry, Cooke's (2013) qualitative case study does provide some insight into the agency of local governments, namely as the Singaporean Government has initiated a process of change, which "opened up other GPNs to innovative competition from other TIS [technological innovation system] set-ups in NICs [Newly Industrialised Countries] and emerging markets" [such as China]" (Cooke, 2012: 1091-2). In this way, the country's strategy has been

"not to find itself at the end of a linear and hierarchical GVC, but to influence it by forging a GPN in which its economic and political interests were met as well as those of the inward investing MNC" (Cooke, 2012: 1091).

However, network and chain constructs and their constituting parts still tend to be black-boxed, and their ontology assumed fixed. Overall, agency is often automatically relegated to lead firms, governments, and institutional contexts (e.g. innovation systems), instead of inquiring into how and whether agency changes over time, and whether other actors may acquire agency, e.g. technologies. Nevertheless, Cooke's study renders new insights, as he looks into how technological change elsewhere in the ICT industry, where GINs have been constructed, may "place the whole GPN sub-network [around hard disk drives (HDD)] in jeopardy" (Cooke, 2013: 1093). Thus, the emergence of disruptive technologies such as cloud computing (Cooke, 2013: 1090) in the innovative GIN of the ICT industry may pose perils to the relatively stable, cost-cutting, low-wage, un-innovative segment of the HDD technology and its GPN. This indicates a gradual (though largely implicit) acknowledgement of the potential agency of non-humans. Further, the GPN framework generally holds a somewhat more 'open' ontology than the other literature streams, sometimes even claiming to allow for the incorporation of material processes (Coe et al., 2008b: 271), since material technicalities of the specific transformational processes shape and are shaped by GPNs (Coe et al., 2008b: 274). Still linked to canonical forms of path dependence from institutional embeddedness, as outlined above, the literature, however, risks overlooking the potential agencies involved in bringing about GINs, i.e. agencies of relationship-building.

Mind the gap!

In the above, the chapter has demonstrated how the existing literature has started to look into the emergence of GINs. When GIN emergence is treated in the GIN literature, this is largely done by explaining it as a matter of evolutionary transition of GPNs into GINs, as causal relations between industrial knowledge bases and firm behaviour, and as knowledge-seeking strategies of MNCs from developing countries embedded in favourable institutional contexts and innovation systems. At the same time, it has illustrated how the literature has managed to offer insights into the structure of relations and the effects of networks, but not into the quality and content of relations. The thesis argues that treating relational structures *after the fact* risks overlooking processes of relationship-building, and thus of the genesis, dynamics, and agency of GINs. To be fair, however, the GIN literature (and the neighbouring literature streams) may not have as its goal to render a narrative on micro-processual and micro-relational genesis. Yet, suggesting that the genesis (as well as dynamics and agency) lies at the heart of the matter, when trying to understand the seeming requalification of the wind power market in China during the current quality crisis, the thesis proposes that an exploration of how and whether another perspective than the GIN perspective might be able to provide insights into aspects of GIN genesis, dynamics, and agency. The argument for the need of a more processual and relational lens, which can render insight into the quality of relations, rather than the structure of relations, has also been raised in economic geography. For instance, in the GPN literature it is argued that

> *"the structure of a network tells us little about the qualitative nature of the relationships, which is far more important than structure per se. Instead, we see power as the capacity to exercise that is realized only through the process of exercising" (Dicken et al., 2001: 93).*

In this way, the existing literature has raised concerns that scholars should 'mind the (relational) gap'. In the following, the thesis dives further into the characteristics of a potential 'relational turn' in the existing literature.

A contested relational turn in economic geography

Through its increasing focus on embeddedness and relations, the GPN framework in particular seems to have embarked on a 'relational turn'. Flirting with ideas and perspectives from New Economic Sociology (NES), a 'relational economic geography' is emerging as a "self-consciously relational and specifically geographic approach to the study of the global space-economy" (Hess and Yeung, 2006 in Bair, 2008a: 356). This relational economic geography draws inspiration from NES, which – as also touched upon in *Chapter 1* – calls for

"[m]ore process-oriented, case-based approaches [that] provide rich accounts of why ties are created, how they are maintained, what resources flow across these linkages, and with what consequences" (Smith-Doerr and Powell, 2005: 394).

Yet, in economic geography there is disagreement as to the benefits of the integration of the sociologically oriented NES perspective into economic geography. For instance, according to Bair (2008a), the relational network approach of NES is claimed to miss out on the 'global factor' (Bair and Gereffi, 2007), as its focus on micro-sociological embeddedness perspectives offers a too myopic and locally biased view according to Bair (2008a). This risks neglecting the multi-scalar, structural dynamics of the global economy and the international dimension of economic organisation (Bair, 2008a: 347). While Bair concludes that the ontological and epistemological differences between NES and economic geography are too vast (Bair, 2008a: 347), Grabher (2005) is relatively open towards the potential cross-fertilisation of economic geography and network approaches in NES, concluding that there are interesting overlaps. At the same time, though, he warns against the ontological and epistemological pitfalls of combining and synthesising theories (Grabher, 2005: 2). This indicates a recognition of the potential benefits of a relational turn in economic geography. Within GPN, Dicken et al. (2001) take a more radical approach than adopting a sociological (NES) perspective, instead emphasising 'the relational' as methodology. This they do by pointing to how a constructivist lens of Actor-Network Theory (ANT) (e.g. Callon, 1986a; 1996a; Callon, 1991; 1998; 2007; 2009; Law, 1994; 2009) may provide an insight into the relational. That is, the constructivist ANT lens looks at "[a]ctions or practices, rather than structures" (Dicken et al., 2001: 101), and treats networks as the configuration of emergent network relations (Dicken et al., 2001: 94).

Indications of a shift towards lateral accounts, dynamics, and agency

While chain constructs of economic geography, in particular, tend to suffer from a mechanistic, hierarchical, and linear lens, the GPN and GIN frameworks have taken steps towards a more relational, contextualised, and embedded network approach. In addition, the GVC framework has attempted to introduce a 'micro-foundational' view of global industries (Gibbon and Ponte, 2008; Ponte, 2007, Ponte, 2009), e.g. by emphasising the role of discourses, as they produce rules, institutions, norms, and conventions of 'quality' (Ponte, 2007; Ponte, 2009, Gibbon and Ponte, 2008). Nevertheless, it is still the GPN framework, which has made the most significant steps towards including more types of actors and proposing a lateral account, where horizontal, diagonal, and vertical links can be seen to form multi-actor, multi-layered lattices of economic activity (Sturgeon, 2001: 10 in Henderson et al., 2002: 442). Proposing this lateral perspective, the GPN framework attempts to move beyond the linear flows and/or 'simple' circuits concept implicit in the chain heuristic/metaphor (Dicken, 2007: 13-15). Proponents within GPN have, accordingly, argued for dissolving the bifurcation of the global-local nexus, which construes a causality between spatial scale and density of ties, and instead operate without one scale dominating the other, i.e. looking into the intermingling of different geographical scales in network formation and network processes, or what is framed as 'spaces of network relations' (Dicken et al., 2001). In addition to these proposals for dissolving the global-local nexus, the GPN framework has also been experimenting with incorporating non-firm actors as *constituent* parts (Coe et al., 2008b: 275) of networks, and thus providing other actors with potential agency. This indicates an increasingly flexible ontology of networks. Lastly, the GPN lens has also taken steps to prevent taking for granted the existence of networks, relating agency to the situational power to create, join, or escape networks (Dicken et al., 2001: 94). Accordingly, power is thus a contextual practice rather than a position within a network (Dicken et al., 2001: 93).

In addition to these moves towards a more relational and lateral perspective, the GIN literature has (indirectly) opened up towards agency of technologies and to variations of GIN emergence within industries. In particular, while not relegating agency explicitly to material actors, Cooke's (2013) study on the HDD subsector indicates that there may exist socio-material barriers to transformation into GINs. In this way, looking into GINs around specific components might be beneficial to a more detailed and sophisticated understanding of genesis, dynamics and agency of GIN construction, and how there may exist (socio-material) barriers to transformation from GPNs into GINs. Overall, a potential relational turn with more lateral accounts and a more flexible ontology of chains and networks might be underway in the existing literature, with more focus on 'the relational'. Despite these attempts in economic geography, the different approaches have in the empirical studies not moved very far in terms of developing a lens, which can capture the micro-processes of building relations and their (potentially shifting) quality. Therefore, the different types of actors central to the analysis remain limited, e.g. not taking a 'symmetrical' approach, which would allow for human and non-human actors on equal terms, and mostly subscribe to a space/scale construct, which divides the world into 'micro-', 'meso-', and 'macro'-scales. Such a space/scale construct tends to assume hierarchical power structures, instead of inquiring into how these structures are established at the outset. Overall, GINs tend to be seen from the outside, treated as a 'result'. Hereby, an account of the emergence of GINs in Chinese wind power is still missing, i.e. an account which can render a deeper insight into aspects of potential GIN genesis, GIN dynamics, and GIN agency.

Towards a constructivist perspective – through a pragmatist tunnel

With an interest in inquiring into the genesis, dynamics, and agency of GINs, the thesis is inspired by moves within economic geography, which has proposed that a constructivist perspective might provide a new set of tools for capturing processes of relationship-building (e.g. Dicken et al., 2001; Grabher, 2005). Such convergence indicates that ANT may not be completely incompatible with the economic geography. Indeed, it can be argued that both the perspectives of constructivism and of parts of the 'relational' economic geography, which have been inspired by NES and/or ANT, share an interest in the relational and processual. In turn, such concern for the 'micro'-relational and –processual has philosophical roots in American pragmatism. ANT is explicitly founded in American pragmatism (e.g. Dewey, 1927; Whitehead, 1978; Elias, 1978; Mead, 1934; e.g. seen in Law, 1994; Callon and Çalişkan 2009; Muniesa, forthcoming; Yaneva, 2012; Latour, 2005a; 2005b). That is, arguing that human beings discover and appropriate the world through their social (inter)action, pragmatist philosophy is interested in the micro-processes and 'the relational'. With its relational and processual lens, a constructivist perspective of ANT, as well, is at its outset founded in American pragmatism (Muniesa, forthcoming). In turn, though economic geography is not founded in American pragmatism, and most streams within it does not ascribe to its micro-sociology, the thesis argues that the 'relational turn' in parts of economic geography and the turn towards constructivist lenses implicitly indicate pragmatist affinities. The thesis in this way seeks to connect the constructivist perspective with economic geography, including the GIN literature, through a 'pragmatist tunnel', due to common concerns for the relational. It is thus the ambition to conduct a study on GIN genesis, dynamics, and agency in Chinese wind power by way of exploring how and whether a constructivist perspective can contribute to the GIN literature through insights into genesis, dynamics, and agency, despite the ontological and epistemological divides between the constructivist and GIN perspectives. Summing up, the analytical framework of the thesis has clear roots in the philosophy of American pragmatism and adopts a constructivist perspective in order to conduct its empirical analysis of GIN genesis, dynamics, and agency within Chinese wind power. In the following, the common 'pragmatist' concerns of the constructivist perspective and of the 'relational turn' in economic geography are briefly outlined.

A constructivist perspective founded in pragmatist philosophy

With a focus on the mode of connecting/relating a nexus of entities (Whitehead, 1989, Latour, 2005 in Yaneva, 2012: 2), American pragmatist philosophy defines all things in terms of their relatedness, as they are coming together in an 'event' (Fraser, 2010). This makes the process of building network relations a matter of practical investigation. As indicated earlier, such pragmatist interest in how things come into being, by inquiring into its relational and processual aspects can be witnessed in parts of economic geography and NES, i.e. what the thesis has coined a potential 'relational turn'. The potential cross-fertilisation between economic geography and pragmatism is explicitly evidenced in an historical study on global supply and value chains, based on economic geography concepts, in the US and European manufacturing industries (automobile, machinery) as well as the U.S., German, and Japanese steel industries (Herrigel, 2010). In this study, a pragmatist lens is employed, looking into the quality and dynamics of relations, to ensure a lens for the *complexity* of supply chain relations through space and time through a bottom-up, anti-structural, and relational approach (Herrigel, 2010: 149).

Summing up, in the above, it has been indicated how some streams within economic geography adopt a micro-relational lens, which can be argued to reflect pragmatist affinities. At the same time, the constructivist perspective of ANT has explicit roots in American pragmatism. The pragmatist roots of ANT is reflected i.a. in the way that the constructivist perspective emphasises processes of connecting and 'becoming together', i.e. of *relating* heterogeneous (i.e. encompassing human and non-human entities) into networks (e.g. Latour, 2005, Yaneva, 2012; Callon and Çalişkan, 2009, 2010a, 2010b; Law, 1994). With the knowledge on the emergence of GINs in different industries and regions, and in particular within China's wind turbine industry, the thesis is interested in *how* these GINs emerge, and in their dynamics and agencies. Further, the thesis is interested in how and whether GINs take part in the de- and re-qualification of China's wind power market during the current quality crisis. That is, the thesis inquires into the potential role of GINs in the market construction – or what is termed *marketisation* (Callon and Çalişkan, 2009; 2010a; 2010b) – in Chinese wind power. Yet, having pointed to the 'micro-relational' gap in the existing literature, the thesis argues that a ‘pragmatist’ move *away* from the foundational GIN literature towards a constructivist perspective is needed. The relational lens of the constructivist perspective, its roots in American pragmatism, and the stream of Anthropology of Markets (AoM) (amongst others) will be expanded upon in *Part II* of the thesis.

Adopting a constructivist marketisation lens for studying genesis, dynamics, and agency

Having construed a ‘pragmatist tunnel’ through their common pragmatist affinities, the thesis can thereby move from the GIN perspective to the constructivist perspective in order to shed light on GIN genesis, dynamics, and agency. Further, this may help shed light on how emerging GINs may form part of market construction (marketisation) in a developmental context of greening, as they participate in qualification processes. By coupling the two seemingly conflicting approaches of the positivistic GIN literature and the constructivist (ANT) perspective through the use of American pragmatism, the thesis extends both the perspectives of economic geography as well as that of constructivism, to render an account of both the structural *and* the processual aspects of GIN construction. To do this, however, the thesis first leaves aside the traditional GIN construct altogether.

In the following *Part II* of the thesis (*Chapters 3-5*), a constructivist theoretical framework for studying the case of potential GIN genesis, as well as dynamics and agency in China’s wind power market is outlined. This lays the foundation for a constructivist analysis in *Part III* (*Chapters 6-12*), which thus does not apply the GIN framework or GIN construct, but instead adopts a constructivist perspective to explore whether and how it can contribute to the GIN literature. Hereafter, the GIN construct re-enters the thesis in *Part IV* (*Chapters 13-15)*, where potential contributions from a constructivist perspective on GIN construction within Chinese wind power are discussed and concluded upon. Exploring what a constructivist perspective may render of insights into aspects of GIN genesis, dynamics, and agency, the thesis thus responds to wider calls within NES for studies on dynamics of network genesis and maintenance (i.e. their emergence, activation, and durability) (Powell et al., 2012; Smith-Doerr and Powell, 2005; Padgett and Powell, 2012).

Part II: Theoretical and Methodological Implications of a Constructivist Perspective – and Modest Modelling

With an interest in the construction of a market for wind power in China, and the potential role of GINs in the current qualification crisis, the thesis points to a need to inquire into the *genesis, dynamics,* and *agency* of GINs within Chinese wind power. Arguing that micro-processes of relationship-building lie at the foundation of GIN genesis, *Chapter 2* conducted a critical review of how 'the relational' has slowly begun to beconceptualised in parts of the GIN-literature and within parts of economic geography, from which the GIN literature has evolved. Illustrating how the GIN literature has adopted a structural lens of looking at GINs 'from the outside', rather than looking at the micro-processes of relationship-building 'from within', the thesis suggests that the GIN literature misses the relational aspects of the genesis, dynamics, and agency of GINs. The thesis proposes that a constructivist perspective – introduced through a so-called 'pragmatist tunnel', which bridges common pragmatist roots of the constructivist perspective and parts of economic geography – might help shed light on these issues.

Inquiring into the potential emergence of GINs around software technologies in Chinese wind power, and exploring how and whether a constructivist perspective can be helpful, *Part II* (*Chapters 3, 4,* and *5*) in the following unfolds a constructivist theoretical and methodological framework and tool set, which concludes with a proposal for how to study GIN genesis, dynamics, and agency in Chinese wind power. This is done by treating GIN construction as part and parcel of the requalification process in China's wind power market. First, *Chapter 3* conveys an outline of some of the basic premises and constructs of the constructivist perspective proposed by the thesis. Second, this leads to *Chapter 4,* which renders an account of the methodological implications of adopting a constructivist perspective. Together, *Chapter 3* and *Chapter 4* lay the foundation for developing a grounded, situational 'model' in *Chapter 5,* which has been developed specifically for studying market construction of 'green markets' in a developmental context of China.

Chapter 3. Theoretical Premises and Constructs of a Constructivist Marketisation Perspective

Inquiring into how GINs around software may be emerging and how they may be part and parcel of the requalification of wind power in China, *Chapter 3* turns away from the GIN literature towards a constructivist perspective, with a focus on constructivist studies on market construction, or what is coined as 'marketisation' (Callon and Çalişkan, 2009; 2010a; 2010b). Yet, while the thesis employs what it coins a 'marketisation lens' to inquire into the qualification of wind power in China as sustainable, the umbrella term of marketisation for the theoretical framework of the thesis covers a number of theoretical streams within the constructivist field of Science and Technology Studies (STS), some of which are not directly concerned with issues of market construction, i.e. marketisation. These different streams within STS have been coupled and synthesised in the thesis to provide the basis for conducting a situational study on the marketisation of Chinese wind power as a matter of qualification (*Part III*), and to expand on how such a marketisation lens of a constructivist perspective may contribute to the GIN literature (in *Part IV*).

Apart from drawing on the marketisation lens of the Anthropology of Markets (AoM) and its *performativity programme* (Callon and Çalişkan, 2009; 2010a; 2010b), the thesis draws inspiration from the sociology of associations (Latour, 2005a; Garud et al., 2010a). These two literature streams are in turn founded on the basic premises of Actor Network Theory (ANT) (e.g. Callon, 1986a; 1986b; 1991; 1998; 2007; 2009; Callon et al., 2002; Latour, 1992; 2004; 2005; Law, 1994; 2003; 2009). Although having different focus, the mentioned STS-streams all adopt a lens of an *ecology of practice* (Stengers, 2005a), or even an *ecologies of practice* (Gad et al., 2014), which is concerned in one way or the other, with the '*hows'* of assembling heterogeneous entities (humans, non-humans, and hybrids) into temporarily stabilised 'wholes' (e.g. 'markets', 'economy', 'GINs', 'scientific facts', sustainability, and 'society'). Thus, founded in an ecology of practice, the unit of analysis in a constructivist marketisation account becomes the very *practice* (action, or so-called 'performance') of connecting and *relating* heterogeneous entities into temporarily stabilised networks. This requires that

"any practice must be studied with a view to the continuous processes through which it comes to change from other practices, but especially its ongoing process of transforming itself" (Gad et al., 2014: 6).

Since each practice is assumed to be particular to the specific assemblage and its constituting parts, "no practice can be defined externally, but has to be qualified 'from within', through its own specific mode of divergence" (Gad et al., 2014: 6). It is the proposition of the thesis that such a study of an ecology (or ecologies) of practice is helpful to trace the relational (Gad et al., 2014: 6) and to open up constructs such as 'the market', 'the economy' (Callon and Çalişkan, 2009: 371), 'science' and 'scientific facts' (Latour, 2004), 'the social' (Law, 1994; Latour, 2005a), as well as 'GINs' and 'sustainability'. In the following, the chapter sets out with a brief historical account of the origins of the marketisation lens. This leads to an outline of some of the basic premises of the adopted constructivist perspective, and some of the key analytical constructs employed in the thesis.

Origins of the marketisation lens – and positioning it within New Economic Sociology (NES)

In the following, the historical roots of the marketisation lens are outlined briefly. This involves an introduction to the origins of ANT, to the streams of the AoM and the Sociology of Associations, and to a positioning of the marketisation lens within New Economic Sociology (NES).

Into the laboratory – on the roots of Actor-Network Theory (ANT)

Since the late 1980s, ANT has emerged as an influential research agenda within STS. However, the stream of ANT already started as a current in the 1970s at the French engineering school oriented towards industrial innovation, *l'École des Mines,* in Paris. Here, scholars of what was later to become labelled as ANT drew inspiration from a number of fields, e.g. American pragmatism (e.g. Elias, 1978; 2006 [1969]; Whitehead, 1989; Dewey, 1927), French poststructuralism (e.g. Serres, 1982; Deleuze and Guattari, 1983; 1987; Greimas; 1987; Foucault, 1991 in Muniesa, forthcoming: 3)[18], as well as from the French tradition of the epistemology of science and the British tradition of sociology of scientific knowledge within studies on scientific inquiry (in Muniesa, forthcoming: 4). During the early foundational years, the main thrust of ANT studies were concerned with the sociology of science and the study of the interrelations between science and society (Muniesa, forthcoming: 2). This involved a number of studies conducted literally 'in the laboratory'. That is, interested in how scientific facts and knowledge are being socio-materially constructed, e.g. through the use of tools for calculation (calculative tools), scholars went

[18] ANT is inspired by e.g. Serres through notions such as 'translation' (Serres, 1982, Serres and Latour, 1995 in Muniesa, forthcoming: 3); Deleuze and Guattari through notions of the rhizome and the collective assemblage of enunciation as well as a "philosophical take on a materialist understanding of signification" (Deleuze and Guattari, 2011 [1980], in Muniesa, forthcoming: 3); Greimas (1987) through a semiotic actantial model to interpret operations of signs and texts (Greimas, 1987 Muniesa, forthcoming: 3), and Foucault (1991) through his concept of power and governmentality.

‘into the laboratory’ (e.g. Latour, 1982; 1987). These laboratory studies illustrate how scientific facts and knowledge are assembled and produced, e.g. through experimentations, measurements, inscriptions, calculations, and writings (Muniesa, forthcoming: 4). Hereby, they helped illustrate

“the Janus face of science as both constructed and realist. In so doing we followed the actors, often ethnographically” (Bowker and Star, 1999: 48).

Over time, the constructivist realism, as proposed by ANT, has moved out of the laboratory and into studies of engineering and technological innovation (e.g. Callon, 1986b), as well as into organisation studies, political science, anthropology, economic sociology etc. Overall, the ANT perspective constitutes a fusion of sociological and technological theory, “characterized by a distinctively materialist, radically constructivist approach to social theory and to empirical research” (Muniesa, forthcoming: 1).

Moving into markets – on the marketisation lens of the Anthropology of Markets (AoM)

After having moved into different fields such as economic sociology, ANT has also moved into the fields of economics and market studies (Callon, 1998; Callon and Çalişkan, 2009; 2010a; 2010b). In his studies on the socio-material construction of the economy, Callon (1998) argues that instead of assuming ‘the economy’ to exist *a priori,* studies should investigate how the economy is consistently performed and maintained by material processes, economics, and economic tools, in processes of economisation (Callon, 1998: 30-31). In what is coined as a ‘performativity programme’ (Callon, 1998; Callon and Çalişkan, 2009; Callon and Çalişkan, 2010a; 2010b), Callon (1998) has, in his seminal study on ‘The Laws of the Markets’ illustrated the embeddedness of the economy in economics (Callon, 1998: 23). By demonstrating how there can be no economy without the theoretical field of economics, as economics enable the establishment of calculative agencies (i.e., the capacity to calculate) (Callon, 1998: 30), Callon and others illustrated how there can also be no market without the progressive construction and performation of the ‘economy’ (‘economisation’) (Callon, 1998; Callon and Çalişkan, 2009; 2010a; 2010b). Drawing inspiration from Callon (1998), Callon and Çalişkan (2009; 2010a; 2010b) have later extended the still emerging performativity programme to a focused study on the construction of markets. Callon and Çalişkan thus propose the development of a research programme – a so-called AoM – dedicated to the study of the socio-material work of *marketisation* (Callon and Çalişkan, 2009; 2010a; 2010b).

The AoM approach combines insights from science studies and disciplines of economic sociology and anthropology to inquire into marketisation and to demonstrate the entangled processes of economisation and marketisation (Callon and Çalişkan, 2009; 2010a; 2010b; Callon, 2007). Hereby, "[m]arketization becomes a dominant modality of economization. If the dynamics of economic markets are to be understood, then they must be placed within the context of broader movements that bring the economic into being" (Callon and Çalişkan, 2010b: 22). By inquiring into the progressive performation of the 'market' through socio-material calculative tools, neither the construct of 'the market' nor of 'the economy' (Callon and Çalişkan, 2009: 371) can be taken for granted or be used as *a priori* explanatory factors. Instead, these constructs take on verbal and processual connotations. This is e.g. seen in how 'the economy' and 'the market' are treated as processes (verb) of economisation and marketisation (Callon and Çalişkan, 2009), as well as of politicisation and scientification (Callon, 2009: 541). As on-going experiments, markets become objects for empirical and anthropological investigation.

Dissolving the ontology-epistemology divide

The lens of ANT sits ambiguously between a constructivist and a realist lens. Almost paradoxically, it conveys a both constructivist and realist lens (Latour, 1987, 1999 in Muniesa, forthcoming: 4; van Heur et al., 2013: 341, 357). That is, while rendering a critique of a purely realist perspective by demonstrating the constructed nature of e.g. 'the market', at the same time it emphasises the role of the materiality of markets (e.g. how they must be inscribed into a physical form, and how they must be socio-materially produced through calculations and calculative tools). With this both constructivist and realist stance, the ANT-lens questions the dualist divide between ontology as 'what is' and epistemology as our understanding and 'representation of what is' (Latour, 2004), a dualism which ANT frames as a product of 'Modern Reason' (Latour, 2004). Instead, founded on an ecology of practice, ANT seeks to dissolve this 'false', foundational dualism[19], inquiring into how this is being constructed in the first place. This line of thought within ANT draws inspiration from the American pragmatist Albert North Whitehead, who, according to Latour (2004), found it much more relevant to dive "much further into the realist attitude and to realize that matters of fact are totally implausible, unrealistic, unjustified definitions of what it is to deal with things" (Latour on Whitehead (1920), 2004: 244). With a both realist and

[19] A related way stating this is that ANT seeks to dissolve the foundational dualism between that which is framed as 'objective objects out there' (what Latour terms 'matters of fact' (*what is/*ontology)) and constructed 'Things' (what Latour terms 'matters of concern' (*representation of what is/*epistemology)) (Latour, 2004; 2005b).

constructivist lens, ANT beckons the researcher to study the practice, actions, and socio-material work involved in constructing 'matters of fact', such as e.g. 'the market', 'the economy' (Callon and Çalişkan, 2009; 2010a; 2010b), 'the social' (Latour, 2005a; Law, 1994). That is, analysis should inquire into the socio-material work involved in assembling such unities into black-boxed, 'objectified Matters of Fact', as well as inquiring into how these objectified 'Matters of Fact' often instead entail controversies and negotiations, i.e., and constituting politicised 'Matters of Concern' (Latour, 2004).

Critique of economics, anthropology, and New Economic Sociology (NES)

The marketisation lens conveys a critique of neo-classical (but also institutional and evolutionary) economics and their studies on the market and the economy (Callon and Çalişkan, 2009: 371-378; Callon and Çalişkan, 2010a: 2), as these tend to take for granted 'the economy' and 'the market' as effects of supply and demand, and/or looking at them as pre-existing institutions, which function as what Callon and Çalişkan (2009) term 'socio-cognitive prostheses' (Callon and Çalişkan, 2009: 392). In contrast, the marketisation lens looks at the economy [and market] as "an achievement as much as an outcome", which is never over (Callon and Çalişkan, 2010a: 2). In addition, the marketisation lens raises a critique of New Economic Sociology (NES) and anthropological studies on markets, value, and worth.

One of the points of critique of these two fields of research is the way in which they tend to focus on the role of humans at the expense of the potential role of material actors (e.g. non-humans such as calculative tools) in the performance of markets (Callon and Çalişkan, 2009). Founded in ANT's radical symmetry (Latour, 2005a; Gad et al., 2014), the marketisation lens treats humans and non-humans 'symmetrically' rather than prioritising humans over non-humans. To allow for an understanding of the potential role of calculative devices in performing the market, according to Callon and Çalişkan (2009), "[t]o arrive at our [performativity] research programme, the next crucial step would be to drop the hypothesis of an ontological asymmetry between valuating subjects/agents and valuated things/objects/goods altogether, while integrating the active role of materialities more generally" (Callon and Çalişkan, 2009: 393). Such materiality obliges the researcher to take seriously that anything is potentially an agent/actor, i.e., that anything may always acquire agency (Gad et al., 2014: 7). In this way, the marketisation lens counters *social* constructivist perspectives, since emphasis is put on how "[t]he construction of markets is a socio-technical construction, not a purely social one" (Callon and Çalişkan, 2009: 384).

In addition, instead of adhering to the heuristic explanatory device of 'embedding markets' within 'society', which NES tends to adopt by "embed[ding] the economy in society (and consequently economics in sociology)" (Callon and Çalişkan, 2009: 391), the marketisation lens sees marketisation as co-producing 'the social/the society' and vice versa. Such entangledness makes it impossible to use the 'society' or the 'institutional context' as an explanatory factor 'outside' of markets, since the social (like the market) must be consistently socio-materially 'produced', and since market and society are deeply intertwined processes.

Positioning the marketisation lens within New Economic Sociology – a pragmatics of valuation

Despite being launched as a critique of i.a. NES, Callon and Çalişkan (2009), however, simultaneously position their constructivist marketisation-lens within NES. That is, they seek to contribute to the study of markets by developing the performativity programme, which constitutes a "pragmatically oriented approach to valuation" (Callon and Çalişkan 2009: 384). The "pragmatics of valuation", which they propose, is based on insights from science studies as well as on the disciplines of economic sociology and anthropology (Callon and Çalişkan: 370). The "pragmatics of valuation" in the marketisation lens refers back to the American pragmatist John Dewey (in Callon and Çalişkan, 2009: 389) and his "Theory of Valuation" (in Stark, 2009: 5-6). Dewey illustrated how a market cannot exist and how products cannot circulate amongst diverse actors, prior to the construction of value and worth. As Dewey puts it,

"Nothing moves on its own. If a good is produced it is because it has a value for its producer; if it is distributed it is because it has a value in its consumer's eyes. The forces that explain the circulation-transformation of things are the same forces that give things value. In short, things circulate because they are valued and it is because they are valued that they become goods" (Dewey cited in Callon and Çalişkan, 2009: 389).

In order to perform the "circulation-transformation of things" (Callon and Çalişkan, 2009: 389), i.e., basically transforming a 'thing' into a valuable good, which is produced, distributed, and consumed, value and associations of worth must first be associated to the thing and potential good. The association of singularised qualities to the thing requires socio-technical tools to enable valuation. Overall, according to Callon and Çalişkan (2009), the "advantages of the pragmatic stance to valuation to the study of economization [and marketisation is] its attentiveness to things and materialities" (Callon and Çalişkan, 2009: 384).

Sociology of associations – and attributing value to a thing through associations

By inquiring into the construction of associations of value to an emerging good, the marketisation lens, which offers a pragmatics of valuation, also draws on a recent stream within ANT, namely the 'sociology of associations', applied to the study of the 'reassembling of the social' (Latour, 2005a). The sociology of associations demonstrates how it is necessary to trace the socio-material work of construing associations to things, as such associations can frame/qualify them, and in turn help attribute a certain (calculable) value to it. That is, in order to valuate the value of a potential good, qualifying associations/properties must first be attached to the thing, which can then potentially transform it into a good. To frame and qualify through the socio-material construction of associations, calculative tools and inscription devices must be employed. "This explains why the materialities of things matter" in marketisation (Callon and Çalişkan, 2009: 389). In other words, by disentangling and relating qualities and associations to a thing, the resulting framing contributes to conferring value on things (Callon and Çalişkan, 2009: 392), and thereby enabling market transactions to be performed. To frame (and qualify) means to establish calculative agencies (the capacities to calculate), making things calculable and actors calculative (Callon, 1998: 3, 16-23). Thus, to construct markets, calculations must be made, as

"markets are not possible without generating and then reproducing a stark distinction between the 'things' to be valued and the 'agencies' capable of valuing them" (Callon and Çalişkan, 2010b: 5).

Overall, the "pragmatically oriented approach to valuation enables us to understand flexibly why certain things have properties that facilitate their engagement in certain regimes of circulation-valuation rather than others" (Callon and Çalişkan, 2009: 389).

Basic Premises of a Marketisation Lens

Having outlined the historical roots of what the thesis coins a 'marketisation lens' and its positioning within the literature, the following section looks further into the main tenets of such a 'marketisation lens', namely by outlining some of its basic premises.

Principles of a radical generalised symmetry, a material semiotics, and a variable ontology

As indicated above, marketisation is a matter of qualification and valuation. To build a network (such as a 'market') around a potential good involves the participation of both human and non-human actors. That is, rather than privileging human and/or institutional actors in a constructivist marketisation lens, heterogeneous actors and entities are treated on the same basis, using the same words (Law, 1994: 12). This means that no entity can be assumed *a priori* to be more 'important' or 'powerful' or to have more 'agency' than others.

This principle of so-called *radical generalised symmetry* of ANT (Law, 1994: 12) lies at the foundation of a constructivist marketisation lens, and implies that the social and the material are perceived as inherently inseparable.

The ANT lens at the foundation of the marketisation lens draws inspiration from Greimas' (1987, in Muniesa, forthcoming and in Law, 2009) 'semiotic approach' to studying narrative structures of fairytales. In fairytales, all entities (actants) perform a certain 'task' to unfold the plot of the story. Hereby, each entity constitutes a 'semiotic sign' within the narrative structure. In turn, ANT-studies are founded on a 'material semiotics' (Law, 2009). This means that all entities (be they human, non-human, or even 'hybrids') are treated as 'actants' in the construction of networks (e.g. markets). An analysis should thus trace how certain entities take on roles as either actors/mediators or intermediaries in the performance of a potential network. Actors are mediators, which means that they attain agency to act and transform others (Latour, 2005a: 39), as they "define one another by means of the intermediaries which they put into circulation" (Callon 1991:140). In contrast, an intermediary, e.g. texts/literary inscriptions (patents, reports etc.), technical artefacts (scientific instruments, machines etc.), human beings (and their know-how, skills etc.), and money (Callon in Law 1991:135), is "anything passing between actors which defines the relationship between them" (Callon, 1991: 134). While actors have agency to act (i.e., acting as what is coined as an 'author'), and to associate texts, humans, non-humans, and money (Callon, 1991: 140), intermediaries do not have agency, but instead transport meaning without transformation (Latour, 2005a: 39; Callon, 1991). According to this account, "intermediaries *describe* their networks in the literary sense of the form. And they *compose* them by giving them form. Intermediaries thus both order and form the medium of the networks they describe" (Callon, 1991: 135).

Further, "[l]ike intermediaries, actors may be hybrid" (Callon 1991: 140). Such hybridity is seen in the way that "*an actor is an intermediary that puts other intermediaries into circulation*" (Callon, 1991: 141). Actants such as intermediaries and actors may thus have variable content, geometry, and ontology (Callon, 1991: 140; Latour, 2005a: 39; Law, 2004). To find out whether an actant constitutes an actor/mediator or intermediary, and whether their ontology shifts over time, thus becomes a matter of empirical investigation (Callon, 1991: 141). Overall, "quite minimal changes may transform intermediaries into actors, or actors back into intermediaries" (Callon, 1991: 142). The hybridity and ambiguity of the ontology of actants is also linked to the way in which "the imputation of authorship [attempts at becoming an actor], like all the other claims or suggestions made by intermediaries, is controversial, open to doubt or question” (Callon, 1991: 141). Accordingly, actors are not always successful, but may be rejected (Callon, 1991: 140).

While the shifting ontology of entities must be traced empirically, the analysis should also trace how the network they constitute is transformed accordingly. That is, rather than treating a network as a context for the actor, or the actor as immersed (‘embedded’) into or framed by the network, actor and network are two sides of the same coin (Karnøe and Garud, 2012: 4). Hereby, as the ontology of entities shifts, the relations between entities and thus the constitution, geometry, and ontology of the network that they constitute shifts as well. Hereby, actors, their relations, and the networks they constitute are treated as network *effects*, i.e. as relational ”effects of a set of materially heterogeneous relations” (Law, 2009: 145).

On network effects of the ‘four moments’ of translation and on distributed agency

Instead of categorising networks through stabilising nouns (Callon and Caliskan, 2009; 2010a; 2010b) such as markets or technical systems (Callon 1991: 140), the marketisation lens looks at networks as continuous and multiple processes of connecting and assembling heterogeneous actors into a collective. Looking into ‘what the thing *does*’ (exploring the *hows*), rather than asking ‘what the thing *is*’, ANT inquires into “the hows of relational materiality”, which reflects a realistic mode of inquiry (Law, 2009: 148). To inquire into and describe the *hows* of assembling actors into a network is in ANT often coined under the heuristic metaphor of ‘translation’ (Callon, 1986a).

Callon (1986a) treats translation through the notion of ‘four moments of translation’ (Callon, 1986s) as described below. If going through the different moments, the ‘translation’ of the network has been (temporarily) completed. First, the need for a new potential network must be problematised in order to connect actors and entities into a potentially emerging network – or what in ANT-parlour is coined as actor-networks (Callon, 1986a; Callon, 1991). Hereby, (1) *problematisation* constitutes the first of four ‘moments’ of translation (Callon, 1986a). Problematisation is often done by a so-called translator-spokesman. Second, if succeeding in problematising the need to connect, entities will be locked into their place in the emerging network. This constitutes the (2) ‘second moment’ of translation, namely *interessement*. When roles have been coordinated in the (3) ‘third moment’ of *enrolment*, the roles and future of heterogeneous entities can be (temporarily) stabilised/irreversibilised, and finally mobilising entities in the (4) ‘fourth moment’ of *mobilisation* (Callon, 1986a). When assembled into a particular network configuration, the network becomes able to ‘act and accomplish something together', i.e. acquiring a situational and particular mode of agency, which is dependent on how and by which entities it has been (temporarily) converged and assembled.

The translation process and conceiving of agency as a network effect denotes how agency is perceived to be distributed amongst heterogeneous actors and entities. That is, agency *"goes beyond the somatic resources of the individual, it is the variable outcome of a complex process of engineering"* (Callon, 2007: 140). The notion of distributed agency was originally coined for technological innovation (Callon et al., 2002; Doganova, 2009), as an 'art of interessement' (Callon et al., 2002). As regards technological innovation,

"the outcome of a project depends on the alliances which it allows for and the interests which it mobilises, no criteria, no algorithm can ensure success a priori. Rather than speak of the rationality of decisions, we need to speak of the aggregation of interests which decisions are capable or incapable of producing. Innovation is the art of interesting an increasing number of allies who will make you stronger and stronger" (Callon et. al. 2002: 205).

Applied to marketisation, distributed agency likewise denotes how agency is not contained within a single human being or contained in institutions, norms, values, and discursive-symbolic systems, but how it is instead distributed amongst heterogeneous actors, constituting a particular network effect (Callon and Çalişkan, 2010b: 28).

Framing in marketisation

When succeeding in a particular mode of translation, the actor network becomes 'framed' or 'qualified' in a particular way, and the translator-spokesman becomes indispensable and representative of the network (Callon, 1986a: 206-214; Callon, 1986b: 24-28; Callon, 1991; Callon, 1998). Translation and framing are thus integral to each other. To frame actors, their relations, and a potentially emerging network implies processes of disentangling, singularising, and bracketing qualities, making "relations visible and calculable in the network" (Callon, 1998: 19). That is, *framing* denotes the 'disentanglement' and singularisation of entangled qualities (Callon, 1998: 19). Framing is both cognitive and physical in nature (Callon, 1998: 249) and works by establishing

"a boundary [a frame against the outside world] within which interactions – the significance and content of which are self-evident to the protagonists – take place more or less independently of their surrounding context" (Goffman, 1971 in Callon, 1998: 249).

In the following, framing/qualification processes are set into a context of marketisation.

Five types of framing for the performance of marketisation

With regard to the construction of a market for an emerging good, as examined earlier, the good must be ‘framed/qualified’ through associations. These associations must be construed i.a. through socio-material calculative tools, which can help ‘pacify’ the potentially multiple and (sometimes mutually conflicting) entangled qualities into a calculable and stable quality and value (Callon and Çalişkan, 2010b: 6-8, 28-29). Thus, calculative tools are needed for the establishment of calculative *agencies*, i.e., for the construction of the capacity to calculate. According to the marketisation approach, there are five types of framing required for the performation of markets. These comprise *(1) pacifying goods, (2) marketising agencies, (3) market encounters, (4) price-setting,* and *(5) market design and maintenance* (Callon and Çalişkan, 2010b: 5). Thus,

“[f]or markets to emerge involves varous framings (framing of goods, of agencies and of encounters), price-setting mechanisms, as well as issues of their design and implementation” (Callon and Çalişkan, 2010b: 22).

These different types of framing are part of the establishment of calculative agencies, which is required for marketisation (Callon and Çalişkan, 2010b), and each *require material, textual and other investments,* e.g. through the employment of so-called pacifying calculative ‘framing tools’. That is, ongoing valuation processes through employment of framing tools are necessary for the circulation and transformation of an emerging good, and thus for price-setting and trading of a good:

In the process of *(1) pacifying goods*, i.e. of stabilising and black-boxing the many potential qualities of the thing into one (temporarily) pacified and irreversibilised quality/framing, framing tools such as property rights [e.g. intellectual property rights (IPRs)] and standardisation (Callon and Çalişkan, 2010b) play an important role. Property rights and standardisation respectively assign ownership rights and quantify qualities through testing and documentation. Thus, in the pacification of goods, which produces pacified agency of the good so that it can be transferred as property (Callon and Çalişkan, 2010b: 5), a distinction “between the ‘things’ to be valued and the ‘agencies’ capable of valuing them” must be generated and reproduced (Callon and Çalişkan, 2010b: 5). In turn, another defining characteristic of marketisation is (2) *marketising agencies*, which is seen in how the “multiplicity and diversity of actors compete to participate in defining goods and valuing them” (Callon and Çalişkan, 2010b: 8). That is, a host of marketising agencies are involved in the definition of the value of the potentially emerging good. Subsequently, (3) “[f]or things to be valued, it is necessary to have agencies capable of valuing them. But for the activity of valuing to take place, calculating agencies and goods have to meet one another.

Market encounters are hereby the third characteristic of the marketiation process (Callon and Çalişkan, 2010b: 14). Yet, such market encounters are not produced haphazardly (Callon and Çalişkan, 2010b: 14), but require a set of encountering devices (Callon and Çalişkan, 2010b: 14) and mediators, which can organise and frame the encounter (Callon and Çalişkan, 2010b).[20] Together, these "three forms of framing (of goods, agencies and encounters) are closely interrelated and shape the process of marketization in its generality" (Callon and Çalişkan, 2010b: 16).

When market encounters have been settled, the thing can be transformed and distributed, as a price can be calculated (4). That is, the "existence of a market implies that the valuations, and the calculations that produce them, come out in the form of prices" (Callon and Çalişkan, 2010b: 16). Yet, "Fixing a price is always the outcome of a struggle between agencies trying to impose their modes for measuring a good's value and qualities" (Stark, 2009 in Callon and Çalişkan, 2010b: 16). Lastly, as a dynamic and ongoing framing process to perform valuations, (5) marketisation requires consistent work of maintenance and market design (Callon and Çalişkan, 2010b).

Overall, these fives processes denote how framing processes are integral to the potential translation of a network configuring around a potentially emerging good.

Overflowing as the norm

While framing processes are integral to marketisation, the process of "cleansing, of disconnection, in short, of framing, is never over" (Callon, 1998: 17). That is, there "are always relations which defy framings" (Callon, 1998: 17). When the framing is defied, the framing *overflows* (Callon, 1998: 17). Overflowing denotes unexpected side-effects, which in mainstream economics would be coined as positive or negative externalities (Callon, 1998: 16-17). Such overflowing may destabilise the framing temporarily. When overflowing has been (temporarily) 'internalised', the overflowing is contained and the framing can be re-instored. Yet, contrary to mainstream economics in which 'framing' (i.e. assigning a more or less stable means of valuation) is the norm, ANT assumes that overflows are the norm (Callon, 1998: 23). Due to this impossibility of total framing (Callon, 1998: 18), translation processes and the final stabilisation of any network can never be assumed to be completed or stabilised. This implies that instead of assuming markets to be stabilised (black-boxed) unities, markets are treated as inherently unstable, as their framing is never

[20] Callon and Çalişkan (2010b) prefer the word mediator rather than the less dynamic term intermediary, "since the idea of mediation stresses the active participation in producing an outcome" (Callon and Çalişkan, 2010b: 14).

complete. In this way, the marketisation lens renders an account of markets as only temporarily stabilised, and as requiring ongoing maintenance, which in turn requires ongoing investments in framing attempts (Callon, 1998: 252). By assuming overflowing to be the norm, a lens for dynamics and agency of markets is conveyed, which does not assume that conventional framing devices (e.g. contracts) can irreversibilise the framing. That is, it is *"illusory to suppose that one can internalize every externality by drawing up an all-embracing contract that provides for every eventuality"*, or even that property rights can prevent this overflowing of know-how and technology (Callon 1998, 255).

This instability also implies that marketisation is not irreversible in economisation (Callon and Çalişkan, 2010b: 23). Instead, the emergence and stabilisation of a market ('genesis') is but a *potentiality* (Fraser, 2010; Stengers, 2005a; 2005b). Thus, instead of assuming the existence of markets, their progressive socio-material construction must be traced as a *potentiality*, and as a matter of *becoming* (Whitehead, 1978). At the same time, by tracing the event of the situational performation of markets, the performativity programme of the AoM is potentially "useful for elucidating the range of possible choices (in terms of calculative equipment, modalities of framing goods, socio-technical algorithms for market encounters, price-setting, etc.)" (Callon and Çalişkan, 2010b: 24). That is, the AoM opens up to the potentiality of multiple ways of assembling markets, or even other modes of organisation than through markets. Hereby,

> *"despite emerging tendencies, the idea of a market is indeed sufficiently open that original significations and alternative forms of organization are still imaginable. Moreover, the movement towards markets is by no means irreversible; other forms of economization can always be envisaged" (Callon and Çalişkan, 2010b: 23).*

Accordingly, a marketisation analysis should trace the specific socio-material construction and the specific types of framing involved in a specific site of valuation.

Lateral accounts on structures, power, and politics

Another basic premise of a marketisation lens founded in ANT is that these networks are laterally constituted. Instead of offering a hierarchical or vertical account of structures and scales, e.g. dividing the economy or market into 'global'/'local' or 'macro'/'micro', a marketisation lens holds the landscape flat by dissolving structures and levels (Latour, 2005a: 181, 183), and thus offering a lateral, flat perspective with vertical, horizontal and diagonal relations.

This evidently has implications for the GIN-approach and economic geography in general, which tend to be construed around constructs of geographical 'spaces' and 'scales' (e.g., micro-macro, local-global). According to Murdoch (1998), such conventional geographical spaces and scales are based on 'Euclidian space', i.e. on physical distance where co-ordinates are relatively fixed (Law 1997a in Murdoch, 1998). Instead, the constructivist (ANT) lens opens up to a new kind of geographical analysis, which is not based on Euclidian space, but instead celebrates a geography of topologies (Murdoch, 1998: 357). In this lens, space depends on the quality and relative stability of the relations of the investigated network. According to Murdoch (1998), adopting such lens of a geography of topologies, the analysis may not only identify spaces of prescription, which follow Euclidian space with relatively fixed coordinates and relatively formal and standardised sets of heterogeneous actors. It may also find spaces constituted by "fluidity, flux and variation as unstable actors or coalitions of actors come together to negotiate their memberships and affiliations" (Murdoch, 1998: 270). These relational spaces produce relatively autonomous topological or rhizomatic spaces of negotiation (Murdoch, 1998: 370). According to Murdoch (1998), in a constructivist ANT lens, even stable ('Euclidian') networks, which are framed by formal modes of calculation (Murdoch, 1998: 363), renders a space for contestation and negotiation, depending on the way in which these networks have been constructed. Thereby, even in more stable networks actors can carve out for themselves a degree of autonomy from the network prescriptions (Murdoch, 1998: 363).

This indicates a high degree of agency and a space for contestation and negotiation. However, how agency and power is mounted must be traced empirically instead of assuming certain actors to hold more agency and power than others, as in a conventional 'hierarchical' and structural sense. That is, ANT seeks to "describe how it [the agency] is mounted" (Muniesa, forthcoming: 5) as a particular relational effect. Adopting such non-foundational, processual, and relational approach to power, inspired by American pragmatism (cf. Garud and Gehman, 2012: 990), the AoM inquires into how structures, hierarchies, and potential asymmetries may come into being as an effect and outcome of specific activities in the construction of markets (Callon and Çalişkan, 2009: 393). At the same time, ANT sees the potentiality of power and politics everywhere, e.g. in the very process of framing. That is,

"Power and politics become a part and parcel of this process as framing contests unfold. However, from a relational perspective power is not a hierarchical concept, but a figurational one based on associations" (Garud and Gehman, 2012: 990).

This illustrates how framing processes due to their contested, negotiated nature can be constituted as 'political'. This political nature of framings is linked to how framings disentangle and simplify, and thereby also produce contestable 'black-boxes', as they not only include, but also exclude certain qualities (Callon, 1986b: 28-34). In this way, framing as processes of inclusion and exclusion produces relations of domination (Callon and Çalişkan, 2010b: 12, 18). Accordingly, framing is fragile (Callon 1991: 140, 141). For instance, when a ‘translator-spokesperson’ attempts to impute him/her/itself as ‘translator-spokesperson’ with ‘authorship’ on behalf of a collective, by imposing a specific framing, this is likely to be “controversial, open to doubt or question” (Callon 1991: 140, 141). This is, e.g., the case during market construction, where ”a multiplicity and diversity of actors compete to participate in defining goods and valuing them” (Callon and Çalişkan, 2010a: 8). Framing and translation is thus marked by power struggles or so-called trials of strength (Callon, 1986a).

How markets produce matters of concern

The ubiquitous nature of politics and power struggles is thereby also inherently part of marketisation. This reflects how markets cannot easily be singularised into a purely social, political, scientific, or economic framing (Callon, 1998: 260). Rather, markets are everywhere (Callon 2009; 2010b), in politics, in science, and, of course, in the economy (Callon and Çalişkan, 2010b: 10). Through a marketisation lens, marketisation is consequently co-constituting and co-constituted by processes of not only *economisation,* but also *politicisation* as well as *scientification* (Callon, 2007). Hereby, the marketisation lens adopted by the thesis seeks to “give up the idea of substantial definitions of the economy and politics that can serve to distinguish between that which is economic and that which is political” (Callon, 2007: 139).

Such entangled processes of marketisation, economisation, politicisation, and scientification at the same time implies a propensity of markets to overflow. Indeed, markets may produce so-called matters of concern and engender issues and feelings in the “ongoing process of co-construction of the economy and politics” (Callon, 2007: 139). That is, markets may

”trigger the emergence of matters of concern to which they are not always able to provide satisfactory answers. These matters of concern then evolve into many (potentially) political issues whose solutions may, in turn, impact on the organization of economic activities” (Callon, 2007: 139).

When markets produce matters of concern, which must be divided into issues, this goes through processes of problematisation, i.e. the production of solvable ‘problems’. As expressed by Callon (2009),

“[l]et us call problematization this gradual process of fragmentation and division of issues that evolves into the joint formulation of a set of different problems which in a sense, at least partially, are a substitute for the initial issue” (Callon, 2009: 543).

Sometimes, however, issues are entangled. In those cases, they may constitute a non-differentiated and 'totipotent stem issue' (Callon, 2009: 543), which have a polysemous and still disputable formatting, which makes the issue neither a "strictly (or primarily) political, economic or scientific issue" (Callon, 2009: 542). In case of problematisation of (stem) issues, the "transformation of an issue into well-identified problems – which can be addressed by planning specific actions – is never completely consensual nor total" (Callon, 2009: 43). In certain cases, markets are more likely than at other times to produce stem issues and to overflow. In particular, when there is no stabilised knowledge base (Callon, 1998: 260) or consensus, markets can produce a so-called hot situation (Callon, 1998: 260)

"where everything becomes controversial: the identification of intermediaries and overflows, the distribution of source and target agents, the way effects are measured" (Callon, 1998: 260).

Such confused hot situations produced by markets have also been coined "hybrid forums because facts and values have become entangled" (Callon, 1998: 260). For instance, when qualities of a potential good have not been pacified and knowledge on and tools used to qualify it lacks or are contested, a hot situation with myriads of different actors involved may evolve, constituting a hybrid forum.

Key Analytical Constructs of a Marketisation Lens

Having presented the key premises of the marketisation lens of the thesis, the last section of the chapter presents a couple of key analytical constructs adopted in the thesis. While the ANT literature has inquired into the ongoing translation of *actor-networks* (e.g. Callon, 1986a; 1986b; Callon, 1991) for the study of translation- and framing processes, other key constructs have been coined over time for the study of networks around the translation of technologies and/or markets, namely *techno-economic networks (TENs)* and *socio-technical agencements (STAs)*.

Techno-Economic Networks (TENs) – and socio-technical agencements (STA)

A key construct for the study of networks constituted around technologies and technological innovation is the notion of Techno-Economic Networks (TENs) (Callon, 1991; Callon, 2007). TENs are organised around three distinct poles: the *market pole*, the *technical pole*, and the *scientific pole* (Callon, 1991: 134). These poles perform specific tasks of a potentially emerging TEN. That is, the *market pole* "refers to users or consumers who more or less explicitly generate, express or seek to satisfy demands or needs" (Callon, 1991: 134), whereas the *scientific pole* is "where scientific research is practiced: for instance, in independent research centres, universities and relatively basic laboratories" (Callon, 1991: 133). Lastly, the *technical pole* "conceives of, develops and/or transforms artefacts. Its products include models, pilot projects, prototypes, tests and trials, patents, norms, and technical rules, and it is found in industrial technical laboratories, research associations, and pilot plants" (Callon, 1991: 134). Lately, in order to describe today's proliferation of '*networks of innovation*' or "innovation networks" (Callon, 2007: 150), Callon (2007) has suggested to look at "markets as TEN[s]" (Callon, 2007: 150). This marks an extension of the original notion of TEN (Callon, 1991), as it is related to an emergent modality of market organisation, which is conventionally termed 'knowledge economies', 'knowledge societies', and/or '(distributed) innovation regimes' (Callon, 2007: 147). According to Callon, markets as TENs are constituted by simultaneous and conflicting forces of collective, interactive organisations ('trans-organisational collectives') and individualism (e.g. individual entrepreneurs) (Callon, 2007: 150-151). Engaged in distributed actions and individual agencies, such 'markets as TEN' constitute somewhat paradoxical dynamics of both collaboration and competition. That is, the "innovative logics" of such emergent innovation networks ('markets as TEN') imply a new form of economic competition "made of strategic interactive agents" (Callon, 2007: 147).

Instead of adopting the notion of TEN to the study of markets, the emergent performativity programme within the AoM has instead proposed the notion of Socio-Technical Agencements (**STA**s) (Callon, 2007; Callon and Çalişkan, 2009; 2010a; 2010b), however. Looking at market(isation) as "*arrangement*" or "*agencement*" (Callon and Çalişkan, 2010b: 22), and as "hybrid collectives" (Callon and Law, 1995 in Callon and Çalişkan, 2010b: 9), the notion of STA denotes an

"arrangement or assemblage (and power field) of heterogeneous elements which include, in particular: rules and conventions; technical devices; metrological systems; logistical infrastructures; texts, discourses and narratives [...]; technical and scientific knowledge [...]; and competencies and skills embodied in living beings" (Callon and Çalişkan, 2010a: 23).

The thesis combines insights of the TEN and STA concepts[21]. Inherently, the thesis ascribes to the inclusion of narratives and discourses as well as to the emphasis on agency, which are integral to the STA construct. That is, agency lies inherently in the notion and in the verbal connotations of an *agencement*. Indeed, "The definition of markets as socio-technical *arrangements or agencements* (STA) raises the question of their design, implementation, management, extension and maintenance – in short, of their dynamics" (Callon and Çalişkan, 2010b: 19).

[21] For the specific type of STA in marketisation, Callon and Çalişkan (2010b) have proposed the specific notion of *market socio-technical agencements* (mSTAs) (Callon and Çalişkan, 2010b: 22).

However, while the inquiry subscribes to the overall AoM-perspective (and thus principles of the STA construct) of Callon and Çalişkan (2009; 2010; 2010b), the conceptual construct of 'TEN' is nevertheless adopted in the inquiry of the thesis, for two reasons. Firstly, the different poles of the TEN construct are pragmatically deemed helpful in the operationalisation of a marketisation analysis of wind power. As marketisation takes place in all poles of the TEN, requiring ongoing work of qualification/framing and translation, the TEN construct can hopefully help open the 'black-box' of the market, as well as of the 'GIN', as these are treated as co-constituting each other in processes of qualification. Secondly, the recent extension of the TEN construct to denote 'networks of innovation' (Callon, 2007), i.e. conceiving 'markets as TEN', makes it appropriate for the inquiry into potential GIN-construction that is part and parcel of the requalification taking place in Chinese wind power, and as constituting paradoxical dynamics of both collaboration and competition, representing coexisting collective and individual agencies.

Moving away from GINs – towards marketisation

Summing up on the above, while conventional studies on China's wind turbine industry and wind power market tend to coin it a 'market' for wind power, the thesis claims that the current 'quality crisis' facing Chinese wind power, vividly illustrates how the valuation of wind has still not transformed wind into a circulating good with a consensus-based 'pacified' value or worth. In this way, wind seems to have defied its own marketisation. That is, the Chinese wind power market overflows – e.g. due to wind turbines being disconnected from the grid, under-performing wind turbines, and component technologies – and can thus not be treated as a stabilised unity. Seeking to open up the black-box of China's wind power market, the thesis traces the practice of attributing value to wind by looking into the progressive socio-material marketisation of wind power in China as a matter of *qualification/framing.* Such qualification may i.a. take place through attempts at technical improvements of the wind turbine's different (overflowing) component technologies. In turn, such technical improvements may take place through collaborative (innovation) networks around specific core components ('markets as TEN').

To map and trace the potential qualification of wind power, the thesis proposes to follow networks around specific core technologies of the wind turbine. In this way, the thesis 'disassembles' the wind turbine, illustrating how it is not just a unified, single entity, but potentially many 'leaking' and overflowing entities, which need to be 'reassembled', pacified, and qualified through processes of framing, in order to succeed in the marketisation of wind power. The thesis engages in such work of tracing valuation processes in China's struggle to re-qualify wind power through the adoption of the TEN-construct. Tracing the entangled translation and framing processes of the wind power market (as TEN) in China, the market is treated as a matter of *potentiality,* and as a particular event (Fraser, 2010; Stengers, 2005a; Whitehead, 1978). This marks a radically different route of the constructivist perspective held by the thesis than that pursued by the positivistic GIN-literature. That is, in the constructivist perspective proposed by the thesis to trace the genesis, dynamics, and agency of GINs, GINs are not 'out there', i.e., they are not (structural) 'Matters of Fact', but rather negotiated and controversial processes producing 'Matters of Concern' in marketisation.

Further, by tracing marketisation of wind power as a matter of qualification, and by zooming in on networks (TENs) around specific core components, it should be noted that the thesis treats GINs methodologically in a radically different way that the GIN literature. That is, while the GIN literature has already claimed GINs to exist in the Chinese wind turbine industry in its entirety (Silva and Klagge, 2013), the thesis instead looks at GIN genesis as a potentiality, and as processes of GIN-ing around a specific core component (software) within the wind turbine industry. By doing so, the thesis hopes to 'unpack' the GIN construct by tracing how they are pontentially assembled through processes of qualification, being part and parcel of marketisation.

Taking a radically different route than the one marked by the positivistic GIN literature, the thesis however has to leave aside the metaphor of GINs in the analysis (*Part III*) to explore its potential progressive construction in the marketisation of wind power in China. Thus, the thesis somewhat paradoxically 'looks away from' the GIN, in order to shed light on its genesis, dynamics, and agency. Yet, the thesis revisits the GIN construct in *Part IV* where the potential contributions of a constructivist perspective to the GIN literature are elaborated on. In the hope that the constructivist perspective can render insight into the 'first act' of GIN-genesis, dynamics, and agency, as well as the potentially transformational and disruptive dynamics and agencies of GINs in the qualification of Chinese wind power, the thesis thus seeks to open the black-box of GINs and markets by de- and reassembling them. In the following *Chapter 4*, the thesis outlines the methodological implications of adopting a marketisation lens.

Chapter 4. Methodological Strategies of Analysis

"Only at the end of the trip *does it make sense to credit the traveler with the courage and rationality necessary for its completion" (On the 'Serresean sea-journey', in Jensen, 2010: 12)*

Having outlined the basic theoretical premises and constructs of the proposed marketisation lens, and having in the previous chapter outlined how the thesis pursues another route than that laid out by the traditional notion of GINs, *Chapter 4* outlines what the implications are for the methodological strategies of analysis, when ascribing to a constructivist perspective. This is done by presenting what the thesis dubs a basic methodological 'tool set', which constitutes a synthesis of strategies of analysis of ANT, the AoM, and of the so-called 'Mapping Controversies' approach within STS, in order to inquire into marketisation within Chinese wind power. Upon a presentation of the basic tool set, this leads to an account of the implications for (1) data collection, (2) data processing, and for the (3) narrative (re)presentation and structure of the thesis. Together, *Chapters 3* and *4* set the background for developing a situational 'model' for studying marketisation in Chinese wind power, which is presented in *Chapter 5*.

Basic 'methodological tool set' of a constructivist perspective

First, the chapter outlines methodological implications of adopting a constructivist perspective on market construction.

Follow the actor – and map the controversy!

A constructivist perspective implies that the researcher should strive to stay as open as possible in regard to detecting which actors and entities are relevant for the analysis. This is based on the methodological premise of ANT that the researcher should always strive to '*follow the actor*', as they emerge one by one in the mapping of an actor network (Latour, 2005a), a TEN, or any other kind of network. For instance, in marketisation, and in marketising agencies, a host of different actors are likely involved, i.a. state services, firms, consumers, NGOs, economists, think-tanks, the international monetary or financial institutions, experts, and regulatory or standardiation agencies (Callon and Çalişkan, 2010b: 8). Hereby, instead of exercising censorship (Callon, 1991: 144) in a marketisation account,

"[T]here is no standard list. Part of the analysis would involve drawing up an inventory for each and every case" (Callon and Çalişkan, 2010b: 8).

In addition, due to the potentially shifting ontology of agents, the constructivist perspective does not preach any “epistemological imperative, since it is entirely dictated by the [shifting] state of the network” (Callon, 1991: 152). In turn, attention to the shifting ontology of agents and the networks they constitute makes chronological history and description a necessary part of the analysis (Callon 1991: 152, 154). That is, the researcher should ”[j]ust follow and describe, describe and draw, draw and map!” (Yaneva, 2012: 45). Interested in tracing the socio-material performance and ‘becoming’ of things, the constructivist ANT lens moves from epistemology to enactment (Jensen, 2010: 2-3). That is, based in an ecology of practice (as outlined in the *Chapter 3*), the constructivist perspective requires an empiricist lens, as it seeks to capture the specificity of actions and processes. This implies that

> *“the only faithful – indeed intelligible – method is that of literary description. Such description multiplies points of view to form a polyphonic narrative distributed over as many voices as there are actors, and recovers all relevant details” (Callon, 1991: 152).*

In this way, ’a good ANT-account’ is one “where a network is being traced”, “letting ‘the social’ become visible” (Latour, 2005a: 128). That is, “[i]f the social is a trace, then it can be *re*traced; if it’s an assembly then it can be *re*assembled” (Latour, 2005a: 128). Interested in the potential requalification of Chinese wind power, the unit of analysis of the thesis becomes the practice of framing/qualification, i.e. of producing associations, which is necessary for relations to be constructed and for the (potential) wind power market to be performed. As a qualification struggle, the thesis inquires into the marketisation of wind power in China by ‘following the (transformation of the) wind’. Tracing framing processes, the thesis inquires into the pacification of the potentially emerging good of wind power, *following* calculative tools such as IPRs and standards, as well as inquiring into price-setting processes by *following* money and price and cost calculations. Along the way, the thesis further *follows* software algorithms, as they ascribe associations of ‘developmental worth’ to wind power.

Mapping Controversies – on mapping spaces of hybridity and transformational agency

Concerned with the unfolding quality crisis in China’s wind power market and a current potential requalification, in which collaborative relations on core technologies are likely to play a critical role, the thesis adopts principles of the methodology of ‘Mapping Controversies’, which is also placed within ANT and STS studies (Yaneva, 2012; Venturini, 2009). That is, collaborative networks in the ongoing qualification struggle are likely to produce conflict and power struggles. Drawing on among others Latour (2005), the Mapping Controversies approach was at the outset developed for visually mapping Web-based controversies (Yaneva, 2012: 81). Yet, the thesis proposes that the Mapping Controversies approach can be a useful inspirational source for the mapping of controversies of market construction (and their inherent qualification), even when not being traced on the Internet, but instead amongst actors in the ‘field’.

According to controversy studies, the analysis must “follow the processes and the associations of all the actors involved” by mapping the controversy ensuing (Yaneva, 2012: 2) around an ‘event’. Taking the ‘event’ to be market qualification and construction in China, (being co-performed by the construction of ‘GINs’), the analysis thus seeks to map actors and “how they agree and disagree, how they shape alliances, how they scale and rescale the spaces where they move and create spatial disjunctions” (Yaneva, 2012: 81). Mapping the controversy as it unfolded (Yaneva, 2012: 3) involves the inclusion of heterogeneous actors (Venturini, 2009: 4; Yaneva, 2012), and will often have to mobilise both humanities and technologies (Yaneva, 2012: 3). That is,

“In controversy studies, the analysis should not constrain the observation to any single theory or methodology; the phenomenon should be observed from as many viewpoints as possible and the actors’ voices listened to more than the researcher’s own assumptions” (Venturini, 2009: 4).

Interested in aspects of *genesis, dynamics, and agency*, the Mapping Controversies approach is proposed to be useful as it offers a tool “to observe the social world and its *making”* (Venturini, 2009: 6, emphasis added). That is, when mapping controversies, where no consensus or agreement has been reached (Venturini, 2009: 4), the ‘social’ and the unstable state of the ‘social’ and the ‘technical’ can be displayed in its most dynamic form (Yaneva, 2012: 3; Venturini, 2009: 4). Controversy mapping helps inquire into the stage where things are *both* solid *and* liquid and where transformation remains a potentiality. Such a hybrid state is with a metaphorical analogy likened to the ‘magma’ of a volcano:

“Controversies are complex because they are the crucible where collective life is melted and forged: they are the social at its magmatic state. As the rock in magma, the social in controversies is both liquid and solid at the same time. But there’s more to this metaphor: in magma solid and liquid states exist in a ceaseless mutual transformation; while, at the margins of the flow, the lava cools down and crystallizes, some other solid rock touched by the heat of the flow melts and becomes part of the stream. The same fluctuation between different states of solidity can be observed in controversies. Through this dynamic the social is unremittingly constructed, deconstructed and reconstructed. This is the social in action and that’s why we have no other choice than diving in magma” (Venturini, 2009: 7).

While the thesis is not as such focused on inquiring into the constitution of ’the social’ as reflected in the above quote but into marketisation, the entangled nature of marketisation, economisation, politicisation, and scientification may also render a glimpse of the socio-material construction of ’the social’. Indeed, the thesis seeks to ’dive into the magma’ of marketisation, looking into the hybrid stage where things have not completely stabilised, but at the same time have not completely disintegrated either. In this hybrid space, there is room for transformational agency.

The promiscuous reduction-resistant approach of ’diving in magma’

Bringing the Mapping Controversies approach into the field of marketisation, requires the marketisation analysis to engage in a so-called ’cartography of controversies’ (Venturini, 2009). At the same time, aligning with basic premises of ANT, the Mapping Controversies approach requires the study to be ‘reduction-resistant’ (Venturini, 2009: 5), i.e. not falling into categorisations, simplifications, dualisms, or generalisations. This is founded in the dictum of ANT to pursue a so-called ‘modest sociology’ (Law, 1994). Such modest sociology implies

”slow method, or vulnerable method, or quiet method. Multiple method. Modest method. Uncertain method. Diverse method” (Law, 2004: 11).

Through this lens, no event, no gathering, and no practice (e.g. marketisation) can be defined as any other. Instead, the ‘practice of green marketisation’ in China should be traced as it unfolds:

”[N]o practice can be defined as any other, just as no living species is like any other. Approaching a practice then means approaching it as it diverges, that is, feeling its borders, experimenting with the questions which practioners may accept as relevant, even if they are not their own questions” (Stengers, 2005a: 184).

In this way, social ”cartographers have no choice but to dive into the technoscientific details” (Venturini, 2009: 8), and engaging in “theoretical and methodological promiscuity” (Venturini, 2009: 3). This implies

“a multifarious inquiry launched with the tools of anthropology, philosophy, metaphysics, history, sociology to detect how many participants *are gathered in a* thing *to make it exist and to maintain its existence” (Latour, 2004: 246).*

In the case of marketisation, processes of framing, so integral to valuation and price-setting, must be approached ethnographically (Callon and Çalişkan, 2010b: 16). With an interest in valuation processes in specific sites, the analysis should also explore “alternative possibilities of markets”, which e.g. requires awareness of the social sciences, economics, and material technologies (Callon and Çalişkan, 2010b: 23). Aligning with such a ”taste for a hybrid disciplinary positioning” characteristic of the marketisation lens, which encourages “a certain freedom of intellectual experimentation (with no imposed canon)” (Muniesa, forthcoming: 3), the researcher – or ‘social cartographer’ – is suggested to venture into an “investigation far beyond the limits of sociology and not only towards the neighboring human sciences" (Venturini, 2009: 8). Indeed, since this often involves paying "painstaking attention to technicalities" (Venturini, 2009: 8), the thesis lies at the borderline of e.g. China studies, but also international business, natural science, political economy, aerodynamics, economic geography, software engineering, the IPR literature, the standardisation literature, mechanical and electrical engineering, and mathematics, in addition to being positioned within New Economic Sociology and founded in the GIN and marketisation lenses.

Strenuous ethnography – roots in anthropological method

Engaging in the 'modest sociology' (Law, 1994) of STS and its ANT stream, by adopting a marketisation lens and a Mapping Controversies approach, the thesis engages in the 'painstaking ethnography' of 'slowing down inquiry into controversy' (Yaneva, 2012: 3). Thus, inquiring into *how* "realities are practically and materially constructed by a multiplicity of things", STS researchers are "[e]ncountering ethnographic situations (Gad et al., 2014: 11). In this way, the AoM and ANT, the latter representing an 'anthropology of modern reason' (Muniesa, forthcoming: 5), have their roots in anthropological method and in an often multisited ethnography in which the investigator studies several, or, even diverse, settings (Stark, 2009: 198). Accordingly, the thesis engages in an anthropological inquiry into marketisation through multisited ethnography. This reflects a general trend within anthropology, in which in-depth 'mapping' through ethnographic fieldwork has gradually moved towards "more complex objects of study" (Marcus, 1995: 95, 96) such as the 'anthropology of globalisation' (Marcus, 2005: 1). Thus, anthropologists – and STS scholars – have moved from the conventional single-site location to "multiple sites of observation and participation that criss-cut dichotomies such as the local and the global, the lifeworld and the system (Marcus, 1995: 95), i.e. to 'multi-sited research' (Marcus, 1995: 72).

Research processes of controversy mapping in Chinese wind power

Having outlined some of the theoretical and methodological premises of the thesis, and having developed a 'tool set' provided by the marketisation lens in combination with the Mapping Controversies approach, the following sections outline how these principles, premises, and assumptions have shaped the research process, as the researcher engaged in the ethnographic inquiry into marketisation in Chinese wind power. This "adventurous [research] journey" has been marked by both "curiosity and *jouissance"* (Serres and Whitehead in Jensen, 2010: 12), but also by iterative stages and 'levels of confusion' when encountering the "relative messiness of practice" of ethnographers (Law, 2004: 18), as well as the "experimental quality" of the anthropological method (Marcus, 1995: 77). In the following, the chapter dives into the messiness of three iterative and inter-connected processes of ethnographic research conducted for the thesis, namely (1) data collection, (2) data processing, and (3) narrative (re)presentation. These interconnected processes have been marked by iteratively changing strategies of e.g. improvisation (Weick, 2003), gut-feeling, and experimentation. In the following, the progressive inquiry into 'what is this a case of', as the researcher ventured into an explorative inquiry about inquiry (Dewey, 1933[1998] in Stark, 2009: 2; Stark, 2009: 204), is outlined. This illustrates how the idea about what to be 'followed' only gradually emerged, as the research(er) set out without a clear idea about what was to be found, reflecting the principle of no 'censorship', yet, still in the hope that something new and unexpected could be discovered (Barley, 2006: 19). Nevertheless, guiding the interest from the outset was the project's formal positioning within a larger research project on GINs, set into the context of Chinese wind power.

Identifying actors to follow – on data collection

First, the chapter looks into iterative processes of data collection (in a symbiotic relationship with data processing and (re)presentation), illustrating processes of narrowing down the inquiry and identifying actors to follow. Following the premise of ethnographic 'controversy mapping' in China's green marketisation, the thesis is based primarily on qualitative, primary data, collected during fieldwork in China (as well as in Denmark and Germany) in the period from the autumn of 2011 until the autumn of 2013[22]. In total, two shorter and three longer field trips have been conducted in this period, resulting in seven months of fieldwork in China and a total of 95 interviews.

Initial phase (autumn 2011 – autumn 2012): Background information and the emergence of component technologies

The first field trip went to Beijing for ten days in the autumn of 2011, just a couple of weeks into the project. The field trip was conducted with a research group[23] from the Sino-Danish University Centre for Research and Education (SDC). Without much time for preparation, the researcher was consequently 'thrown' into the field at a relatively early stage.

The field trip resulted in valuable introductory interviews with some of the major Chinese and Western WTMs in China, as well as with some of the most important Chinese research

[22] One interview has been used in the thesis as well, although conducted in 2010 for the author's Master thesis project, as it relates to China's process of 'greening' within renewable energies, including wind power.

[23] With researchers from Copenhagen Business School, the Technical University of Denmark/Risø, and the Chinese Academy of Sciences of Technology for Development (CASTED).

institutions in the field. As the research group consisted of both Chinese and foreign researchers (and Chinese and foreign government officials), some within wind power engineering, a number of the interviews took on a relatively 'technical' character. In this way, without any prior insight into wind turbines, which had indeed been 'black boxed' by the researcher at the outset, the interviews started opening the black box slightly. That is, the wind turbine as a 'whole' already early in the research process started to 'disintegrate' and 'leak', as the thousands of wind turbine components started to emerge as more or less important entities for the wind turbine to 'perform'. In particular, a very preliminary understanding, of how specific components such as control system technologies and simulation tools were being constituted as more 'core' to the wind turbine and its 'quality' and 'performance' than others, was gained. In addition, during this first field-trip the 'story' already figuring in the mind of the researcher had to be re-drafted. While the research project had set out with an intent to illustrate and inquire into the '*hows*' of what seemed an unprecedented 'success story' of rapid 'green' market construction, and the seemingly successful construction of GINs, it became clear that something new and unexpected was taking place in the field. That is, most of the interviews drew attention to an emerging and ongoing consolidation phase and 'quality crisis' in Chinese wind power. Consequently, attention was drawn towards the potential need to re-draft the initial 'plot' of the story to be told in the thesis.

The initial insight into the role of different components for the performance of a wind turbine was further strengthened through a visit to the Technical University of Denmark (DTU, Risø), where one of the members of the SDC research working group was employed. This involved – apart from literally climbing into a wind turbine's drive train – further insights into the complex dynamics of generating electricity from the kinetic forces of the wind. Here, the turbine's drive train (containing many of the wind turbine's 'core components') and the control system were emphasised as particularly 'critical' to wind turbine performance. Later, further insights into the many technicalities of a wind turbine and the role of e.g. simulation tools for wind turbine design were gained through interviews with a wind turbine design company. Apart from the emerging understanding of some of the critical component technologies, it was also becoming clear that both the Chinese and foreigners considered Chinese actors as 'laggards' in regard to these specific core technologies, and that this laggard position plays a critical role in the seemingly emergent 'quality crisis' in Chinese wind power. Lastly, during the spring of 2012, additional background interviews were conducted in collaboration with the SDC working group in Denmark (and Germany) (some conducted at industrial conferences held in Denmark (EWEA, Copenhagen April 2012) and Germany (Husum Wind, September 2012) with

Chinese and Danish/German companies present in Denmark, as well as with Danish industry associations and ministries related to wind power and to science, research, and innovation. Eventually, a last week-long joint field trip to China with the SDC working group was undertaken, with interviews conducted in the Shanghai and Chengdu areas. During this field trip, further insight into Chinese and foreign component suppliers was gained, not only within the field of wind power, but also within other renewable energy industries. These interviews have served as background information, enabling an ongoing comparison between wind power and other (related) industries, e.g. to cross-check whether or not the information on the wind power industry can be considered as ‘unique’ to the industry, or whether there were more general trends of market construction across industries.

While the data already collected pointed towards a consolidation phase upon unprecedented growth rates, and a potential shift in attention from quantity to quality, as well as to the critical role of specific component technologies and collaborations, work on a comprehensive literature review of the GIN-literature, which was part of the overall research design form the outset, was conducted. The literature review helped narrow down the focus to an interest into the *hows* of GIN-genesis, -dynamics, and –agency, and linking it to the construction of a wind power market, which seemed to have stumbled upon a quality crisis. Yet, the consolidation and quality crisis only gradually entered the research as the researcher got more acquainted with the field. Further, while the interest in the potential role of ‘GINs’ had been part of the research from the outset, the interest in specific core technologies for these also only emerged gradually during field-work. Identifiying a ‘gap’ in the existing GIN literature in regard to issues of *genesis, dynamics,* and *agency*, as well as the potential role of both human and non-human actors (e.g. technologies and algorithms), the focus of the thesis moved towards the idea of following (GINs around) one or several critical component technologies. However, not acquainted with mechanical or electrical engineering or any of the like, the researcher still found the workings of the wind turbine ‘black boxed’, that is, impossible to grasp and disentangle, and thus selecting which component to follow was still unsettled.

Further into the field (autumn 2012 (– spring 2013)): The emergence of algorithms

Based on the initial insights already gained during the first year of research, the first longer (three months long) and individual field trip to China (Beijing, Shanghai, Hangzhou, and Ningbo) was conducted in the autumn of 2012. The two first shorter field trips had provided preliminary insights into the field, but still remained largely at the level of MNC strategies of supply and value chain governance, and of formal international collaborations. Thus, they lacked in-depth inquiry, e.g. into how collaborative relations had been established, as well as into the dynamics (and potential controversies) of such collaborations and the potential role of core technologies on network dynamics. Indeed, one of the major insights gained during the first year of research had been the acknowledgement that tracing genesis, dynamics, and agency of 'GINs' within wind power, without selecting specific technologies to follow, would be impossible not only due to the 'leaking' black box of the wind turbine, but also due to pragmatic and practical reasons related to the vast size of China and the large number of potentially relevant actors and components to trace.

Based on the initial insights already gained (i.a. from engineering experts within wind power in Denmark and China, lead firms and component suppliers, as well as secondary sources such as industry reports and Chinese policies on industry development), it was decided that tracing network configurations around components, which were being constituted as 'critical' or 'core' to the performance of a wind turbine, would be interesting in terms of mapping controversies and upgrading potential. This was based on the rationale that development of Chinese capabilities within such 'core components', e.g. through international R&D collaborations, Chinese actors would not only be critical to the qualification of wind power as (e.g. technically and economically) sustainable, during what seemed an ongoing 'quality crisis', but would potentially also produce power struggles, as core technologies are often well-protected by owners and developers, and as rising capabilities would likely lead to power struggles as Chinese actors seek new roles and positions.

As many of the earlier interviews as well as industry reports had pointed towards the electrical main control as 'critical' to the inter-play of the turbine's many components, interviews during the third field trip focused on control system technologies. Accordingly, a variety of interviews were conducted with foreign control system suppliers in China, in addition to a number of in-depth interviews with a Chinese WTM, which provided insights into Chinese 'upgrading' strategies, i.a. through the establishment of various R&D-collaborations and international R&D-facilities abroad, and an overall strategic emphasis on quality through building capabilities in software. In this way, a mapping was beginning of supply-customer relations configuring around control system technologies, in particular with focus on software. That is, during the fieldwork, it was gradually becoming clear that what was being constituted as 'core' was the software parts of the main control, and in particular the core algorithms that they contain. Construed as 'critical' to both wind turbine performance and to upgrading Chinese capabilities, as well as for framing wind power with qualities of sustainability, an actor to be followed had begun to crystallise, namely software algorithms, around which controversies could be mapped. This process of inquiry reflects how "[s]urprise and curiosity should inspire their [the researcher's] notions and protocols more than the other way around" (Venturini, 2009: 2). Indeed, it had never been expected at the outset that software algorithms would become central actors in the account, and the researcher was thus attempting "to remain as open as possible" (Venturini, 2009: 2),

As the Mapping Controversies approach "refuses any handrail and recommends swimming" (Venturini, 2009: 6), the innumerable possible traces and potential actors to follow rendered the data collection process in China extremely hectic and somewhat chaotic. This is not the least due to the inevitable "illimitability of a certain kind"" (Strathern, 1999: 240 in Jensen, 2007: 844) of ethnographic field-work, as "there are always more people to talk to, more situations to participate in – and how do you choose the right ones?" (Jensen, 2007: 844). The complexity of the data collection was also exacerbated by the lack of contacts at the outset. While some contacts had been established to certain actors during the first two field trips, the field trip in the autumn of 2012 was marked by the establishment 'from scratch' of an overwhelming number of contacts to be established. However, with a background in China studies and earlier employment at the Royal Danish Embassy in Beijing, some contact information could be gained through initial pilot interviews with diplomats. Apart from this, a critical source of data collection was participation in scholarly and industrial conferences, e.g. at the annual China Wind Power Conference, 2012 (Beijing). Whereas some initial interviews were not groundbreaking, they were, however, "*good enough* to generate a number of new ideas for topics and get suggestions for new contact persons" (Jensen, 2007: 844). The snowballing (Saunders et al., 2003: 171-172, 176) strategy, with a consistently expanding spreadsheet of contacts, resulted in in-depth insight into different customer-supplier networks emerging around Danish and German control system suppliers and their Chinese customers (WTMs), as well as controversies configuring around algorithms, in particular in relation to issues of Intellectual Property (Rights) (IPRs).

Data processing and validating the data – digging deeper into the field (spring 2013 – autumn 2013): Initial controversy mapping

After the first longer field trip to China in 2012, an intensive phase of data processing was undertaken during April 2013. Transcribed interviews were cut to pieces, constituting myriads of individual documents with interview quotes under headings according to type of actor, themes, and sub-themes, which could potentially be put together to constitute discourses, narratives, and/or controversies. Based on this, an initial rough outline of a structure for the analysis was taking shape. In this emerging story line of the analysis, it became clear that controversies over IPRs and standardisation were configuring around core algorithms. In addition, a controversy was indicated around the issue of money (lacking liquidity) and trust, in what seemed a rhizomatic Chinese 'spider web' of state-owned actors in China's power sector. Lastly, a controversy was surfacing in regard to the definition of sustainability, in what was emerging as a potentially particular Chinese mode of 'green experimental marketisation'. To inquire further into whether these story lines could be confirmed by different technical experts, follow-up interviews were conducted in Denmark with control system suppliers, design houses, as well as with researchers at the Technical University of Denmark/Risø in order to gain a further understanding of some of the more technical aspects of the algorithms and different component technologies, which increasingly seemed critical to the configuration of the emerging controversies. These interviews confirmed the findings, while also fine-tuning the understanding of some of the more technical aspects. For example, it became clear that what was constituted as particularly 'core' to the optimisation of wind turbine performance was a variety of software programmes. Through these interviews, further insight was gained in regard to how not only control system software plays a vital role for wind turbine performance, but also how simulation tools and their aero-elastic codes as well as forecasting tools play a critical role for international standardisation and grid connection respectively. With this in mind, the next longer, field-trip was conducted in China (to Beijing and Shanghai) from late April to mid-July 2013. During this field-trip, concurrent processes were undertaken, namely data collection as well as data processing and data presentation. As it had become clear that it was necessary to inquire further into the wider network of the power sector, in order to understand the controversy dynamics of the traced networks within wind power and software, the focus of interviews was expanded from customer-supplier-(university) relations around software to interviews with i.a. grid companies, think tanks, ministries, test laboratories, and certification bodies. At the same time, a first rough draft of the analysis was written, with controversies over IPR and standardisation centred around core algorithms, set into a 'developmental' context of experimental industrial policy in a state controlled power sector.

Lastly, upon further data processing in Denmark, the last field trip to China (to Beijing, Chengdu, Chongqing, and Zhangbei) was conducted in August-September 2013, with the aim of following up on some of the 'loose ends' in the account, in particular getting deeper into the Chinese perspective on the supplier-customer-(university) collaborations on control systems, expanding focus to the grid system and wider power sector, as well as getting more insight into the function of so-called Chinese ‘agents’. While this field trip did not provide drastic changes to the overall story line that had already emerged, it functioned as a way of strengthening and fine-tuning the data and the account, as the findings could be cross-checked with different actors. Overall, neither purely structured nor purely unstructured, the continuous explorative searching and exploration during “’yo-yo fieldwork’” (Wulff 2002 in Garsten, 2010: 63) in China has thus been characterised by a movement ”back and forth between home and the multi-sited field” (Garsten 2010: 63).

Outline of Collected Data

The five field trips undertaken in China (as well as others in Denmark and Germany) from the autumn of 2011 to the autumn of 2013 have resulted in 95 interviews, 22 of which have been conducted in Denmark (in Copenhagen, Roskilde, Odense, Ikast, and Silkeborg), one in Germany (in Husum), while the rest have been conducted in China, three of those over Skype. Interviews have been conducted with a host of different types of organisations, in particular Chinese and Danish/German/U.S. WTMs, as well as with Chinese, Danish, and Austrian component suppliers within wind power (and other related fields). In addition, interviews have been conducted with Danish and Chinese universities and research institutes, interest organisations and industry associations, with government officials and diplomats from different ministry departments and agencies, with China State Grid (i.e., different research institutions within Chinese State Grid Corporation), design/consulting companies, think tanks, certification bodies, test laboratories, and finance institutions.

When allowed to be recorded, these interviews have been transcribed *verbatim*, resulting in a 859 page long single-spaced interview transcription. To render a voice for everyone on an equal basis, interviews have been conducted in English, Danish, and Chinese (Mandarin), on the preference of the interviewee. Speaking Chinese has been an opportunity for the researcher to get access to Chinese respondents who were not in command of English. Yet, it should be said that there is always something ‘lost in translation’, when conducting an interview in a foreign language. In addition, there exist certain language codes in Chinese used by Chinese officials, which are not easily noticed (Thøgersen, 2006). This was particularly evident when speaking to Chinese state-owned companies and officials, who often talk ‘as the policy and Five-Year-Plan reads’. In the analysis, Danish and Chinese quotes have been translated as literally as possible into English to ensure consistency and making the thesis readable (Chinese interviews, policies, and other references are marked by an asterix *).

Apart from face-to-face interviews set up in advance, an extensive amount of data has been gathered at conferences where informal meetings and interviews can often be conducted, and where business cards are often exchanged. In addition, observations have been made during interviews[24], at conferences[25], at a four-day long grid connection workshop held by the Asian Development Bank in China (involving e.g. a visit to a Chinese test laboratory) [26], and at a meeting with various foreign component suppliers present. Finally, archival data including academic and newspaper articles within wind power, consultancy and industry reports, statistics on China and renewable energies and wind power in particular, power point presentations by companies, and product portfolios have served to get more acquainted with the topic and potential issues. Further, pictures and drawings in the secondary data as well as pictures drawn by respondents to clarify technical issues have served to get a further understanding of control system technologies in the wind turbine, in wind farms, and for grid connection. Chinese policies, regulations, and Five-Year Plans (5YPs) on renewable energies, wind power, and (indigenous) innovation (in Chinese and/or English) have been consistently surveyed, serving as a foundation to detect and map discourses on indigenous innovation, sustainable development, and a 'harmonious socialist society'.

The thesis treats documents such as policies and plans as intermediaries and potential non-human 'actors', as they may encourage "people to 'perform'" (Mol, 2000 in Prior, 2008: 81), and thereby acting-at-a-distance (Latour, 1987 in Prior, 2008: 88). For instance, by classifying things, such documents may encourage people to do certain things, serving as a "script for doing. In that sense, the text orders its readers as much as it orders 'things'" "in

[24] e.g. observing production halls, control system technologies, use of computers and software in different settings, signs of collaborations and use of particular types of software (e.g. posters, advertisements), as well as body language regarding specific issues on software.

[25] Participation in the following industrial conferences: China Wind Power 2012 (China), EWEA Copenhagen 2012 (Denmark), Husum Wind Power 2012 (Germany), and International Symposium on Materials for Wind Energy Applications 2012 (China). In addition to this, academic conferences have been attended, i.a. on wind power in China and different conferences on green transition in China, in Asia, and globally (Denmark; Hong Kong). Further, the researcher participated in the concluding meeting of the INGINEUS-study (2009-2011) on GINs under the European Union's 7th Framework Programme, in 2011 in Brussels.

[26] Data collection (interviews and observations) were conducted at the 'Regional Workshop on Large Scale Wind Power Integration' in September 2013 with participants from a wide range of Asian countries including Chinese and foreign experts on grid connection. The conference involved a trip to Zhangbei (Hebei Province), one of the largest wind power basins in China, with visits to the Zhangbei National Wind and Solar Energy Storage and Transmission Demonstration Project and a wind farm in connection with a new test laboratory for grid connection of Chinese wind turbines.

the world" (Prior, 2008: 81), which means that "decisions written down in one context and setting can carry implications for action in future settings" (Prior, 2008: 88). Collecting both primary and secondary data continuously over a period of more than two and a half year has enabled continuous cross-checking of information between different types of data sources. In addition, it has rendered a processual study, as it has been possible to detect development and change over time within Chinese wind power, e.g. in terms of policy priorities, company strategies, and network configurations. In *table 2* below, an overview of collected data (archival data, observations and ethnographic field diary, interviews) and its function in the research process is provided.

Table 2: Overview of collected data

Data source	Type of data	Usage in the analysis
Archival data	Company-related documents: - Company presentations - Product catalogues Policy documents and plans: - Renewable energies - Wind power - Innovation Pictures and drawings: - Wind turbines - Control system technologies - Grid system	General background on companies and their products Familiarise with issues and new actors and entities Familiarise with political strategies and plans Keep record and produce a map of the development of new discourses and instruments in policies and plans Familiarise with control systems and their function in the wind turbine Support and integrate with interview data
Observations and field diary	Field notes from interviews Field notes from visits to wind farm, test and certification site Field notes from conferences Field diary Participation in and observations at three industry conferences (China 2012, Denmark 2012, Germany 2012) Participation in and observations at one academic seminar on materials for wind energy application (China 2011) One industrial workshop for State Grid and Asian countries on grid integration (Asian Development Bank, China 2013) Informal conversations and notes with interviewees, e.g. at conferences and workshops Arranging workshop with researchers on wind power in China, held at CBS 2012	Support reconstruction Support and integrate with findings from interviews Use as basis for further investigation in formal interviews and in archival data Support and integrate with analytical findings from interviews
Interviews (859 pages, single-spaced)	95 interviews in total, representing 56 different organisations: - company interviews with 37 different companies (23 of which Chinese); - 4 different research institutions and universities (3 of which Chinese); - 5 different ministries (2 of which Chinese)	Familiarise oneself with issues and new actors and entities Support reconstruction Keep record of new controversies, issues, actors,

	- 1 think tank (Chinese) - 5 different interest organisations/industry associations (2 of which Chinese) - 1 certification body (Chinese); - 1 test laboratory (Chinese); - 1 multinational finance institution (international) - 1 grid company (and 3 different research institutions within State Grid) Companies were represented as follows: Western companies*:* - 3 different WTMs - 8 different component suppliers related to wind power - 2 design companies - 1 service company Chinese companies*:* - 7 different WTMs - 4 different component suppliers related to wind power - 3 service companies - 9 background interviews with companies related to renewable energies 1 panel discussion at component suppliers' meeting	and entities Use for further investigation in the following interviews Detect and map relations between actors Map network configurations and their dynamic changes over time Map controversies and issues and their changes over time

Whereever possible, company interviews have been conducted with innovation managers, R&D directors, R&D engineers and/or chief engineers, at other times, with directors, general managers, vice presidents, CEOs, managing directors, policy advisors, technical experts and scientists, international business managers, sales managers, or chief strategists. Interviews have lasted a minimum of 30 minutes to around two to three hours.

Interviews have normally been set up through e-mail correspondence and/or phone calls. In the initial phase, interview guides (in English, Chinese, and/or Danish) were sent to respondents in advance, reflecting questions related to issues identified in the GIN (and related) literature(s)[27] as well as being informed by questions related to specific Chinese plans and policies on wind power, renewable energies, and to Science & Technology (S&T). Hereby, operationalisation of the GIN literature has helped guide the study in the initial phase, when the researcher was still lacking knowledge on what controversies or actors would turn out to be relevant. Over time, as discourses, narratives, controversy traces, and human and non-human actors had gradually emerged, interviews became more focused and customised to each type of actor. This made it possible to conduct very specialised

[27] e.g. IPRs, upgrading, learning, technology transfer, in- and outsourcing of specific activities, value and supply chain governance, innovation strategies, and R&D-collaborations.

interviews at the same time as the study continued to expand, revealing new issues and actors. At the same time, knowing the field better and better over time, the initial semi-structured interviews became even less structured, with the overall guideline being specific controversy traces, actors, issues, and concerns. Thus, interviewees often did not receive an interview guide, while the researcher had a notepaper with specific actors and issues that would always have to be covered, so that a coherent account could be gathered, while also keeping an eye (and ear) open for new themes, actors, discourses, stories, and other surprises. To keep track of the continuously expanding networks with new actors, relations, stories, issues, and controversies etc. emerging along the way, a comprehensive note-keeping system along with a field diary and multiple drawings was kept to assist in the researcher's sensemaking (Weick, 2003) and the continuous tracing of themes, discourses, actors, controversies, time-lines, metaphors etc. Indeed, deciding which actors to follow has been a gradual process amongst the innumerable traces and data encountered in the field. However, over time, it became increasingly possible to detect how the same kind of actors and issues, concerns, and controversy-traces were re-appearing and repeated by respondents, which strengthened the 'validation' and 'reliability' of the account.

Iterative data processing

In order to identify relevant, reoccurring actors, themes, controversies etc. to enable the work with the narrative storyline of the thesis, intensive data coding has been conducted both during data collection as well as during breaks between field trips. With some resemblance to coding processes characteristic of the method of grounded theory, engaging in a constant comparison between data and theory (Glaser and Strauss, 1967), rather than being interested in general theory making and dividing data into 1st and 2nd order codes, the data has been coded along themes and subthemes. This thematic coding enabled the progressive work on categorisation and grouping together of themes, identifying potential storylines in the process of controversy mapping. In the first comprehensive round of data processing (spring 2013), an approximately 250-page long document was constructed with quotes from the different interview documents sorted under different themes and sub-themes. This coding provided the basis for conducting the last field trip, with the aim of 'filling in' some of the 'holes' in the data material and of verifying some of the statements in the data from various sources, as a matter of 'triangulation' (Erzberger and Prein, 1997). Thematic coding was later repeated after the last, longer field trip in the autumn of 2013, sharpening the story line and resulting in several new drafts of the analysis, during which the story line was slightly modified, although more or less sticking to the overall 'story'. Thus, as early as during the initial data processing, (1) IPRs, (2) standardisation and certification,

(3) money, corruption, and trust in a Chinese ‘relational’ economy, and (4) a Chinese experimental pragmatism of green marketisation in a fight against fossil fuels and the role of price and cost calculations had emerged as traces of controversy. *Table 3* below renders examples of some of the codes from the first, initial data coding used for developing the story line for the first draft of the analysis:

Table 3: Thematic controversies

Thematic controversies ('2nd order codes')	Thematic issues (subcategories) ('1st order codes')
I: Controversy over intellectual property	- Qualifying control system software as 'core' - Collaborations configuring around control system technologies - Dilemma between sharing and protecting algorithms - Negotiated access to core algorithms, negotiated boundaries of 'coreness' - Relating core algorithms to issues of quality problems in the industry - Cases of IPR infringement - Issue of upgrading - Issue of independence from foreign technologies and technology transfer - Knowledge transfer
II: Controversy over standardisation and certification	- Issue of quality - Difficulties of obtaining international certification of Chinese wind turbines - Certification requirements and industry standards - Issue of the right to define quality, construing quality through tools of certificates and standards - Negotiated quality - Issue of price versus quality - Emergence of Chinese certification system - Issue of Indigenous Innovation
III: Controversy over money and China's system problem	- Issue of Politicised Market Conditions - Managing the Chinese web of ‘common pockets’ - State-controlled power sector - Issue of interlinked state-owned companies and corruption - Quality as personal relations (guanxi) - Issue of dealing with the headquarter for Danish control system suppliers - Issue of emerging 'agents' - Destabilised network relations - Issue of trust - A skewed market and how to survive as foreign wind turbine manufacturer in China
IV: Controversy over cost- and price-calculations entangled in experimental sustainable transition	- Struggle for allowing wind power on to the grid - Resistance from wind park owners and utilities - Issue of fluctating wind due to poor quality wind turbines - Issue of poor planning and implementation - Issue of political resistance - Power of calculative tools (e.g. cost and price calculations) - Collaborations on grid connection and grid compliance - Controversies over Sustainable Transition - Struggles with conventional power sources - Experimental policy-making in China - A pragmatics of market construction - Chinese exploration in a 'Big Laboratory' – bad planning or adaptive governance?

Apart from rendering an overview of changing network configurations, a ‘story’ about the struggle to qualify wind power in China as sustainable, which was entangled in a struggle to succeed in industrial upgrading and economic catch-up emerged. Set into a developmental context of industrial policy with focus on quantity rather than quality, an historical mapping of rapid growth and decline was thus pitching the story. Later stages of re-writing and gradually ‘fixating’ the story line was conducted alongside theoretical considerations of contributions to the GIN literature and other fields of study, with readings of industry-related scholarly articles, policies, and reports, in which it was easier to detect and find ‘the relevant’ actors, issues, and controversies for the story of the thesis. Further, the process of writing the discussion of the thesis has informed and fed into the last draft of the analysis, as the wider implications of the analysis to the GIN literature as well as to other academic fields gradually became clearer. Hereby, while the analysis is empirically and ethnographically ‘thick’ and detailed (Geertz, 1973), and has been driven by a largely inductive method of open inquiry, the research process has also been informed by theory, resulting in a somewhat ‘abductive’ or ‘retroductive’ reasoning (Blaikie, 2007).

In this process, it has become evident that while algorithms are framed as critical actors in the account of the thesis, it is, however, more precise to say that it is the associations which software algorithms (and other calculative framing tools, such as IPRs, standards, cost and price calculations) ascribe to wind power, and the calculative agencies and controversies they produce, which are being followed. Construing associations of different qualities of sustainability and ascribing them to wind power, these algorithms play a critical role in the overall qualification struggle within Chinese wind power and can engender controversy in the framings they produce. In this way, the thesis offers a lens for studying actual, *in situ* valuations in ethnographic sites (inspired by Dewey in Stark, 2009: 32). As indicated, two ‘story lines’ are intertwined in the thesis, namely an empirical story line alongside a theoretical story line. In the following, the narrative (re)presentation of the findings through both an empirical and a theorised story line is outlined further.

Data presentation – on emplotted narratives and shifting, polyphonic stories

Having outlined the data collection and data processing during the research, the following looks into the (re)presentation of the data. This is done by looking further into the narrative mode of emplotting the empirical and theorised story lines of the thesis. The narrative concern for emplotting the thesis – e.g. with the assistance of metaphors – is founded in the constructivist perspective of ANT, which is generally seeking for *detailed* descriptions (Law, 1994; Latour, 2005a) characteristic of anthropological method and its *thick* descriptions (Geertz, 1973). Thus, the ANT lens emphasises that “good sociology has to be well written; if not, the social doesn’t appear through it” (Law, 2004: 124). Consequently, the thesis is inspired by the way in which the evocation of metaphors can be seen as a mode of inductive theory building (Boxenbaum and Rouleau, 2011: 274), while the narrative represents a particular *narrative mode of knowing* in contrast to the logico-scientific mode of knowing (Bruner 1986 in Czarniawska, 2008: 7).

Emplotting the data

As already indicated above, the researcher has consistently experimented with different potential story lines in order to convey a coherent, fully fledged, and emplotted story. Indeed, the thesis has taken many shapes, as it has been re-drafted and re-written in myriads of iterative writing processes, in which the plot and the many details of the story has only slowly emerged and settled. That is, whereas “a narrative is understood as a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected” (Czarniawska, 2008: 17), a plot can be seen as the ”basic means by which specific events, otherwise represented as lists or chronicles, are brought into one meaningful whole” (Polkinghorne 1987 in Czarniawska, 2008: 7). In this lens, a story is a narrative with a plot (Czarniawska, 2008: 19). Consisting of seven chapters, each chapter of the analysis constitutes a narrative in itself or a ‘fractal’, which has to be emplotted into a coherent (though rhizomatic) story.

Over time, as algorithms and other calculative framing tools such as money, prices, and cost-calculations were construed as main actors in the emerging account, a plot similar to those of ‘crime novels’ seemed to evolve over time, in which a power struggle between Chinese and foreign actors in the ongoing reconfiguring of the Chinese wind power market and the simultaneous collaborative and competitive dynamics of relations between Chinese and foreign actors was taking place. To build a story through different fractionally coherent accounts, the crime plot has served as an inspiration in the writing process. Yet, rather than being emplotted as a relatively simple, structural detective fiction, configuring a unidirectional maze, the thesis is inspired by Eco’s (1983) notion of the highest and most refined form of the crime plot as mystery, or as a so-called ‘rhizo[matic] maze’ whose structure is relational (Eco, 1983: 253). In this way drawing inspiration from Deleuze and Guattari’s ((2011 [1980]) metaphor of the ‘Rhizome’, Eco (1983) outlines how a story can be emplotted as a rhizomatic maze, denoting its potential endlessness as well as how it does not end up with one story, one conclusion, but rather with multiple fractals, beginnings and potential endings (Eco, 1983: 252; Kirkegaard, 2014). The botanical metaphor or the rhizome with its ever expanding roots underground thus indicates how the story has no centre, no periphery, no exit, and thereby no clear-cut solution, trust, victim, or culprit. The emplotment of algorithms (and other calculative tools) as a red thread in the analysis of the thesis thereby only renders the illusion of finality, which has been necessary for the framing of the thesis.

Indeed, despite the doctrine of "[j]ust observing a controversy" (Latour in Venturini, 2009), doing 'Mapping Controversies' research "is like wandering in a maze with a twine of threads to follow" (Venturini, 2009: 6). As the analysis dives deeper and deeper into the magma of diverse inter-twined controversies with one plot, one actor, one action, one relation, and one issue leading to the next, the analysis sheds light on what may be termed a web of 'rhizomatic negotiated spaces' (Murdoch, 1998). Controversy mapping hereby resembles a "composition of many diverse compositions, a plurality of pluralities" (Yaneva, 2012: 107-108), which aligns with anthropological method (Marcus 1992 in Czarniawska, 2008: 15). Expressed in terms of narrative, "openness to competing interpretations [...] is a virtue in narrative", which means "that the same set of events can be organized around different plots" (Czarniawska, 2008: 7).

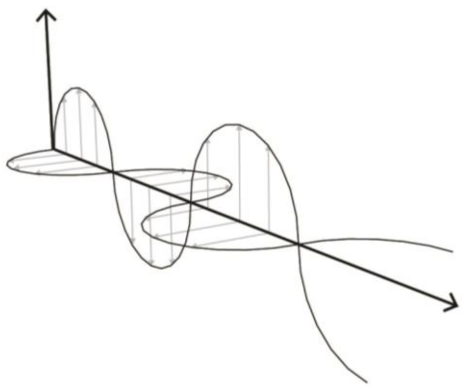
Further, it should be noted that apart from the overall storyline of the analysis, another ethnographic storyline runs through the analysis, as each chapter in the analysis starts with a brief empirical vignette, shaped around ethnographic field-notes and sketching a 'personal' storyline of the research process. Lastly, the progressive construction of associations of worth and value to wind power can be seen as a power battle on emplotment (Czarniawska, 2008: 31). That is, a power battle on the right to emplot the construction of a market for wind power as sustainable and/or as a 'success' or 'failure' is taking place.

Seeing through metaphors and figures

The above has outlined how the metaphor of rhizome has served as a way of 'disciplined imagination' (Weick, 1989), serving as a cognitive and heuristic device (Cornelissen, 2006; Weick, 1989) in writing. What may seem particular to a 'developmental', and 'socialist' context' of China is i.a. how sometimes multiple, conflicting agendas, ambitions, and priorities are colliding, constituting multiple, dense, and intertwined controversies. To reflect such 'tightness' and 'density' of controversies, the metaphor of rhizome alone may be insufficient, however. Consequently, the alternative metaphor of the 'meshwork' as "a tightly knitted net" has also assisted in the sensemaking process, as a meshwork seizes the "'thick' mesh of entanglements, as a cosmology" (Yaneva, 2012: 2), of e.g. marketisation. Apart from these metaphors, metaphors employed by respondents in the field have also inspired the research, e.g. the ‘Chinese spider web’ of state-owned actors and ‘agents’ as well as human body analogies (e.g. ‘central nervous system’, ’spine’, and ’brain’) to explain the role of software tools in the wind turbine.

Through the work on the thesis and representation of the data, figures and models have also been consistently developed as a means for sensemaking. The thesis uses a number of figures to illustrate some of the points visually. Yet, a ‘disclaimer’ to the figures must be made, as they all seem two-dimensional and static, due to limitations in the visual tools applied. Thus, while the function of the figures in the thesis is meant to ease comprehension, they should not be taken at face value, and the reader should try to abstract and see them as three-dimensional and dynamic in nature. Further, two-dimensional figures tend to separate things into levels and layers, with some circles and brackets seeming ‘larger’ than others. Again, in a constructivist, lateral, and symmetrical lens, none of these layers should be taken for granted. Thus, while some circles are depicted as visually larger, this is not meant to entail that they are more powerful or important than others. This is instead a matter of empirical investigation. Lastly, for practical reasons, many circles (e.g. poles and TENs) and brackets seem to be separated; yet, the reader of the figures should take into account how these different circles (poles and TENs) often tend to overlap. Despite this disclaimer, it is hoped that the figures will help in easing comprehension of the relatively abstract theoretical assumptions, in illustrating how the thesis has approached the field, and in summing up on some of the findings. A visual metaphor for how to approach controversy mapping has been the metaphor of electro-magnetic waves. While related to electricity – and thus fitting the issue of wind power – the fluctuating, multi-dimensional electro-magnetic waves can help render a sense of fluctuating controversies and transformative changes (waves) over time.

Figure 3: Electro-magnetic waves – as metaphor for controversy mapping



Source: Own design.

Not taken by the letter, but with a sense of 'pragmatism', the horizontal line can illustrate dynamics over time, with the vertical line illustrating intensity/quality of conflict, and the flat/lateral line illustrating the number actants involved. Still if each floating wave is seen to illustrate a controversy related to a specific issue, the figure is not meant to argue that one controversy necessarily follows the other; instead, controversies tend to overflow, overlap, and evolve simultaneously. The metaphor of electro-magnetic waves has been employed to reflect the potentially disruptive, 'transformational change' identified in Chinese wind power as a battle, illustrated and seen as a fluctuating wave.

Theorised story line – construing an ambiguous space for coupling the incompatible

While the seven chapter long analysis in itself has been emplotted as a coherent story, the analysis constitutes, at the same time, a part of an overall *theorised story line* (a plot) (Golden-Biddle and Locke, 2007: 5, 46), weaving together relevant literature(s) with the field insights. That is, the different bits and pieces of the wider puzzle, i.e. the wider story of 'experimental green marketisation' in a developmental context of China and the link to GINs, have also been emplotted along a theorised story line. In this way, the explorative research resembles a continuous 'inquiry about inquiry', as the researcher has consistently explored what story the data is really 'about' or a 'case of', using theory as a mirror, against which to debate the findings and fine-tune the plot. Paraphrasing Eco (1983), theoretical discussions function throughout the analysis as background music (1983: 252), displaying how issues relate to each other like rhizomatic structures. Hereby, it seems 'impossible only to tell one story' (Eco, 1983: 253). In the thesis, the review of the existing literature on GINs and some of its founding literature streams has been plotted so as to fill in a gap on genesis, dynamics, and agency. This reflects how "we are never the sole authors of our own narratives; in every conversation a *positioning* takes place" (Davies and Harré 1991 in Czarniawska, 2008: 5).

Overall, the theorised story line of the thesis construes a pragmatic bridge, which spans the ontological and epistemological divides between the positivistic GIN and the constructivist accounts. This is introduced in *Chapter 2*, and later elaborated on in the discussion (*Part IV)*. By bridging such colliding accounts, the thesis may at first sight seem to sit ambiguously between two 'incompatible' perspectives: That is, the GIN literature seeks for causal explanations, generalisations, and theorisation, and thus represents what can be called a 'strong research programme'. Such frameworks are in a constructivist perspective criticised for rushing "into classifying and inserting what you see into contextual frameworks, pre-defined lists and categories of explanation!" (Yaneva, 2012: 45). Instead of seeking for certainty and stable conclusions (Law, 2004: 9), the proposed constructivist perspective represents a 'weak', yet "radical programme" (Yaneva, 2012: 43), which pursues anti-reductionism (Fraser, 2010) and a regime of 'presentational immediacy'" (Whitehead, 1978: 174 in Yaneva, 2012: 106):

"Theories usually try to explain why something happens, but actor network theory is descriptive rather than foundational in explanatory terms, which means that it is a disappointment for those seeking strong accounts. Instead it tells stories about 'how' relations assemble or don't" (Law, 2009: 141).

Raising such critique of the 'strong narratives' of causalities, in a search for accuracy and consistency (Fraser, 2010), the modest method (Law, 1994) of the constructivist perspective instead prizes a good story and empirical detail to provide an account of the singularity, specificity, and situatedness of the specific event (Fraser, 2010: 66; Venturini, 2009: 12). This implies that the thesis does not render a strong account resembling conventional GIN studies.

Nevertheless, while aligning with principles of 'modest method' (Law, 1994), the thesis simultaneously has an ambition to contribute to the GIN perspective (and vice versa). This reflects an acknowledgment that "formal organizations, networks of actors and actor-networks, action nets and spontaneous organizing coexist – at the same time and in the same territory" (Czarniawska, 2013: 13). In other words, acknowledging the coexistence of genesis and structure and of disorder and order, the thesis embarks on the task of exploring how and whether the 'thick descriptions' of the processual and relational lens of the constructivist perspective can feed into the 'stronger accounts' of the structuralist and positivistic GIN literature, and vice versa. Indeed, setting out on such daring task, the courage and rationality of which can only be judged at its completion (paraphrasing the

‘Serresean sea-journey’, in Jensen, 2010: 12), the scientific journey of the researcher has admittedly been characterised by doubts and concerns throughout the research. Nonetheless, the ‘ambiguous positioning’ of the thesis reflects not only the ‘theoretical promiscuity’ inherent in mapping controversies (Venturini, 2009), but also an acknowledgement of how different approaches and ways of conceptualising organising each have their advantages and shortcomings (Czarniawska, 2013: 13). Running the risk of being rejected by either discipline, the thesis takes up the challenge of mobilising audiences from different disciplines (e.g. China-studies, the GIN-literature, marketisation studies, and even practitioners) by bringing ”together ideas or objects from previously unrelated domains” (Davis, 1971: 325). Ideally, such ‘innovative’ bridging can make the study ’interesting’ (Barley, 2006: 18), e.g. through its production of spaces of ambiguity (Stark, 2009: 3).

Challenges of Doing Research in Chinese Wind Power

Having provided an account of the methodological ‘tool set’ employed in the thesis and the implications that this has had for data collection, processing, and representation, the following provides a brief critique of the data and reflexive considerations on doing fieldwork in China.

Becoming an ‘expert’ in unforeseen fields

Throughout the process, as actors have been identified, the project took on a more and more technical character, going well beyond the familiar ‘terrain’ of the researcher. While Venturini (2009) claims that the best controversies to map are those configuring around technical issues (Venturini, 2009), the highly technical character of the field has been an ongoing concern and challenge, as the researcher did not speak the ‘local [scientific and technical] language’ of the respondents, so to speak. Over time, it became evident that it was necessary to make an attempt at learning to speak with respondents in their own terms (MacKenzie, 2003), as much as possible, that is, adhering to the notion of reduction resistant research and the approach of science-without-borders of the ‘promiscuous’ Mapping Controversies approach (Venturini, 2009: 5). Indeed, an understanding of ‘algorithms’, control systems, simulation tools, aero-elastic codes, and other technical aspects had to be built, but often also to be demolished and modified, since the ‘blackboxed’ understanding of the different components construed by the researcher proved unstable in many situations. Over time, a new vocabulary (in English, Danish, and Chinese) was gradually built, making it possible over time to explore an increasing amount of the technical aspects, which turned out as unexpectedly critical to the story line.

Lost in sensitivity?

Apart from the challenge of technical specificities, there has been an ongoing concern of becoming “an entangled participant rather than an external observer occupying an overhead position” (Muniesa, forthcoming: 3). Indeed, sometimes it seemed as if the researcher was being drawn into the field, being treated as a consultant or ‘soul-searcher’ to render advice and recommendations for Chinese and Western respondents alike. This may largely be due to the in-between hybrid status of the researcher, i.e. being acquainted both with the Chinese and Western culture and language. It has thus been a challenge at times to handle the high degree of sensitivity of some of the investigated issues. Anonymisation of all interviews has been chosen throughout the analysis (coding them as ‘Int. 1’, ‘Int. 2’ and so forth, as they are being employed chronologically throughout the thesis), at the request of many respondents and in acknowledgement of the actual sensitivity of certain issues, which could have repercussions within the Chinese bureaucratic cadre-system in particular. Such high level of sensitivity and need to anonymise data is a prevalent concern in the field of China-studies (Heimer and Thøgersen, 2006). The level of sensitivity has further been reflected in the way that it has sometimes been impossible to decide whom to talk with. For instance, when conducting interviews during a field trip to China with the SDC group, everything had been settled in advance by the Chinese collaboration partners without any chance to select which companies and people to talk to, and with interviews translated through interpreter. Sometimes, there have even been indications of being ‘spied upon’, as well as attempts at ‘recruiting’ the researcher as ‘agent’, to assist in the work of maintaining relations. Indeed, some things and details may have been lost in translation during some interviews, that is to say, potentially also being ‘lost in sensitivity’. On the other hand, Chinese contacts have been crucial in terms of assisting in establishing contacts with otherwise inaccessible state-owned enterprises (SOEs) and diplomats.

In China, the conception of what is perceived as ‘sensitive’ is often different from Denmark. Sometimes, the researcher has been directly (or indirectly) warned about the ‘sensitivity’ of the investigated issues. This created continuous experimentation as to ‘how far’ into the explorations the researcher was allowed to proceed. That is, as more and more knowledge was gained on the field (and its technicalities) over time, it was increasingly possible to ask more sensitive questions. Yet, this was a balancing act that had to be managed with care, always being observant of almost invisible signs in body language, eye movements etc. as indications of whether or not the limit had been reached or even trespassed. Often, Chinese people reject answering a question which is sensitive (or offensive), by way of silence and/or laughter, i.e. responding with *non-action* (无为 *wuwei*), which is a typical sign of *losing face* (丢面子*diu mianzi*) (Wong et al., 2007, Fang, 1999). Otherwise, a way of rejection due to the sensitivity of the issues may have been the many times that phone calls or e-mails have been left unanswered. Over time, the researcher managed to get 'deeper' into the field than initially expected. This was largely made possible by establishing relations with some respondents with whom several interviews were conducted. Such critical contacts functioned in many ways as gatekeepers in order to get in contact with otherwise inaccessible contacts. In China it is often impossible to establish contact without a good personal relation to refer to. Hereby, 'snow-balling' seemed the only viable strategy for data collection, as the personal relations (*guanxi* 关系) of one respondent had to be employed as an 'interessement device', to mobilise the next respondent in line[28]. Indeed, the fieldwork oftentimes resembled the translation process of a 'detective's undercover work', slowly mobilising and translating actors into the 'web' (or assemblage/agencement) of the thesis. Overall, personal relations (*guanxi*) have been critical to the research, since changes in rules and policies or changes in the industrial landscape are often not possible to be found officially in China, but are often only accessible through 'Chinese whispers'. In turn, such whispers have to be double-checked as much as possible, as the meaning of these 'whispers' may be diverted over time and as they are translated from agent to agent, often starting from the political leadership. Indeed, 'Chinese whispers' are ubiquitous in the Chinese wind power industry, be it about new regulations and policies, upcoming Five-Year Plans (5YPs), new industrial standards, the status of competitors, or the development trend of the industry etc.

Towards 'Modest Modelling'

Having outlined the methodological implications of adopting a constructivist perspective, as well as how the thesis is positioned ambiguously in the space between the stronger and weaker programs of the GIN and constructivist perspectives, the thesis in the following *Chapter 5* develops a 'model' for studying marketisation in a developmental context. While this at first sight might seem to 'compromise' principles of modest method, it renders no grand scale ideal-type model. That is, acknowledging limits to generalisation, what is to be presented is a brief account of how the theoretical and methodological 'tool set' has been operationalised (and modified) for a situational study of marketisation of wind power in a development context of China. On that note, and having outlined the methodological tool

[28] In China, meetings are often set up with very short notice, while planning of meetings more than a week ahead is more or less impossible. This requires a high degree of flexibility and agility on part of the researcher.

box of a marketisation lens, the next chapter outlines a situational model for studying green marketisation in China, engaging in what may be termed ‘modest modelling’.

Chapter 5. Proposing a 'Modest Model' for Studying Green Marketisation within a Developmental Context of China

After having introduced the general theoretical and methodological premises of the constructivist perspective of the thesis, *Chapter 5* engages in 'modest modelling', i.e. outlining a 'model' for inquiring into 'green marketisation' within wind power in a developmental context of China. Together, *Part I* (*Chapters 1* and *2*) and *Part II* (*Chapters 3, 4,* and *5*) lay the foundation for the analysis in *Part III*. First, *Chapter 5* outlines a few aspects of the marketisation lens, which have been 'adjusted' to suit a study of wind power in China. Second, the 'modest model' is developed, which concludes by an example of what kind of actors may be captured through a marketisation lens, which would most likely not be captured through a conventional GIN lens. As mentioned earlier, the model to be developed is not an ideal-type model, but a pragmatic means to bring order to the analytical account.

Twisting the marketisation lens

In the following, the chapter outlines how the marketisation lens has been slightly 'tweeked' and adjusted in order to look into the specific case of Chinese wind power. Indeed, taking the marketisation lens to China may help shed light on the many alternative possibilities of markets, i.e., potentially capturing some of the 'Chinese characteristics' of marketisation in China.

Introducing TENs within TENs

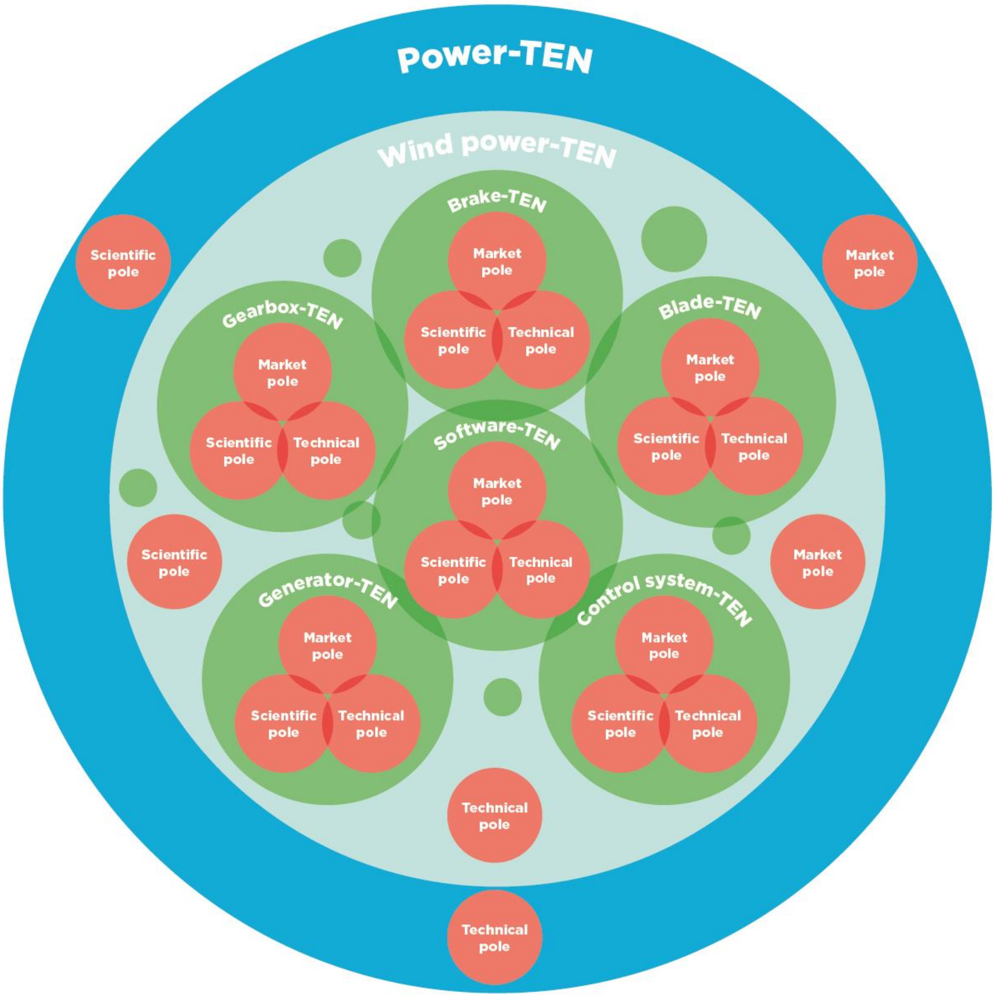
Through the notion of (market as) TEN, the analysis maps how and whether market, technical, and scientific poles around wind power are being assembled into a TEN in processes of framing/qualification. The thesis treats marketisation of wind power as a potentially emerging *wind power-TEN*. As the wind power-TEN is overflowing in the current quality crisis, the wind power-TEN seems to disintegrate, revealing how it is constituted by TENs around different component technologies. To inquire into the requalification of wind power in China, the thesis disassembles the wind turbine into its component parts, and zooms in on one component, which is being constituted as critical to the requalification of wind power, namely software. With a focus on a potentially emerging *software-TEN*, the thesis traces how the software-TEN and wind power-TEN are co-performing each other. Below, *figure 4* provides a few examples of some of the myriads of TENs around different wind turbine component technologies, which co-constitute the potential wind power-TEN, and *vice versa*. (Though with the caveat, that the two-dimensional figure provides only a static and hierarchical perspective, and therefore does not illustrate that poles and TENs overlap, does not illustrate their relations, nor how these may change over time). The different component-TENs are perceived as co-constituting parts of the wind power-TEN's different poles.

Figure 4: Examples of TENs within TENs in Chinese wind power-TEN

Source: Own design.

Apart from tracing the translation of an emergent wind power-TEN and software-TEN, the thesis also looks into how these are co-constituted by and co-constituting China's state-controlled electrical power sector, or what the thesis coins a *power-TEN*. This entangled nature of 'TENs within TENs' is attempted illustrated in *figure 5* below. Although they are not depicted in the figure, the power-TEN – apart from the wind power-TEN – contains i.a. a coal-TEN, solar-TEN, and biomass-TEN. Further, while for instance the blade-TEN, the control system-TEN, and software-TEN are depicted as part of the wind power-TEN, they are also part of the power-TEN. This means that the same TENs and poles may figure in different TENs simultaneously.

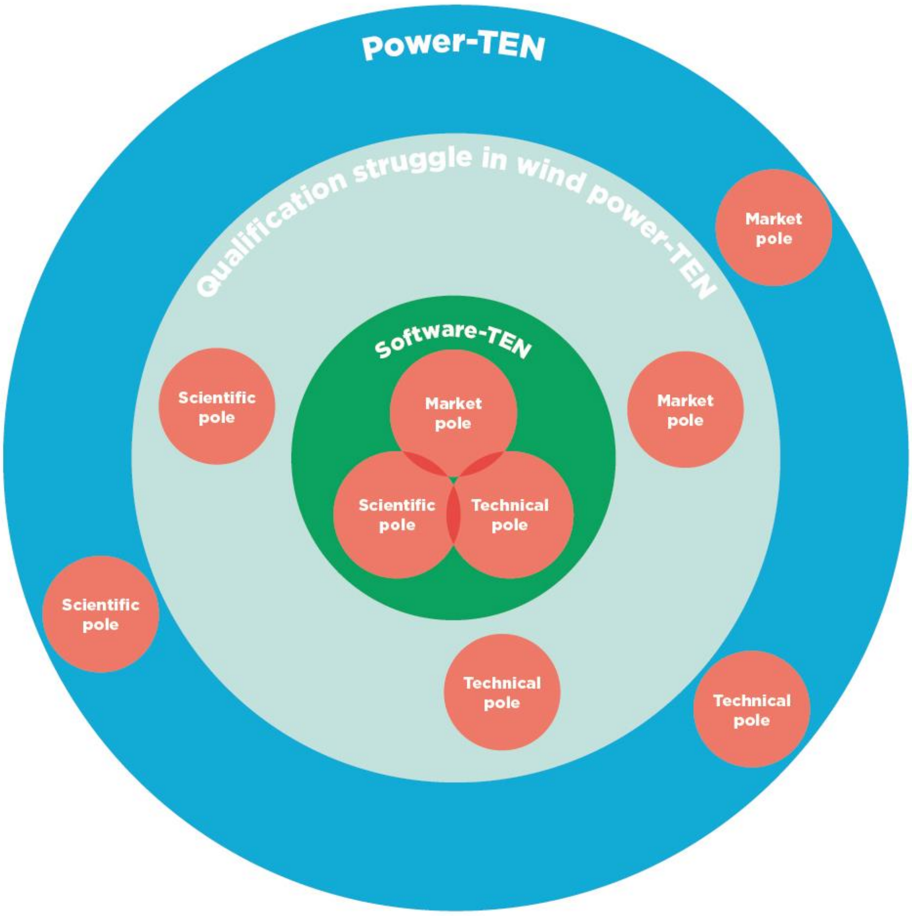
Figure 5: TENs within TENs – introducing a power-TEN



Source: Own design.

It should be noted that linkages of the entangled networks can unravel quickly, with "even one change impacting all the other links in a domino like fashion" (Garud et al., 2010a: 7). Hereby, the de- and re-framing processes of the wind power-TEN impact not only the configuration of the software-TEN, but also the power-TEN, and *vice versa* (as well as other component technology-TENs). As described in *Chapter 4*, the thesis zooms into the potential software-TEN and the network configurations and controversies it may produce in the ongoing qualification struggle of the emerging wind power-TEN. The choice to trace the potential construction of a software-TEN has been selected not only because of its status as a 'critical' component for wind turbine performance and grid connection, and thus also for its potentially disruptive agency to the framing of the wind power-TEN, but also because of its importance for China's upgrading potential in accordance with Chinese industrial policy ambitions. Constituting a strategic component for China's 'Scientific-' and 'Sustainable Development', a software-TEN is deemed a fruitful site for tracing a qualification struggle and for mapping controversies. In *figure 6* below, the entangled mesh of 'TENs within TENs', and the focus of the thesis on a potential software-TEN in the marketisation of wind power, is illustrated.

Figure 6: Zooming in on the software-TEN



Source: Own design.

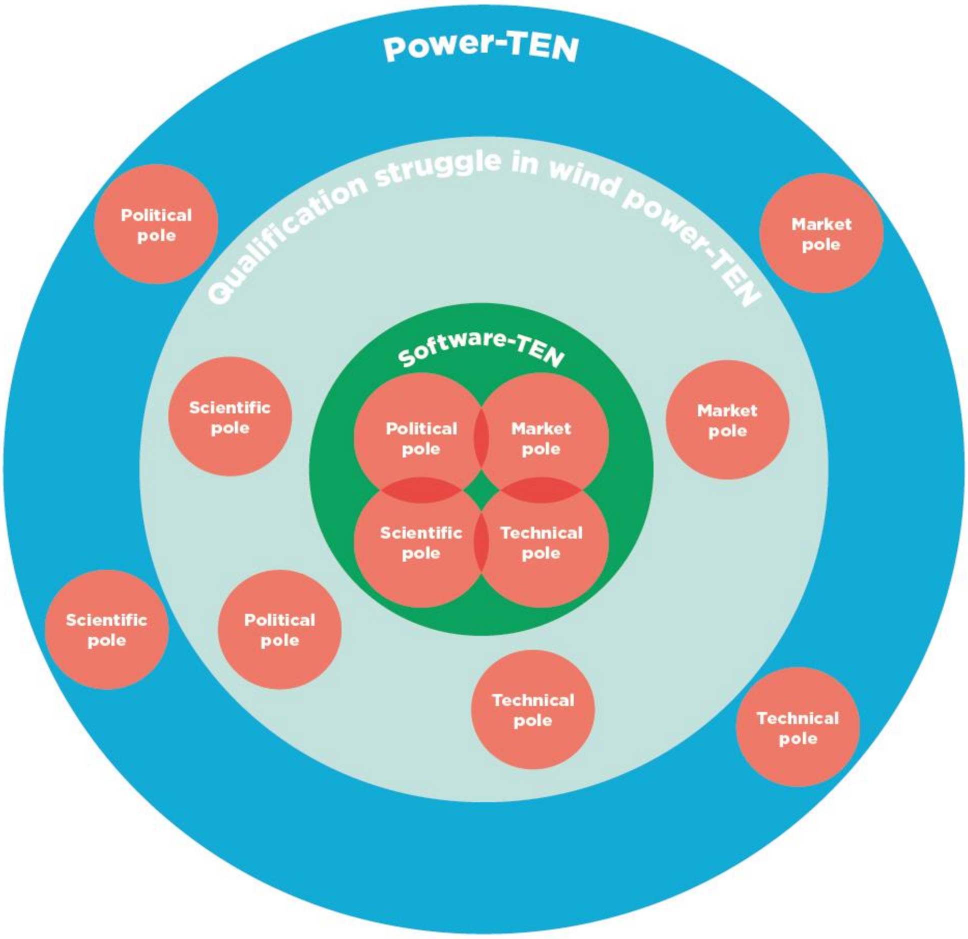
Introducing a political pole

Entangled in a heavily state-controlled power sector (power-TEN), the thesis adds a fourth pole, a so-called political pole, to the market, scientific, and technical poles of the TEN construct. The political pole in a Chinese context denotes China's political leadership, which in particular denotes Central and local Chinese governments, the Communist Party of China (CPC), party cadres and nomenclature, and sometimes even state-owned enterprises (SOEs) within state-controlled sectors[29].

The political pole is in addition the space in which political agendas and priorities are inscribed into policies, plans, and regulations, e.g. through interessement devices such as discourses, narratives, feed-in-tariffs (FITs), and targets. In *figure 7* below, the political pole has been added. By adding a political pole, the thesis argues that it becomes possible to account for how the political pole at times attempts to institute itself as 'translator-spokesperson' in the marketisation of Chinese wind power. Thus, while a marketisation lens normally conceives politics to be part and parcel of 'everything', the thesis claims that politics takes on a more direct and distinct role in the developmental context of China, i.e. constituting and entangled in 'big politics'. It should be noted that due to the way in which certain sectors may be more or less controlled and/or owned by the political pole in China, the market, scientific, and technical may be(come) deeply intertwined and sometimes even impossible to disentangle from the political pole. In turn, such impossibility of framing (and thus of bracketing and disentangling) may institute myriads of coexisting controversies, which in turn produce extensive and potentially disruptive overflowing.

[29] In the thesis, the political pole encompasses the Chinese political leadership, Central and local governments, the Communist Party of China (CPC), the local and central Chinese state bureaucracy, as well as policies and Five- and 15-Year Plans, political discources and narratives, as well as state-owned enterprises, etc. This also reflects how China oftentimes is referred to as a 'Party-State' (Delman, 2005), due to the monopoly right of the CPC to form the government (Lawrence and Martin, 2013).

Figure 7: Introducing a political pole



Source: Own design.

By enabling a lens for the potentially particular 'political' characteristic of Chinese marketisation in wind power, the thesis may be claimed to look into the potentially multiple modes of marketisation and economisation. This aligns with the call for marketisation studies, which are open to multiple modes of marketisation and economisation, which in turn

"introduces an explicitly political dimension into the process of economization, especially when it means marketizing objects and behaviours that have previously defied marketization" (Callon and Çalişkan, 2010b: 23).

Indeed, in a 'socialist' market economy of China, it can be argued to be (particularly) relevant to dig into the potentially many alternative possibilities of markets, which do not necessarily fit into the ‘Western’, ‘capitalist’ model of ‘developed countries’. That is, ”[m]arkets have a history; they also have a future that cannot be reduced simply to an extrapolation of the past” (Callon and Çalişkan, 2010b: 24). Accordingly, the thesis proposes to look into marketisation in Chinese wind power by tracing how it may constitute a particular tension between *designing* and *experimenting* characteristic of marketisation (Callon, 2009: 536).

‘Narrative’ and ‘discursive’ devices

The often activist ’political pole’ (and/or other poles) in the potentially emerging Chinese wind power-TEN might employ interessement devices to mobilise other poles in the collective, distributed effort of marketisation. Such interessement devices may i.a. be policies and plans, into which discourses have been inscribed. When such discourses add a temporal aspect – often intertwining past, present, and future – such as a plot, a narrative is constructed, which can potentially delineate, order, and perform certain roles and framings of the TEN. When employed strategically to enrol and mobilise other actors into an emerging TEN, the thesis terms these ’discursive’ or ’narrative’ tools/devices’. In this way, amongst calculative tools, not only ‘metrological’, calculative tools (e.g. simulation tools, certificates, audit systems) (Callon, 1998: 21)[30] play a role, but also ‘textual’ calculative tools[31]. Treated as physical (material) textual tools, constituted by material things (words), these tools not only function as intermediaries, but may also play a role as actors, as they make other actors act and de- and reconfigure the emerging TEN[32]. Textual (discursive and/or narrative) devices can assist in the (de- and re)qualification (and legitimisation) of new potential products and the markets that they may assemble, and thus in the translation of a potential TEN. This is done through the (temporal) framings they produce, as they sever

[30] Although the notion of ‘qualculative’ tools has been advanced to display how agents are capable of making both qualitative and quantitative calculations, i.e. so-called qualculations (Callon and Çalişkan, 2010a: 29), the thesis does not find the distinction between calculation and qualculation particularly clarifying, as calculative tools can also associate qualities and thus be qualculative and vice versa.

[31]Doganova and Eyquem-Renault (2009) illustrate how business models can act as both calculative and narrative devices that allow entrepreneurs to explore a market, thereby playing a performative role (Doganova and Eyquem-Renault, 2009: 1559).

[32] Constituting “any kind of symbolic expression requiring a physical medium and permitting a permanent storage”, texts not only describe things, but *do* things (Taylor and Every in Phillips et al., 2004: 636). Although this definition subscribes to a social constructivist account of discourses (e.g. Phillips et al. 2004; Czarniawska 2008), the thesis takes a constructivist approach rather than a social constructivist, sensemaking, and/or institutionalisation approach to discourses or narratives.

certain links and (at least temporarily) stabilise/make irreversible certain trajectories of a potential TEN.

Narrative tools in a developmental context may be employed to construe associations of e.g. a ‘grand narrative’ of ‘(sustainable) development’ or ‘catch-up’. On a related note, as regards the construction of new markets within a clean-tech sector such as wind power, marketisation requires the economisation of environmental concerns (Karnøe and Doganova, 2014, forthcoming). That is, to transform wind from a thing into a good requires the construction of associations of environmental quality (“cleanliness”) and economic worth (price) (Karnøe and Doganova, 2014, forthcoming). However, set into a developmental context of China, the thesis opens up to the potentiality of other coexisting concerns, qualities (such as different ‘sustainabilities’), and the construction of different worths. For instance, economic worth may collide with what may be termed ‘developmental worth’, and the quality of ‘environmental sustainability’ may collide (even more than in developed countries) with ‘technical sustainability’. Such colliding qualities and worths are likely to produce controversy, and to be ubiquitous in a developmental context with multiple, shifting, and often conflicting agendas.

Forces of opening up and protection – introducing a competitive space

The potentially multiple and competing worths and qualities of wind power, which are likely to complicate marketisation, may be linked to how China as a newly industrialised country (and the wind power-TEN in particular) is entangled in seemingly contradictory and paradoxical processes of so-called national “community economies” and “global interdependent markets” (Callon and Çalişkan, 2010a: 42-43). That is, seeking to protect its domestic enterprises, China may be claimed to bear traits of a national ‘community economy’. Such national community economies are likely to create hierarchies, alliances, and boundaries, as well as to produce confrontations between communities. In contrast, simultaneous forces of global interdependent markets, which are characterised by extending boundaries, and by principles of free circulation of people, knowledge, and technologies (e.g. software), are producing a ‘flat world’. Whereas the national framework of community economies “remains politically strategic” (Callon and Çalişkan, 2010a: 42) for a newly industrialised country such as China, participation in global interdependent markets is becoming more critical, e.g. in order to access important resources. Hereby, the two processes “coexist and merge, shaping hybrid and evolving configurations as they do so” (Callon and Çalişkan, 2010a: 45). As newly industrialised countries integrate into global interdependent markets, positions and roles of actors are likely to be transformed, constituting a new *agencement* (Callon and Çalişkan, 2010: 42). In turn, the coexistence of such conflicting processes is likely to produce a hybrid space of confrontation and power contestations in the marketisation of Chinese wind power. To account for these processes, the thesis extends Murdoch's (1998) negotiated spaces, introducing a so-called '*competitive space'* between Chinese and foreign actors in the marketisation of Chinese wind power, to illuminate the potentially conflicting agendas and spaces of confrontation, as well as the negotiation of roles, positions, and identities of actors (Callon, 2007: 159) in the simultaneously collaborative and competitive relations around software.

Unfolding a case-specific marketisation framework within Chinese wind power

Having outlined how different concepts and constructs of the marketisation lens have been adjusted to the situated study of green marketisation in a developmental context of China, the chapter briefly outlines a situated model for studying marketisation of wind power in China. This is done by outlining how the thesis treats the current quality crisis as a qualification struggle, i.e. of framing. The section concludes with a visual model along with an outline of how the model will be employed in the different chapters of the analysis.

Tracing the potential emergence of a wind power-TEN

If calculative agencies for calculating and valuating the worth of wind have not been established, wind is not to be considered a good, as no market can be assembled around it. Lacking stable calculative agencies of wind power in China, the thesis treats the wind power market (the wind power-TEN) as a *potentiality*. In order to build a strong collective – a market – around wind where wind power can be dispatched in the grid, it must first be transformed from a thing (wind) to a good (wind power). This necessitates work of qualification, which can contribute to the valuation of wind power. The thesis proposes that a marketisation analysis of wind power in China should inquire into how and through what means different actors of various poles are enrolled into a collective around an emerging good. To enroll poles, different interessement devices may be employed. For instance, if the political pole attempts to institute itself as translator-spokesperson on behalf of a potential new wind power-TEN, the political pole might employ subsidies such as FITs, quantitative growth targets (e.g. GW targets), purchase agreements, and 'narrative' and 'discursive' devices. Further, mobilisation of poles may happen by problematising the need to solve a (stem) issue such as i.a. 'sustainable development'. Raising such matters of concern, and framing a potential good as a potential (partial) solution to such issues, a collective may be mobilised around an emerging market.

If the framing of an emerging TEN has been severely destabilised, however, it must be restabilised by containing the overflowing. That is, when not containing the overflowing (temporarily), the emerging TEN is likely to disintegrate. This means that if wind power cannot be framed as a sustainable good, it can be difficult to translate i.a. the grid system, algorithms, generating companies, coal-fired power plants, standards, local governments and other actors into an emerging wind power-TEN. Accordingly, overflowing can result in *socio-technological lock-in* (Callon, 2007: 140) to fossil fuels. A way of stabilising the framing and pacifying the emerging good may be the translation of other related TENs around specific component technologies, which can produce associations of higher quality. In this way, the translation of a potential software-TEN, amongst others, can be construed as a (partial) solution to frame wind power as ’technically’ or ’economically’ sustainable.

Stabilising associations through calculative framing tools

When a market undergoes a qualification struggle due to overflowing, the good has not been successfully framed or pacified. A marketisation analysis should look into the work of stabilising the framing (e.g. producing associations of sustainability), i.e., into the pacification of goods. In this way, the analysis should trace the employment of calculative framing devices, which are adopted to associate the product (wind power) with specific qualities. Amongst other framing tools, these may involve (a) IPRs and (b) standards. IPRs (a) and standards (b) take part is the pacification of goods, which are necessary for marketisation (Callon and Çalişkan, 2010a: 8). In addition, IPRs and standards can in a Chinese context produce associations of scientific and technical quality, which aligns with ambitions of industrial upgrading, and potentially producing a framing of sustainability. As regards IPRs, they assist in defining the right to use certain assets, and thus enable the

> *“laborious and ongoing process of construction of spaces for calculation and transaction, of accounting systems that determine both who is accountable and how and what to count and not to count, and of simplified, uncontroversial owners, products and modes of ownership” (Callon 1998 in Lohmann, 2009: 500).*

In addition, by transforming a thing into a good through specific processes of standardisation, described in both abstract and precise terms, certified and guaranteed by a series of textual and material devices, the framing of a thing can be disentangled from other possible framings/qualifications and issues, and be (temporarily) stabilised (Callon and Çalişkan, 2010b: 7, 8). In this way, the process of certification and standardisation legitimises a certain way of evaluating quality, and its worth. Such calculative framing tools can be seen as *obligatory passage points* (OPP) (Callon, 1986b: 26-27) through which entities must pass to be legitimised and associated as constituting parts of the network. By pacifying the potentially multiple qualities of the thing into a certain framing, *marketising agencies* can be established, and the good can be marketed (a.k.a. '*market encounters'*). In turn, *price-setting* can be conducted, i.a. involving the flow of (c) money and the handling of liquidity between actors in the emerging TEN, as well as (d) price and cost calculations, to make the value and worth of wind power comparable to other goods. However, in a 'socialist' Chinese context, price-setting may employ other calculative tools and involve other actors than conventionally expected, e.g. ('corrupted') agents, personal relations (*guanxi 关系*), local growth targets, and coal quota.

Controversies over framing tools – on IPRs, standardisation, money, and costs and prices

As illustrated earlier, framing processes – including the framing tools and the calculative, marketising agencies, they produce for price-setting – may engender conflict and controversy. That is, natural objects do not express stable qualities without resistance, but instead involve controversy ”because objects participate in producing conflicting data about themselves” (Callon and Çalişkan, 2010b: 6). For instance, protection of IPRs leads to the exclusion of others, as e.g. patent rights confer ownership on specific entities to the exclusion of others. Hereby, even though software, technical devices, documents, people and their embodied knowledge may increasingly circulate freely in today's emergent global interdependent markets (Callon, 2007: 140), there may be limits to the circulation of certain entities (e.g. software algorithms). Just as calculative framing tools (e.g. IPRs, standards and certificates) can stabilise, their framing displays powerful mechanisms of exclusion (Callon and Çalişkan, 2010b: 7), which can make the framing overflow. When some actors are excluded from e.g. access and property rights to specific entities (e.g. algorithms), which are framed as 'critical' to the stabilisation of an emergent market (wind power-TEN), IPRs (as well as other framing devices) may destabilise more than stabilise. That is, rather than pacifying the framing of the potential product, a variety of sometimes conflicting qualities may emerge, destabilising the emerging TEN even further. In terms of a framing of sustainability, this may in particular be the case as "different organizational actors may define sustainability differently based on the practices that they embrace" (Garud and Gehman, 2012: 990). When *calculative tools*, *modes of valuation*, and *marketising agencies* conflict, controversies are likely to configure over the very right to choose calculative tools and to define qualities.

Mapping controversies in the qualification of Chinese wind power

In a developmental context of China, the construction of a market for wind power is likely to be entangled in concerns or (stem) issues for e.g. 'Sustainable Development' through

‘Scientific Development’. Yet, if stumbling upon exclusion processes performed by framing tools (IPRs, international standards) and price-setting (money and price and cost calculations), these exclusion processes are likely to engender ethical or political considerations, as well as resistance and rejection. Markets can hereby function as an apparatus for spurring and triggering the proliferation of new social identities and unexpected groups that demand to be heard, recognised, and received (Callon, 2007: 158). It is thus relevant to follow some of the potential

“legal, ethical, scientific or economic debates triggered by actions of framing and assigning ownership. The directions taken by marketization processes are profoundly shaped by the content of these controversies and by their resolutions” (Callon and Çalişkan, 2010b: 8).

Such debates may reflect how roles, positions, and identities of the different involved actors and ‘new social identities’ collide. Such overflowing may be further intensified when actors and poles are deeply intertwined. This can e.g. be the case of state-controlled markets and markets characterised by many SOEs, which in the case of China is sometimes constituted as a specific Chinese ‘system problem’.

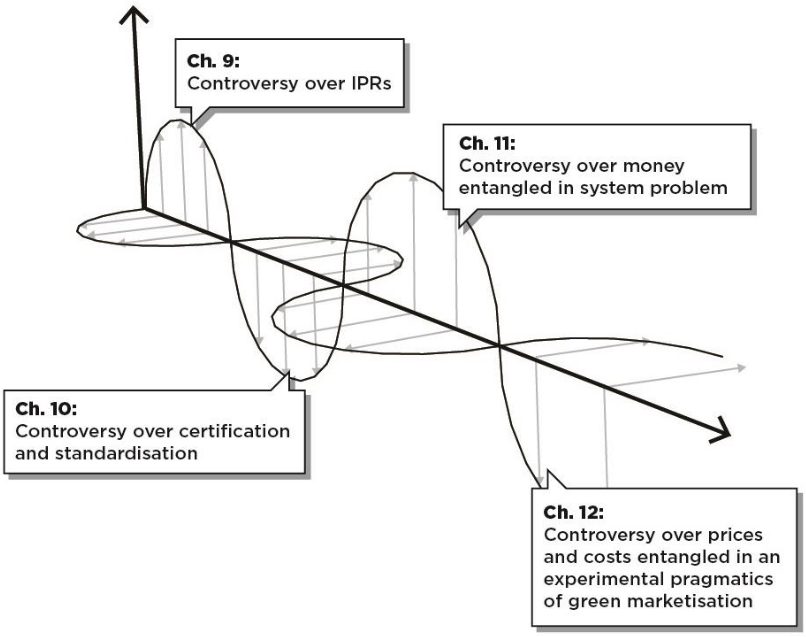
The marketisation analysis inquires into how overflowing is allowed and how it is being contained, potentially constituting a ‘pragmatic’ and experimental mode of ‘designing’ and ‘planning’, with a particular blend of agnosticism and experimentation (Callon, 2009: 536). Since the recognition of emergent identities and the construction of spaces of confrontation are preconditions for finding economic or political solutions (Callon, 2007: 159) to an overflowing market, the marketisation analysis of the thesis attempts to trace the situational myriads of overflows and their different sources. To inquire into the diverse yet entangled controversies, the analysis first outlines an historical background of the marketisation of wind power in China as a matter of ‘boom and (potential) bust’. After this, a controversy mapping is conducted, diving into the magma of controversies over IPRs, standardisation, money, and price and cost calculations, which in turn are entangled in a Chinese ‘system problem’ and a potential ‘pragmatics of green marketisation’[33].

The progression of the controversy mapping of the thesis is illustrated in *figure 8* below, which simultaneously visualises the multidimensional and potentially transformational dynamics of such controversies, by using the figure of electro-magnetic waves. It should be noted that all controversies intermingle and overlap, which tends to intensify each other’s

[33] This notion plays on the words of ’pragmatic’ industrial policy often ascribed to Chinese policy-making (Heilmann, 2008; 2009; 2011) and theoretical ’American pragmatism’, which has been used as way to bridge the GIN literature with a constructivist perspective.

dynamics. Thus, the figure is employed as a visual-analytical tool to illustrate the progression of the analysis, which firstly looks into the controversy over IPR, secondly into the controversy over certification and standardisation, thirdly over money and China's 'system problem', and lastly over money and cost calculations entangled in a Chinese 'pragmatics of marketisation'. Thus, the fluctuating waves do not depict how certain controversies come before the other; instead, they are seen as overlapping.

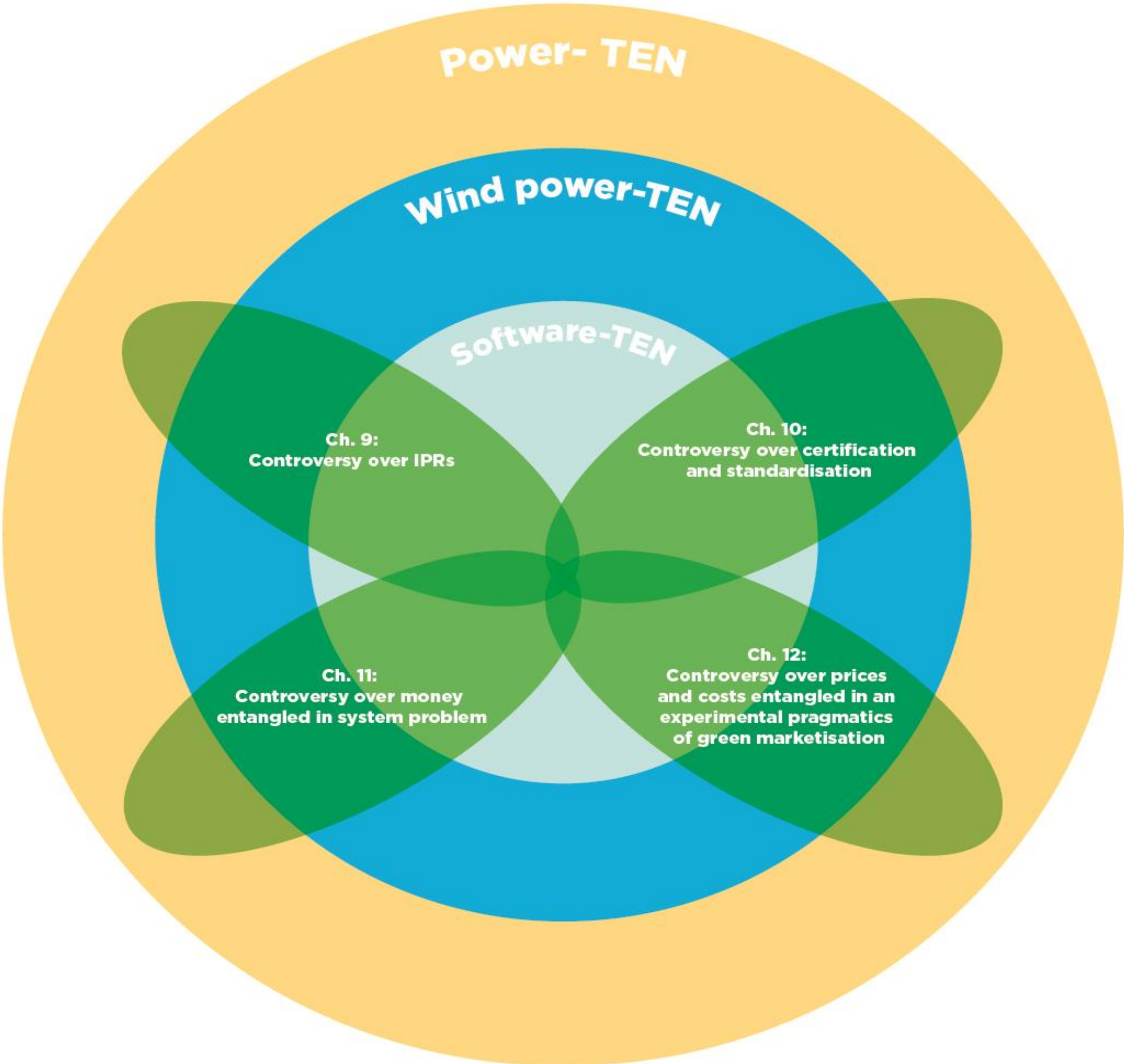
Figure 8: Analytical model for mapping controversies



Source: Own design – adapted model of electro-magnetic waves.

Set into the context of a marketisation account, *figure 9* below illustrates the overall structure of the controversy mapping within the software-, wind power-, and power-TENs. It should be noted that all controversies are overlapping and at times can be part of one or several TENs.

Figure 9: Mapping controversies over marketisation of wind power in China

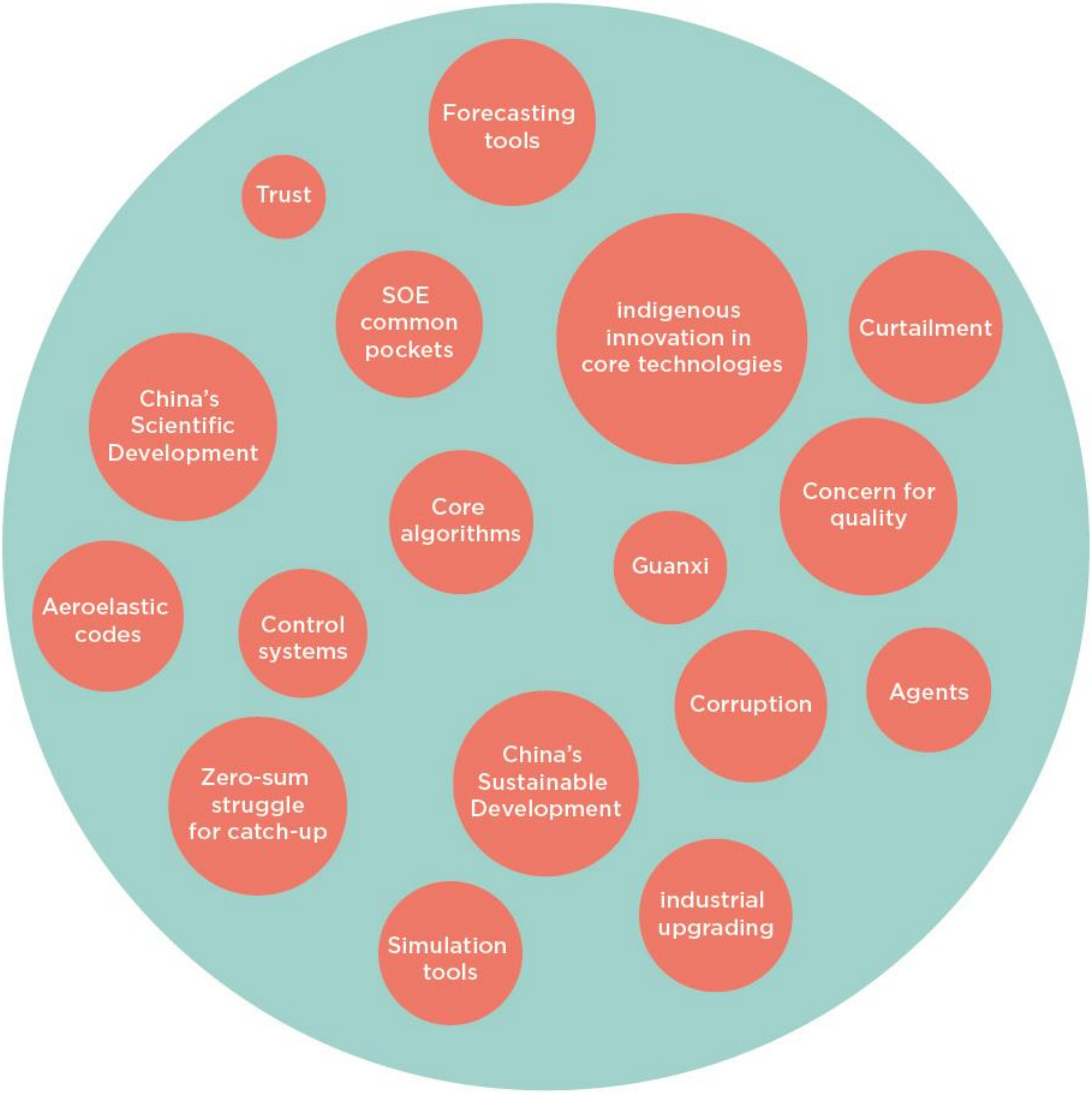


Source: Own design.

On prospects of capturing genesis, dynamics, and agency of GIN construction

By disassembling the GIN construct – decomposing the wind turbine and diving into controversies around a particular core component – the thesis inquires into the *dynamics* and *agencies* of shifting relations. The constructivist perspective seeks to capture some of the multiple actors and dynamics involved in the genesis of GINs. In *figure 10* below, a few examples of the heterogeneous actors, calculative devices, intermediaries, and issues potentially to be captured in the mapping of controversies of green marketisation in China are illustrated. These are not normally captured through a GIN account.

Figure 10: Examples of unexpected actors



Source: Own design.

By opening the black box of the GIN construct and mapping the controversies it configures, the thesis argues that by diving into the 'magma' of controversies over green marketisation in China – and capturing some of the 'Chinese characteristics' of green marketisation in China - insights into the genesis, dynamics, and agency of GINs can be gained. This will be explored as the thesis now moves on to the analysis (*Chapters 6-12)* of *Part III*, which adopts the constructivist perspective as outlined above. Later, in *Part IV*, the thesis elaborates on the potential contributions from such constructivist perspective to the GIN literature.

Part III: Analysis – Mapping Controversies in China's Emerging Wind Power Market

After having met and talked briefly at the China Wind Power Conference in 2012, I am pleased to finally have managed setting up a meeting with this foreign wind power scientist, before I am soon going back on fieldwork in China.

"The important part to understand is that…well, they [the Chinese] have had a lot of different agendas along the way. Well, they also had an industrial policy agenda, and that was very obvious, and they didn't conceal that either. Wind power development – that was industrial policy. In the beginning, it was about building an industry, and then within a number of years, China was meant to become competitive. Chinese industry experts were predicting that, within a certain number of years, based on the industrial base, China would be able to produce quality wind turbines. But quality was not the first step. That was not the important thing in the beginning. The most important was to make the industry try…to let them try out producing turbines. And then see if any turbines could come out of that, and find out who were getting good at it, while giving a lot of financial support at the same time".

As I board the plane to China, I am filled with anxiety, but also hope…I am looking forward to tracing the *genesis, dynamics, and agency* of China's wind power market in China. What shape the story will take, though, I am still not sure!

Parts I and *II* have positioned the thesis and provided the theoretical and methodological backdrop for the following marketisation analysis in *Part III* (*Chapters 6-12*). Each chapter of the following analysis begins with a short empirical *vignette*, which renders an account of the personal 'scientific journey' of the researcher, while contributing to the narrative that each of the chapters of the analysis constitutes in itself. Together, the seven chapters of the analysis provide an emplotted 'story' on (green) marketisation in China. Each chapter concludes by short theoretical considerations in relation to a constructivist perspective.

The first three chapters of the analysis (*Chapters 6, 7,* and *8*) provide an historical background for understanding the emergence of a potential wind power-TEN (Techno-Economic Network) as well as of a potentially emerging software-TEN. The three introductory chapters lead to a detailed controversy mapping conducted in *Chapters 9-12*. In the two controversy mappings, a 'micro'-relational 'algorithmic' account of controversies over intellectual property (rights) (IPRs) and standardisation, taking shape around software algorithms, is offered. In this way, the two algorithmic controversy-mappings dive into dynamics around the *pacification of goods,* as referred to in *Part II*. The last two controversy-mappings shed additional light on the paradoxes and dynamics illustrated in the two former controversy mappings, diving into dynamics of *price-setting.* This is done first by mapping a controversy over money, which is entangled in a so-called Chinese ‘system problem’ of corporate restructuring and ‘capitalist transition’. Second, the last controversy mapping looks into a controversy over price and cost calculations, which is entangled in a controversy over the sustainability of a seeming Chinese ‘pragmatics of green marketisation’. Together, this controversy cartography provides a picture of a paradoxical collaborative and competitive space marked by negotiation and ambiguity, in which identities, roles, positions, relations, and qualities are contested.

Overall, it is the ambition of the thesis that *Part III* can capture some of the ‘Chinese characteristics’ of green marketisation in China, indirectly contributing to an insight into the *genesis, agency, and dynamics* of GIN construction within Chinese wind power. *Part III* concludes by summing up on the main findings from the analysis (*Chapters 6-12*), in light of a constructivist perspective of marketisation. On this basis, *Part IV* discusses some of the potential contributions to the GIN literature (*Chapter 13*) from the constructivist perspective. Having concluding on insights for a constructivist and GIN perspective respectively, *Chapter 14* concludes on the dually motivated research question, which leads to a discussion on wider implications for related literatures (*Chapter 15*).

Chapter 6. The Emergence of a Chinese Wind Power-TEN in China?

Silently, I sit listening to the foreign wind power expert. We have talked for a long time this morning about the rapid and volatile development of China's wind turbine industry. Now he turns his attention to the current challenges that seem to be facing the wind power market. To do this, he refers back to the initial Renewable Energy Law, which focused on scale-up of installed capacity of wind power:

"I found it a senseless policy back then – when the new wind power market started up around 2005…a bad policy…because you use a lot of resources, areable land…eh, and grid, electricity grid in order to install some poor technology. But according to the Chinese experts, this was not a problem back then…they said, 'we have enough land, we will make sure to maintain them, it will be okay'. They based this argument on a rationale of low production costs, that is, China will have a comparative advantage just being cheaper. This was used to argue for not having to develop in technological terms. 'We can make do with the second-las [technology] generation'. Nevertheless, some Chinese experts were critical towards the lack of requirements and standards for wind farm design and wind turbine quality…But back then, the only thing that mattered, and the only thing really demanded in the Renewable Energy Law, was just Megawatt…how much Megawatt could be installed. Whether the turbine would run, they didn't care. It was all about capacity [measured in Gigawatt], and nothing about productivity [measured in Gigawatt per hour]".

Is something new about to happen in China's wind power industry I wonder, as I walk home.

Historical overview of the potential genesis of a Chinese wind power-TEN in China

The analysis starts with *Chapter 6* offering an historical backdrop for understanding the rapid development of a potential Chinese wind power-TEN, which has already been hinted at in earlier *Parts I* and *II*.

This is done by looking into how policies and regulations have been employed over time in China to mobilise rapid growth in installed capacity of wind power, which is measured in Gigawatt. As the resulting rapid quantitative growth has led to diverse quality issues, however, the framing of wind power as sustainable seems to have become unstable. The chapter hereby points towards an emerging 'qualification struggle' taking place in China's wind power market. The chapter first offers an account of the emergence of a comprehensive notion of sustainability in China, which has been linked closely by the Chinese political leadership to the doctrine of so-called Scientific Development as well as to a broader narrative of China's catch-up and industrial upgrading. Entangled in concerns for 'sustainable catch-up', the chapter secondly offers an historical outline of the diverse range of policies and plans in support of renewable energies, in particular wind power. Thirdly, the chapter looks into how different poles of a potential wind power-TEN seem to be gradually assembled. Next, the chapter inquires into the current quality crisis and consolidation, in which the very sustainability of the emerging wind power-TEN seems to be put increasingly into question. The chapter ends by pointing towards a potential reconfiguration – or a 'qualitative shift' – of China's potentially emerging wind power-TEN, leading on to *Chapter 7*, which dives further into a potential 'turn to quality' in Chinese policies, regulations, and plans on wind power.

Sustainability in China – a matter of Scientific Development?

In order to understand the rapid growth of China's wind power sector, it is necessary to understand how wind power as a renewable energy source has been framed as sustainable. First, however, this requires a brief outline of the genealogy of the very notion of sustainability in China.

Towards a comprehensive 'developmental' framing of sustainability

China's transformation from a low-income centralised planned economy into an emerging industrialising giant has brought with it vast, detrimental environmental effects. With rising concerns over environmental degradation, an emerging regulatory framework for China's fossil fuel-dominated energy sector has emerged. This includes i.a. supportive policies, regulations, and plans for the development of renewable energies. Although environmental concerns (and concerns for energy security) are linked to the Chinese notion of sustainability and the development of renewable energies, the very notion of sustainability in China is being constituted by and linked to a wider web of ideas concerning China's general social and economic development strategy (Christensen, 2013: 69, 91; Lewis, 2013; Fan, 2006). In the following, the chapter inquires into how sustainability has been constituted as a matter of what may be termed 'developmentalist concerns' of a newly industrialised country.

Sustainable development and the aim of a "Harmonious Socialist Society"

Whereas industrial growth was the overarching mantra of the first generations of China's communist political leadership, the notion of 'Sustainable Development' has been gradually incorporated into the party doctrine of China’s Communist Party (CCP) (Christensen, 2013; Fan, 2006), marking its legitimisation. Below follows a brief account of how a comprehensive notion of sustainable development has been developed, as part of a potential ‘new economic mode’ of China’s modernisation project.

A ‘social’ vision for China’s sustainable development – the Harmonious Socialist Society

The idea of sustainable development entered Chinese political discourse in 1994 when China formulated its own Agenda 21, two years after China’s participation in the United Nations Conference on Environment and Development held in 1992 (Christensen, 2013: 69). Whereas the 3rd generation of China’s leadership (1992-2003/Jiang Zemin) was relatively liberal in economic terms (Meidan et al., 2009: 593), promoting the notion of ‘common prosperity’ (Jiang Zemin, 1995: 12 in Christensen, 2013: 84), a more ‘social’ vision for China’s economic and social development was developed during the subsequent 4th generation (Hu Jintao-Wen Jiabao, 2003-2012). During the 4th generation, while holding back on giving freer rein to market mechanisms although continuing market reforms (Meidan et al., 2009: 592), emphasis was put more on social equity and a more balanced growth pattern (Meidan et al., 2009: 593; Fan, 2006; Christensen, 2013). This is e.g. reflected in slogans such as *‘the Moderately Well-Off Society’/‘a well-off society in an all-round way’*, which through *people-centered growth* and *putting people first* (*yiren weiben* /一人为本) should contribute to ensuring *common prosperity* (*gongtong fuyu* /共同富裕) (Fan, 2006; Christensen, 2013: 85, 86). Hereby, it was only with the 4th leadership generation that sustainability as a matter of sustainable development was taking a centre stage in plans and policies, being linked to a web of other ideas (Fan, 2006), which all form part of the overarching objective of establishing a so-called Harmonious Socialist Society (*shehui zhuyi hexie sheshui* / 社会主义和谐社会) (Fan, 2006; Meidan et al., 2009) with long-term, environmentally, and socially sustainable, economic development. This ‘social’ vision for China’s sustainable economic and social development, which denotes a remarkable shift away from the previous development philosophy of ‘letting some get rich first’ (Deng Xiaoping 1978; in Fan, 2006; Christensen, 2013), is continued by China’s current political leadership (Xi Jinping–Li Keqiang-administration, 2013-continued). This is e.g. reflected in the recent slogan of the *‘Chinese Dream’* (*zhongguomeng* / 中国梦) (People’s Daily, May 11, 2014; The Economist, May 4, 2013), which reflects a goal of achieving a harmonious, stable, peaceful, equitable, and sustainable development (PWC, 2013; The Economist May 4, 2013).

Achieving a *Harmonious Socialist Society* through Scientific Development

The goal of a '*Harmonious (Socialist) Society*' is to be achieved through Scientific Development, that is, through a so-called *'Scientific Outlook on Development'* (Meidan et al., 2009; Fan, 2006; Christensen, 2013) (科学发展观), which is a notion, which was introduced in 2003 by President Hu Jintao (Christensen, 2013: 85, 86). However, the idea that science, technology, and education are critical to 'Sustainable Development' was already expressed earlier, e.g. in 1996 when China "adopted 'Sustainable Development' and 'invigorating China through science and education' as principles in the national guidelines for development (Christensen, 2013: 84). As the ideas of a '*Scientific Outlook on Development'* and 'Sustainable Development' were enshrined in Party doctrines of the Chinese Communist Party (CPC) in 2007 (Christensen, 2013: 86), Scientific Development has become constituted as a critical means to comprehensive, balanced and sustainable development (Christensen, 2013: 85, 86). Put briefly, a "harmonious society is the objective and scientific development is the method to reach it" (Fan, 2006: 709-717). Linking doctrines and ideas of Sustainable Development with the goal of a Harmonious Socialist Society through the means of Scientific Development marks a way of constituting sustainability in comprehensive terms. That is, sustainability and sustainable development is a matter not only of environmental concerns and efficient resource consumption, but also of

"what type of industrial production the government was promoting. An industrial upgrading was called for with an increased reliance on advances in science and technology" (Hu Jintao's report at the 17th Party Congress. Chapter V. Promoting Sound and Rapid Development of the National Economy in Christensen, 2013: 86).

The notion of Scientific Development, framed as a means of Sustainable Development towards a 'harmonious socialist society', is consequently being linked to industrial upgrading.

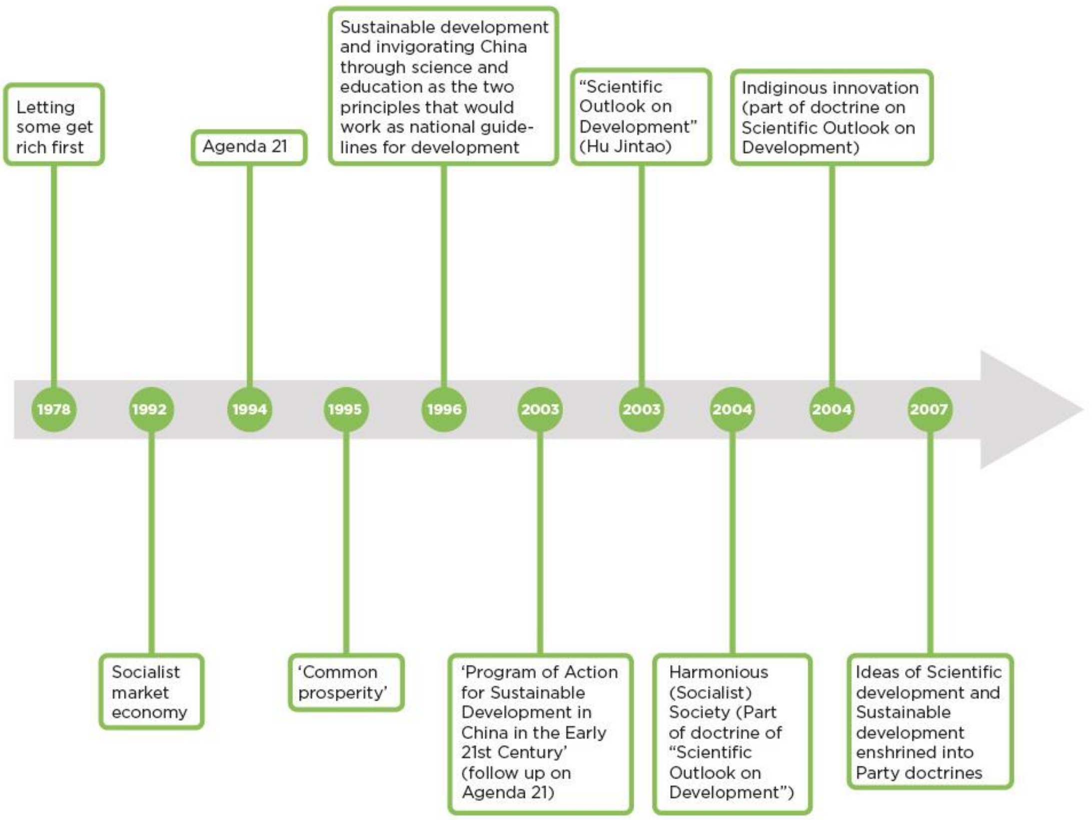
Scientific Development as a matter of industrial upgrading and advances in core technologies

While critical to achieving the goal of sustainable development, Scientific Development is in turn to be achieved through science, education, and industrial upgrading within 'Core Technologies' (Christensen, 2013: 85). In this regard, so-called 'indigenous innovation' (*zizhu chuangxin* / 自主创新) capabilities, i.e. capabilities of 'homebred' or 'independent' innovation, is based on the urge to reduce dependence on Western technology (Christensen, 2013: 89; Serger and Breidne, 2007). The idea of indigenous innovation has been promoted systematically by the Chinese leadership since 2004 "as a way for China to climb up the global value chain" (Christensen, 2013: 88). In this way, building 'indigenous innovation' capabilities within core technologies is being constituted as a solution to the issue of China's sustainable development.

Sustainable development as 'scientific developmentalism' – a note on China's 'economic mode'

The above description has shown how a web of notions around sustainable development has gradually been developed. In particular, the notion of a "Scientific Outlook on Development" and the national guidelines for development, i.e. the guideline of 'invigorating China through science and education' to achieve sustainable development, have become "increasingly intertwined as a new way of thinking development in China" (Christensen, 2013: 86). In this way, "a comprehensive, programmatic idea of sustainability becomes elevated to a 'national guideline of sustainable development'" (Christensen, 2013: 90), representing what may be termed a specific type of 'scientific developmentalism' (Naughton, 2011) and a reflection of a *'new economic mode'* (Christensen, 2013: 83). In other words, Sustainable Development is linked to China's 'socialist modernisation' through the means of a Scientific Outlook on Development (Hu Jintao's report at the 17th Party Congress, in Christensen, 2013: 87), launched in 1978 with Deng Xiaoping's 'Opening Up Reforms' and the strategy of 'letting some get rich first' (Deng in Christensen, 2013: 84). China's socialist modernisation project along the protracted transitioning process from a so-called planned to a market-based economy has been marked by cautious and still ongoing market and liberalisation reforms (Meidan et al., 2009: 593; PWC, 2013). Over time, framed variably as the official ideology of 'socialism with Chinese characteristics' associated with the Open Door Policy (1978) and a 'socialist market economy' (1992), both attributed to Deng Xiaoping, the more recent 'Scientific Outlook on Development' can "be seen as the substantiation of the milestones of the second phase in the national tale" (Christensen, 2013: 86), as China attempts to move from an extensive economic growth model towards an intensive economic growth model (former President Jiang Zemin, 1995: 8 in Christensen, 2013: 83). In this shift, science and technology is positioned as a critical means for Sustainable Development. Below, the timeline in *figure 11* seeks to depict some of the most noticeable developments in China's conceptualisation of sustainability and sustainable development.

Figure 11: Timeline over notions of Sustainable and Scientific Development in China



Source: Own design; based on Christensen, 2013; Fan, 2006; Serger and Breidne, 2007; Meidan et al., 2009.

Ensuring the great renaissance of China through Science & Technology

As indigenous innovation capabilities within core technologies have been positioned as a critical means of Scientific Development towards a sustainable development in the realisation of the second part of China's national tale, a host of plans, regulations, and policies on innovation and Science & Technology (S&T) have been issued. In particular, the Chinese Ministry of Science and Technology's (MOST) 15-year National Plan for the Development of Science and Technology in the Medium and Long Term (2006-2020) (MLP S&T) links the notion of scientific development to the rejuvenation of China (MLP S&T(II(1)). Further, following the concept of scientific development, the plan claims that China "must strive for the prosperous development of China's scientific and technological enterprise so as to realize the goals of the full-fledged construction of a well-to-do society and provide powerful S&T support for building a harmonious socialist society" (MLP

S&T(II(1)). Overall, the plan encapsulates entangled objectives of "indigenous innovation, leapfrogging in priority fields, enabling development, and leading the future" (MLP S&T(II(1)) to realise "the great renaissance of the Chinese nation" (MLP S&T, preface). Hereby, China's S&T policy is being inscribed into a wider narrative of China's overall development, catch-up, and renaissance. Overall, the MLP S&T seeks to transform China's S&T system into a national innovation system, e.g. including strategies on IPRs and standards (China's Intellectual Property Rights Strategy and Technology Standards Strategy) and the expansion of international and regional S&T cooperation and exchanges. Accordingly, in addition to the MLP S&T, a comprehensive policy framework has been developed in regard to e.g. IPRs and standards. This has particularly gathered pace since China's accession to the World Trade Organisation (WTO) in 2001 (Ernst, 2013). China's innovation policy (including policies on S&T, standards, and IPRs) can be seen as an integral part of strengthening China's domestic innovative capacity as a key to transforming China's economy beyond the export-oriented 'global factory' model (Ernst, 2013: 2). In the following, the chapter briefly accounts for how different 'frontier' technologies and research areas are framed as critical in aligning with the narrative of China's rejuvenation and renaissance.

Selected frontier technologies and research areas – on software, renewable energies, and manufacturing

To achieve the goal of a harmonious socialist society and ensure the renaissance of China, the plan develops a vision for "frontier technologies and basic research, which will, in turn, create new market demands and new industries expected to lead the future economic growth and social development" (MLP S&T, preface/(II(1)). Striving "for breakthroughs in key, enabling technologies that are urgently needed for the sustainable and coordinated economic and social development" (MLP S&T(II(1)), the plan selects a number of main areas, priority topics (e.g. renewables, the manufacturing industry, IT and software (the 'Information Industry and Modern Service Industry')). In addition, it outlines 'major special projects' and various 'frontier technologies'[34], and 'frontier scientific basic research issues'[35] (MLP S&T, III/MLP S&T, VI, 3(6); MLP S&T, VI, 3(10)). These are often related to IT, software, core mathematics, manufacturing, and (renewable) energies. For instance, the MLP S&T emphasises the need to raise the capability of equipment design, manufacturing, and

[34] E.g. information technology (IT), advanced manufacturing technologies, and advanced energy technologies.

[35] E.g. core mathematics and its application in cross disciplines and key scientific issues in sustainable energy development.

integration, e.g. by promoting technological innovation, realising proprietary design and manufacturing of high-end programmed machine tools and key components. It further highlights the need for transforming and upgrading manufacturing industry using high technology (MLP S&T). In addition to the MLP S&T, a host of strategies, plans, and laws are positioning core technologies, often related directly or indirectly to wind power, as critical to China's sustainable development trajectory and the transformation from a 'global factory' to an innovation-based development. In the following, the chapter inquires into how renewable energies, in particular wind power, have been constituted as part of China's Sustainable Development, and constituting a means of China's Scientific Development towards it.

China's energy policy as sustainable scientific development

The doctrines of Scientific Development and sustainable development have also had an impact on China's Energy Policy (2012). Thus, as stated in China's Energy Policy,

"China will continue to take the Scientific Outlook on Development as its guiding principle, and work hard to transform its development pattern, giving prominence to building a resource-conserving and environment-friendly society. It relies on scientific, technological and system innovation to raise efficiency in all aspects of energy utilization, further develop new and renewable energy resources, and promote the clean and efficient development and utilization of fossil energy resources" (Energy Policy 2012, preface).

In addition, the Energy Policy aligns itself with the comprehensive, developmentalist doctrine of sustainable development of the economy, society, and ecology, "as the country moves towards its goals of modernization and common prosperity for its people" (Energy Policy 2012, preface). In addition, the Energy Policy mentions the strategic role of core technologies (and the need to reduce dependency on foreign import of these), key equipment, and the need for further R&D, international cooperation, standardisation, and technological upgrading as well as a more environment-friendly energy mix (Energy Policy 2012).

Renewable energies and wind power as matter of sustainable and scientific development

With regard to renewable energies as part of the energy policy, these have recently been promoted as constituting an increasingly important strategic sector in China, although still only accounting for a minor role in the overall energy mix. China's 12th Five-Year Plan (5YP) (2011-2015) promotes renewable energy as one amongst several other "strategic and emerging" industries, namely industries such as energy saving and environmental protection, next generation IT, biotechnology, high-end manufacturing, new energy (nuclear, solar, wind, and biomass), new materials, and clean- energy vehicles (Lewis, 2013: 23). These new strategic and emerging industries are replacing the often state-owned old strategic pillar industries such as coal, oil, national defense, telecom, electricity, airlines, and marine shipping (Lewis, 2013: 23). Apart from being constituted as 'strategic', the rationale for supporting renewable energies is largely based on the concern for 'sustainable development'. This is e.g. reflected in the Medium and Long Term Development Plan for Renewable Energies (MLP RE (2007)):

"In order to speed up the development of renewable energy, promote energy conservation and reduce pollutants, mitigate climate change, and better meet the requirements of sustainable social and economic development, the Medium and Long-term Development Plan for Renewable Energy in China is formulated" (MLP RE 2007 p. 1/preface).

While renewable energies have been included in earlier plans and policies[36], it was particularly during the 'revolutionary' 11th 5YP (2006-2010) (Fan, 2006) that emphasis on the renewable sector was linked to the emerging, comprehensive notion of sustainability (REN21, 2009; Fan, 2006). Linking renewable energies to China's sustainable and scientific development and being framed as a means towards the goal of a harmonious socialist society, renewable energies have been framed within the wider narrative of China's sustainable development. In addition to the 11th and 12th 5YPs (2011-2015) (the latter continuing the focus on sustainable development and renewable energies) for the general social and economic development of China, specific action plans for each renewable energy source (e.g. wind power) have been formulated in different dedicated 5YPs for renewable energy. In particular, a watershed shift in terms of emphasis on renewable energies was marked with the Renewable Energy Law (REL) (2005) and the Medium- and Long-Term Plan for Renewable Energies (MLP RE) (Fan, 2006: 709-717; Klagge et al., 2012: 379). The single legitimising reason of the REL (2005) is to ensure "the sustainable development of the economy and society" (REL, 2005, art. 1). The REL is China's first comprehensive policy document for the promotion of renewable energy (Cherni and Kentish, 2007: 3618). In addition, different policies and plans emphasise the need to develop indigenous innovation capabilities within renewable energies. For instance, as expressed in the MLP RE (2007), "China should also develop selfdependent [indigenous] innovation abilities as the basis for its renewable energy R&D and industry development system" (MLP RE 2007:

[36] Alternative energy was already included in China's 5th 5YP, and the Electricity Law (1995) encouraged supply of power in rural areas through wind, solar energy, and biomass in 1995.

2.2). This includes the absorption of foreign technologies in order to establish China’s own domestic manufacturing capability (MLP2007: 5(5)):

“On the basis of bringing in foreign technology from abroad, the capacity to absorb and innovate should be strengthened, so that, as soon as possible, selfdependent innovation capabilities are achieved” (MLP2007: 5(5)).

In addition, goals are set for China’s “domestic manufacturing capability based mainly on China’s own IPRs […] satisfying the needs for deploying renewable energy on a large scale in China” (MLP2007: 5(5)). This reflects an overall strategy of building indigenous innovation capabilities. The comprehensive notion of sustainability, as a matter of achieving a harmonious socialist society through scientific development and by mastering core technologies, has not only been linked to renewable energies in general but also to wind power in particular. For instance, apart from constituting a central, ‘mature’ renewable energy source in the REL (2006) and being framed as a sustainable ’new energy’ under ’encouraged development’ (People’s Daily Online, May 11, 2011; Lewis, 2013), a 5YP, specifically directed at the ’Scientific and Technological Development of Wind Power’, links wind power to China’s Sustainable and Scientific Development (12th Five-Year Plan for the Scientific and Technological Development of Wind Power, 关于印发风力发电科技发展“十二五”专项规划的通知,国科发计(2012) 197号; hereafter 5YP S&T Wind Power*).

Mobilising concerns for developing a wind power-TEN

Having outlined the genealogy of the Chinese notion of Sustainable Development and its connection to Scientific Development in the above, and how it has been linked to renewable energies such as wind power, it has been indicated how the notion of sustainability has been strategically employed by the Chinese political leaderhip as a ‘narrative tool/interessement device’ to mobilise i.a. a wind power market. That is, linking sustainability to broader discourses of China’s catch-up and reinvigoration, sustainability has been construed with temporal properties, rendering a story on China’s ‘renaissance’. Due to its equivocal qualities, sustainability is constituted as a ‘stem issue’. Such stem issue has largely worked to enrol heterogeneous actors, e.g. WTMs, scientists, wind turbines, and core technologies, to engage in solving some of the diverse challenges linked to China’s sustainable and Scientific Development. In this way, it seems that the Chinese political leadership is attempting to install itself as translator-spokesperson on behalf of a potentially emerging wind power-TEN. As expressed by a Chinese wind turbine manufacturer (WTM): “What drives the growth is the Chinese policy. With the passage of the Renewable Energy Law

[REL]. That was kind of a kick off" (Int. 3). Accordingly, in industry reports and scholarly analyses on China's wind power market, the REL is being framed as critical to the rapid growth of China's wind turbine industry since 2005 (Li, 2010; Yu et al., 2009; Zhao et al., 2012b; Korsnes, 2014; Wang et al., 2011). This is e.g. due to how the REL introduces "a mandatory grid-connection system, national target system, cost-sharing scheme, and feed-in tariff scheme" (REL, 2006). Hereby, despite the general character of the REL, "the law was an unequivocal declaration of intent to promote renewable energy both as a part of the total energy mix and as an area of industrial and technological development" (Lema and Ruby, 2007: 3886). Consequently, with the REL,

"the Chinese electricity generating companies were asked to enter this [renewable energy sector]; as wind energy is a more mature technology than solar; the wind power industrial chain is long, it is leading the industry, so we had to choose a major industry, and wind energy was receiving more national attention (Int. 4, 2011).*

Overall, the political pole's wind power policy continues to play a central role in wind power (Fang et al., 2012: 350). In addition to the aforementioned interessement devices, a host of other tools have been employed by the emerging political pole to spur the genesis of a wind power-TEN. In particular, these are linked to money. That is, what moves and drives wind energy development in China is largely 'show me the money' (Lam et al., 2013: 423).

Thus, financial and regulatory support including investment and R&D subsidies, tax breaks, favourable pool purchase pricing of wind power, tax exemptions or reductions, financial subsidies, government-run projects (concessions, 2003-2009), and fixed feed-in tariffs (FIT), have all played a critical role in spurring industrial growth (Klagge, Liu et al., 2011; Fang et al., 2012: 350). In the following, some of the central policies and regulations directed at spurring growth in the wind market industry are outlined, many of which have been focused on quantitative growth in installed capacity. First, however, a brief historical account of a gradually more coordinated policy effort towards wind power is outlined, set into the context of China's power sector.

From fragmented to concentrated efforts at constructing a wind power market

China's wind turbine manufacturing industry was founded in the late 1980s, relatively late compared to mature, advanced Western wind turbine industries. In general, the development of a policy framework for China's wind turbine industry can be divided into several stages (e.g. Li, 2010; Lema and Ruby, 2007), moving gradually from more 'fragmented' (i.e. uncoordinated) efforts towards more concentrated (coordinated) efforts (Lema and Ruby, 2007). Starting out with limited experience (Lema and Ruby, 2007; Korsnes, 2014; Liu and

Kokko, 2010; Wiser and Lewis, 2007; Li, 2010), wind power investment was in the initial years primarily undertaken in the form of scientific research or state demonstration projects without commercialisation, largely based on foreign grants, soft loans, and foreign aid (Zhao et al., 2012a: 227-228; Lema and Ruby, 2007). Since the early 1990s, efforts at building a wind turbine manufacturing industry became more coordinated, mainly through the *Ride the Wind Programme* (1996), in which Sino-foreign joint ventures were promoted, as well as through the National 863 hi-tech scientific research plan and other Science and Technology-advancing projects (S&T) (Cherni and Kentish, 2007; Lewis and Wiser, 2007; Wang et al., 2011; Lema and Ruby, 2007; Li, 2010).

Whereas the period up until 2002 was marked by an extensive fragmentation of authority, reflecting an indecisive Chinese leadership as to whether China should seek to establish its own domestic industry or rely on turbine import (Lema and Ruby, 2007), the pace and coordination of development changed with the beginning of the so-called wind farm concession programme/wind tender programme, introduced in 2003 and running until 2009 (García, 2013: 130). Corresponding more or less with the time of the introduction of the doctrine of Scientific Development, a central decision was made to boost (local) indigenous wind turbine production through such wind farm concession programme, which implies large government-led wind farm concessions with a guaranteed grid-connection tariff, determined by the tendering process (Li, 2010: 1159). As a tender system, developers of wind power were invited by the National Development and Reform Commission (NDRC) to bid for a given site that had been chosen by the government and assessed for wind resources (Lema and Ruby, 2007; Wang et al., 2011: 146; Zhao et al., 2012b; Lewis and Wiser, 2007; García, 2013; Korsnes, 2014). The concession programme marked a shift towards centralised, large-scale commercialisation of wind farms.

Increased coordination – on unbundling in the power sector

The shift towards more concentrated efforts in China's wind power market came alongside the general 'unbundling' of China's power sector. That is, although China's power sector has undergone several rounds of liberalisation reforms, the major restructuring of the energy sector did not come until 2002, when power generation was unbundled from transmission. This means that the pre-existing China State Power Corporation was split into two grid companies (State Grid Corporation of China (hereafter, *State Grid*) and China Southern Power Grid Corporation) and five separate power generating companies, the so-called '*Big Five'* (the Huaneng Group, Huadian Corporation, China Datang Corporation, Guodian Corporation, China Power Investment Group, accounting for 40 per cent of the installed capacity in China) (Yu et al., 2009: 5223; García, 2013; Liu and Kokko, 2010: 5523; Lema and Ruby, 2007)[37]. Further, along with the concession strategy in 2003, the National Development and Reform Commission (NDRC, and in particular, the Energy Bureau of the NDRC), which has departments at local levels (local Development and Reform Commissions (DRCs) (Lema and Ruby, 2007: 3885), took on a more active role in coordinating supply and demand for wind power and for renewable energy in general (Lema and Ruby, 2007; Korsnes, 2014). Consequently, a more coherent policy for the wind power sector was to be developed (Liu and Kokko, 2010: 5523). In the following, the chapter looks further into policies which have spurred quantitative growth in China's wind power installations and the build-up of indigenous, local manufacturing capabilities.

Policies spurring quantitative growth (scale-up) and delegating responsibilities

Along with more coordinated efforts to construct a base for commercialising wind power, numerous policies and regulations have been introduced over time. First, the chapter looks into policies and regulations which have focused on spurring quantity-based growth, including targets for installed capacity (GW), responsibility delegation between involved actors, and fiscal and financial aids and pricing policies.

Setting national targets for installed capacity

First, while the aforementioned concession programme constitutes a quantity-based system for promotion of renewable energies (García, 2013: 130), other supportive policies for scale-up are e.g. quantitative national targets. That is, a national target system for the development and utilisation of renewable energy was introduced with the REL, whereby targets for installed capacity of wind power, measured in GW, are set at the central level by the energy authorities of the State Council for both mid- and long-term (REL, art. 4). A few years later, the MLP RE (2007) set a target for wind power for 2020 at 30 GW wind (including 1 GW offshore) (MLP RE, 2007). Yet, this target was later revised upwards to 100 GW by 2020, as the target had already been met by 2010 (García, 2013: 135; Wang et al., 2011). In addition, the MLP RE set market share targets for non-hydro renewable electricity at 10 per cent in 2010 and 15 per cent in 2020 of China's total primary energy consumption (MLP RE, 2007)[38]. Although these targets are not compulsory (García, 2013: 135), targets for wind power have several times been superseded before time.

[37] In addition to these Big Five, a number of smaller generating companies were established.
[38] In China, electricity generated by wind power accounted for 2.6 per cent of the national total in 2013, an increase of 0.5 per cent from 2012 (GWEC, 2014: 42).

Delegating responsibilities to wind power generators, grid companies, and governments

Second, in order to ensure that targets can be met, policies have been formulated to ensure a supply and demand for the wind power by delegating responsibilities to the different actors involved. For instance, the REL requires grid companies to purchase all the generated electricity (REL, art. 4; Lewis, 2007). Further, through the concession programme, the NDRC sought to ensure ”that power companies are compelled to produce wind power and grid companies are compelled to buy it” (Lema and Ruby, 2007: 3885). Measures to ensure compliance by both wind power generators, wind power transmitters (grid companies), and wind power consumers (local governments) have been undertaken, e.g. through mandatory/mandated market shares (MMS), national renewable energy portfolio standards (RPS), and power purchase agreements (PPAs) (Bloomberg, 2012: 3). Further, a cost sharing mechanism has been introduced, ensuring that the incremental cost of wind power is shared within the provincial power grid (nationwide since 2006) (Wang et al., 2011: 138, 146) (in REL 2005; Amendment to REL, 2009).

First of all, MMSs have been introduced in the MLP RE in order to ensure supply of renewable energy power. That is, MMSs oblige power generating companies (that is, the Big Five) to source a proportion of their power from renewable energy generation and thus to invest in wind farms (Bloomberg, 2012: 2; Cherni and Kentish, 2007: 3624; Lema and Ruby, 2007). In terms of demand-side goals, grid corporations are required to source a certain share of its transmitted power from non-hydro renewables (Bloomberg, 2012: 2). Other demand-side related means are PPAs (e.g. seen in the concession programme) as well as the mandatory grid connection system introduced in the REL. These instruments oblige grid companies to ensure that all electricity generated by wind projects is purchased by the provincial power grid company (Wang et al., 2011: 146; Lema and Ruby, 2007: 3888; García, 2013: 132; Liu and Kokko, 2010: 5524), as well as obliging grid companies to provide each wind farm facility with connection to the grid (García, 2013: 132). Due to lack of enforcement, however, the REL Amendment, which was issued in 2009, introduced stronger central supervision and control of grid companies to ensure the purchase of renewable power, and introduced fines on grid companies for non-compliance (Bloomberg, 2010). Lastly, the demand-related scheme also obliges local governments to consume the renewable energy generated, transmitted, and dispatched to local consumers (Lema and Ruby, 2007: 3888).

Fiscal and financial aids and pricing policies

Third, fiscal and financial aids and pricing policies have been employed over time to ensure growth and compliance to targets and agreements. To counter the higher costs of generating wind power compared with fossil fuels, a host of fiscal and financial aids and preferential pricing policies and tax rebates, as well as preferential loans and fiscal aids such as tax reductions, have been introduced over time (e.g. REL, art. 25, 26; García, 2013; Lewis and Wiser, 2007; Cherni and Kentish, 2007). In addition, an important part of supporting the development of wind power in China has been the establishment of a pricing system. The development of the pricing system has undergone several stages, experimenting with setting prices that cover the costs of wind power.

From 1986 to the early 1990s, wind power prices were extremely low and similar to thermal power, making it unattractive for investors due to the higher generating costs (Zhao et al., 2012a: 227-228; Wang et al., 2011: 146). Later, from 1994 to 1997, grid companies were obliged to purchase wind power at a price determined by repayment of capital with interest, yet, still being more or less similar to thermal power (Zhao et al., 2012a: 227-228; Wang et al., 2011: 146). From 1998 to 2002, the price was negotiated on a case by case basis between wind farms and the former Power Grid Company (now, the State Grid) (Zhao et al., 2012a: 228). It was particularly during the period with concessions, however, that experiments were undertaken to find the 'appropriate' price, in order to ensure that wind power prices were held above wind power generating costs, which so far entailed that wind power prices must be higher than thermal power prices (Zhao et al., 2012a; Wang et al., 2011). In the tender system, investors were invited to submit offers/bids, specifying the lowest price at which the investor was prepared to supply electricity to the grid (Wang et al., 2011: 140). In effect, two pricing systems existed during the concession period, namely (1) wind power concession bidding pricing and (2) government-led pricing, based on local benchmarked coal prices and a wind power compensation model (Wang et al., 2011: 140). Whereas concession projects were above 50 MW, smaller wind farm projects were approved by government contracts with power generating companies through PPAs (Li, 2010: 1160).

As tender pricing had a tendency to result in below cost pricing, however, bidding was over time complemented with examination and approval pricing[39] (Zhao et al., 2012a: 228; Liao

[39] Bidding prices in the four years of concession projects were in the range of 0.373-0.519 yuan/kWh, whereas financially feasible prices were deemed to be around 0.566-0.703 yuan/kWh (Li et al., 2006 in Lema and Ruby, 2007: 3887). Even though there were hopes for a FIT in the REL, it was only in 2009 that it was finally implemented (Lema and Ruby, 2007:

et al., 2010). The final approval price was based on ’cost plus revenue’, ensuring that a revenue would be earned (Zhao et al., 2012a: 228). Finally, in the period from 2009 till now, a fixed benchmark pricing (Feed-in-Tariffs (FITs)) and bidding pricing system has eventually been introduced by the NDRC. The FITs/benchmark prices are divided into four different levels, according to four geographical regions which China has been divided into, based on regional differences in wind energy resources and engineering construction conditions (Zhao et al., 2012a: 228; Wang et al., 2011; García, 2013; Korsnes, 2014). Apart from supporting the development of a wind power market through quantitative targets, delegating responsibilities, and support through financial and fiscal means, policies have also spurred local indigenous manufacturing capabilities, e.g. through localisation policies, attraction of foreign technologies, and support of Research and Development (R&D) .

Policies spurring localisation of production and improving indigenous capabilities

Many of the aforementioned policies bear within them a degree of a ’localisation’ agenda, i.e. an aim to encourage domestic production of wind turbines rather than to continue imports. While concessions have favoured the lowest bidding price, which have been offered by Chinese state-owned enterprises (SOEs), so-called local content requirements is another means to build indigenous capabilities. For instance, local content requirements have been a central part in the evaluation criteria during concessions, meaning that a certain amount of the equipment must be produced in China (Lewis, 2007; Lewis 2013; Wang et al., 2011). This reflects an urge to master novel technologies and reinforce national competitiveness, as well as to reduce investment costs by building national manufacturing competences. This localisation strategy was already seen early on, namely in the *Ride the Wind Programme* (1996), which e.g. included an element of demand for local products through local content requirements. This indicates that China from early on has pursued an industry-oriented approach (Lema and Ruby, 2007: 3882; Cherni and Kentish, 2007; Zhao et al., 2012b; Lewis and Wiser, 2007; Klagge et al., 2012; Wang et al., 2011; Korsnes, 2014).

Technology for market – attracting foreign technologies

Localisation policies have further been instrumental in attracting foreign technologies. For instance, a goal of the *Ride the Wind Programme,* constituting a part of the so-called

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3887; Korsnes, 2014; García, 2013). In 2009, bidding as a basis for pricing was forbidden according to a ‘Notice on Wind Power Energy Prices’ NDRC. Benchmark prices were set for each of these areas, ranging from 0.51 and 0.61 yuan per kWh (the bidding prices, in contrast, were sometimes as low as 0.38 yuan per kWh) (Liu and Kokko, 2010: 5524).

‘technology for market’/’trade-market-access-for-technology’’ policy (Klagge et al., 2012), was to encourage domestic manufacturers to cooperate with foreign manufacturers by means of importing technology and constructing Sino-foreign joint ventures (Wang et al., 2011: 144; Cherni and Kentish, 2007: 3620; Lewis and Wiser, 2007; Klagge et al., 2012: 376). As expressed by a Chinese component manufacturer,

“your technology is an asset in your hand, you should take advantage of this asset, you should just find a good market, and China has a good market, and that is what I [Chinese supplier] want: to reap your technology in exchange for this market exchange” (Int. 6, 2013).*

Further, to win bids during concessions, foreign WTMs have also sought to abide by the local content criteria. That is, apart from being evaluated (first and foremost) on the lowest price, the degree of localisation has constituted an important evaluation criterion qualifying bidders (Wang et al., 2011; Ru et al., 2012: 65; Liu and Kokko, 2010; Zhao et al., 2012b)[40]. The strategy of attracting foreign technologies to the Chinese market is also visible in import tariffs for renewable energy equipment, which have been in place since 1996 (Cherni and Kentish, 2007: 3623), refunding import tariffs on imported wind turbines. Over time, however, only key parts and components for larger-size wind turbines could receive tax refunds in order to promote domestic development of wind power equipment (Lewis and Wiser, 2007: 1853; Cherni and Kentish, 2007; Liu and Kokko, 2010).

Supporting R&D activities

In addition to these policies, financial and fiscal support has been granted to R&D-related activities. For instance, the REL introduced the Renewable Energy Development Fund to support S&T development as well as to spur localisation of production (REL, 2005: Chapter 6, Art. 24; Cherni and Kentish, 2007: 3624; Lema and Ruby, 2007: 3887)[41]. The amendment to the Renewable Energy Law (2009) establishes further guidelines as to the management of the fund, which is to be financed by a surcharge on retail power tariffs for power grid companies along with a contribution from the Ministry of Finance. In addition, fiscal and tax incentives for R&D-related activities have been introduced in the MLP RE (2007: 5(4)).

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[40] In the beginning of the concession programme, all bids were expected to reach a minimum of 50 per cent localisation. This local content requirement was raised to 70 per cent by 2005 to help promote the development of a local wind power industry; however, it was abolished in 2009 in order to attract foreign companies (Zhao et al., 2012b: 425; Ru et al., 2012: 65). By then, however, most foreign companies in China had already fulfilled the requirement.

[41] As early as 1996, the National High Tech R&D Programme (863 Programme) was introduced in the 9th, 10th, and 11th 5YPs, in which funds were made available from MOST for renewable energy R&D (Lewis, 2013: 68-69).

Scale-up in China’s wind power industry – on unprecedented growth rates

So far, the chapter has outlined some of the most central policies, plans, and regulations, which have supported the development of a domestic wind turbine industry and wind power sector. While China has experimented with grid-connected wind turbines since the 1980s, development of the sector was relatively slow until the early 2000s (Lema and Ruby, 2007; Liu and Kokko, 2010: 5523; Li, 2010: 1155). It was only with the wind farm concession programme and the REL (2005) that growth in all round investment in wind power, capacity installed (GW), manufacturing scale-up, and large-scale commercialisation of wind farms took off (Li, 2010: 1155; Korsnes, 2014; Klagge et al., 2012: 379; Lema and Ruby, 2007: 3886-3887). Reflecting the will and support of the Chinese political leadership (Ru et al., 2012; Zhao et al., 2012a: 223; Zhao et al., 2012b: 424; Lema and Ruby, 2007: 3886-3887), the REL resulted in ”very rapid development of wind energy, each year about 100 percent increase. According to this development, we [domestic WTM] took this opportunity to develop” (Int. 7, 2011). This resulted in a veritable boom in terms of installed capacity. China’s wind power capacity grew from 0.8 GW in 2004 to 91 GW in the beginning of 2014 (Li et al., 2007; GWEC, 2014 in Korsnes, 2014: 176). By 2008, China’s new wind power capacity ranked as the second largest in the world and accounted for 22 per cent of the world’s wind power capacity. The year after, China became the fastest growing wind power country in the world, number one in scale in new wind power installations and accounting for 33 per cent of new installations globally. In 2010, this trend continued, and China became number one in total wind power capacity (Zhao et al., 2012a: 223). Thus, as expressed by a Chinese wind power expert, due to the incentives policy,

“that's why we are...our wind turbine installation has increased. Haha! Abruptly during the period of 2006 and to 2010, I think that, arrrrrh, the growth was about one hundred per cent” (Int. 8, 2013).

With a comprehensive policy framework installed for wind power, China has witnessed a velocity in growth rates within wind power capacity never witnessed before (Korsnes, 2014: 176).

Growth in investments and equipment manufacturers – domestic as well as foreign

Within a few years, investments from power generating companies increased dramatically, with the number of wind turbine- and component manufacturers rising accordingly. That is, largely “stimulated from above”, these Chinese companies have “thrown themselves after the ball” in large numbers, as money have been ”rushing down the system very fast” (Int. 9). The rapid growth leads industry analyses to argue that ”the Chinese manufacturing industry is becoming increasingly mature, stretching over the entire supply chain" (Yu et al., 2009: 5222). Hereby, in terms of wind turbine manufacturing, although not directly part of the electric sector reform, but constituting a crucial sector in the manufacturing production chain for the renewable energy industry (García, 2013: 137), the wind turbine industry has experienced a dramatic increase in the number of wind turbine manufacturers (WTMs). For instance, while Goldwind was the only notable domestic WTM in 1998, and although there were only about five WTMs prior to 2004, there were about 40 companies operating in the sector by the end of 2007, and by the end of 2008, WTMs numbered between 70 and 80 or even higher (Global Wind Energy Outlook, 2010; REN21, 2009; García, 2013: 137-138; Ru et al., 2012: 58; Interviews). At the same time, the number of Chinese component suppliers is in the hundreds (García, 2013: 138). By 2013, the top three Chinese WTMs were Goldwind, Guodian United Power, and Mingyang, together accounting for a 40 per cent share of the annual Chinese market. In addition, the previously "dark horse" Envision, has more than doubled its market share and moved up from 15th in 2011 to 4th place in 2013 (GWEC, 2014: 42). Indeed, Chinese companies and research institutes

"are listening to what they receive, as I understand it, to what kind of signals that they get from above, and then they try to adapt their strategies according to these signals […] coming from above. And that means that they start shifting their targets in another direction, when they receive new instructions" (Int. 20, 2013).

While Chinese WTMs are constituted by four types, namely, (1) SOEs and state-holding enterprises, (2) private enterprises, (3) wholly foreign-owned enterprises (WFOE), and (4) joint ventures (Zhao et al., 2012b: 425; García, 2013: 138), Western WTMs have also entered the Chinese wind power industry, in particular since 2005. As a foreign component supplier expressed it: "Yeah, yeah – we also jumped on this train" after the issuing of the REL (Int. 15). Some of the major foreign WTMs operating in China have included Suzlon, Vestas, Gamesa, and more recently General Electric and Siemens (REN21 2009a in García, 2013: 138, Zhao et al., 2012b). Whereas joint ventures were the only way to enter the Chinese market in the initial phase, from 2005 foreign WTMs started to establish wholly foreign owned enterprises (WFOEs) in China (Zhao et al., 2012b: 424). However, it may be noted that none of the international WTMs are any longer on the top ten list in terms of installed capacity in China (GWEC, 2014).

An emerging market pole?

In the above, it has been indicated how a variety of different actors within what seems an emerging *market pole* have been assembled, as they engage i.a. in wind turbine manufacturing, component manufacturing, wind farm operations, and transmission and dispatch of wind power in the grid. First, in terms of equipment manufacturing, WTMs and component suppliers are engaged in the design, testing, manufacturing, and operational assistance and maintenance of wind turbines, sometimes assisted by consultancy companies, design houses, certification bodies, and industry associations (Stargrove, 2011). Second, in terms of wind farm operations, wind farm operators/developers, primarily constituted by one of the 'Big Five' power generating companies, are responsible for generating wind power and operating wind farms. Wind farm developers develop and sometimes own and operate wind farms. Wind power managing owners are in turn responsible for the operation, maintenance, and administration of the completed wind farms (Stargrove, 2011). Often, much of this responsibility is subcontracted to specialist firms, including subsidiaries of the manufacturers. Wind power managing owners sell the electricity generated to public utilities under project-specific, long-term agreements. Often, wind farm developers and park owners are the same in China (Stargrove, 2011). Third, grid corporations are responsible for transmitting and dispatching power to end users in local provinces. Finally, administrative bodies control and steer the market at both central and local levels, while service companies supporting Operations and Maintenance (O&M) are increasingly emerging as well (Stargrove, 2011; Interviews).

Destabilising the framing of wind power

While looking impressive, the high growth rates have had unintended effects, i.e., they have overflowed. In the following, the chapter inquires into some of the seeming overflows, which is followed by an inquiry into what the overflowing means for the framing of wind power as a sustainable renewable energy source.

A period of consolidating flux?

As early as late 2010 there were visible flaws in China's wind power industry, the first being the production quality of turbines, and the second being oversupply, which persists till today (Klagge et al., 2012; Korsnes, 2014). At the same time as a 'quality crisis' is indicated, more or less concurrently, a slowdown in growth rates came in the wind power market, which marks a consolidation phase taking place since 2011 (Korsnes, 2014: 186). According to a Chinese WTM,

"the market is not stable, it's moving. [...] Up and down... [...] Exactly. And in the year of 2008, that's the golden period for Chinese wind... [After the REL] [...] That's a cycle. But [in the] last two years, it developed too fast" (Int. 10, 2012).

Further, as expressed by a foreign WTM, the Chinese wind turbine industry *"*is in flux – the high-peak years with more than 100 per cent growth rates are gone, and now the market is stabilising or even in crisis, stagnating…in flux. According to some, the around 100 manufacturers will have to go down to around a handful" (Int. 3, 2012). Accordingly, the number of Chinese WTMs is being reduced, as "almost all wind companies are struggling badly right now", going bankrupt and struggling with losses (Int. 11, 2012):

"From an historical point of view, then in 2009 there was a peak, and then from 2009 to 2012 there was a period of adjustment, just like the stock market adjusts itself slowly from time to time, adjusting from the peak period to a recession period…until June 2012 that was the time of the lowest price, the growth in accumulated installed capacity was also slow. It was certainly not just our company, it was the entire wind power industry which was like this" (Int. 12, 2013).*

While China seemed more or less back on track in 2013 in terms of growth rates (GWEC, 2014; China Energy Viewpoint, Feb. 06, 2014), it is predicted that a consolidation will continue in the coming years. Further, while the 'ups and downs' of the Chinese wind turbine industry are influenced by global economic recession and wider development trends, investments in wind power have also been reduced over time due to severe quality issues, which face the industry. Indeed, the quality crisis is not yet quite over in China (China Energy Viewpoint, Feb. 06, 2014). In the following, the different quality issues, many of which can be linked to 'overflowing' incentive policies, which have focused on quantitative growth in GW, are outlined. Amongst other challenges, the issues most often mentioned are poor quality of wind turbines, poor efficiency of wind farms, and large shares of wasted wind power due to a lack of grid connection.

An issue of poor wind turbine quality – favouring installed capacity and low prices over quality

The emerging market for wind power in China has in recent years been haunted by low quality of turbines. For instance, this is seen in low capacity factors, uncertain long-term performance, and major quality accidents. These quality issues are suggested to be caused by China's lack of experience (and consequent reliance on foreign technology licenses), incentive policies and targets spurring quantitative growth in capacity, and wind-generated electricity prices being determined by the lowest price provider. Thus, "[s]ome problems are the result of immature technologies, while others stem from poor craftsmanship and a low-skilled workforce, the lack of proper preventive maintenance or from poor decisions regarding site selection and appropriate equipment" (Klagge et al. 2012: 376). As expressed by a foreign component supplier,

”China started…as I remember it, around 2005, ’06, or ’07. And what did they do? They went out and bought some licenses…started producing some turbines or wind turbines from those drawings and explanations. And then they produced like crazy. And the background was a policy of the State, because they gave subsidies for the number of machines that came out of it. A totally mistaken strategy in my view. But that’s how it was. And that means that a host of companies – all more or less state-supported – started producing wind turbines, because now that was the thing” (Int. 13, 2013).

That is, economic incentives have been based on adding installed capacity rather than generating electricity as “what was required in the Renewable Energy Law” was just ”how many megawatt, how much capacity, that had to be installed. But they didn’t care whether they were running” (Int. 18, 2013), or whether they produced electricity (Int. 18, 2013). With a focus on quantitative growth in installments together with a bidding criterion emphasising the lowest bid, bidders have intentionally underestimated operating costs to get a lower grid connection price compared to other bidders (Li, 2010: 1163; Korsnes, 2014; García, 2013: 138; Liu and Kokko, 2010: 5524; Yu et al., 2009). Apart from making investments in wind power projects unprofitable, this bidding strategy has been at the expense of wind turbine quality, as wind farm owners have pushed WTMs and component suppliers to press down prices of equipment (Li, 2010: 1163; Liao et al., 2010) and also pushed “the manufacturing sector to produce poor quality products” (Yu et al., 2009: 5224):

”There are many types of analysis of what goes into the winning. A part of this is the overwhelming criterion to have low equipment prices…Which is not the cost of the 20 years but the costs up front, the CAPEX [capital expenditure]. This is also something that we really emphasise. We cannot compete on these” (Int. 3, 2012).

In this way, “[t]he low prices may impact the entire fledgling Chinese wind industry negatively as utilities may unduly pressurize wind turbine manufacturers to reduce costs, to offset the low concession” (Liao et al., 2010: 1884). Overall, price competition across the wind power equipment market has become fierce, which brings hidden dangers to the quality of wind turbines (CWEA-Vestas Wind Technology (China) Co., Ltd., 2011*). However, the rating of different criteria in concession projects has moved gradually from an (almost) exclusive focus on prices to take the quality of inputs, the management capacity, and size of wind turbines into account, which i.a. involves choosing the average bid rather than the lowest or highest-price bid (García, 2013: 130). Price is, however, still the determining factor (García, 2013: 130; Yu et al., 2009: 5224; Interviews). It is increasingly acknowledged, it seems, that “Lower prices of wind turbines manufactured by domestic firms, however, come along with major drawbacks” (Klagge et al. 2012: 376). For instance, there have been ”frequent reports of quality problems and technical difficulties of domestically manufactured wind turbines” such as blade and shaft fractures, generator fires, or gearbox or brake failures (Lian and Wu, 2011 in Klagge et al. 2012: 376). Increasingly, wind power in China is framed as ‘sick’:

“I don't think the wind energy, the wind, the whole energy is healthy. No. It's sick. Because of the end market. […] The competition now is very poor. It's not healthy development. [...] Because the policy-making for the bidding – cheap price. That's not a wise term to judge a bid” (Int. 10, 2012).

Another central reason for quality issues are overflowing quantitative targets and incentives, which have been focused on installed capacity (measured in GW) rather than generated electricity (GWh). Overall, the underperformance of Chinese wind turbines can be linked to a lack of incentives to ensure improvements or innovation in regard to power output and efficiency rather than growth in installations (Gosens and Lu, 2014).

An issue of underperforming wind farms

Poor wind turbine quality, where domestically made turbines are often operating below expected production levels, e.g. due to repeated introduction of cheaper, outdated technologies, has also led to an issue of wind farm underperformance, as Chinese companies develop parks and generate electricity with lower standards than foreign companies would (García, 2013: 137; Klagge et al. 2012: 376; Int. 14). Accordingly, many wind farms cannot generate electricity in accordance with their installed capacity (Fang et al., 2012: 353). That is, technical obstacles, poor quality control, unfit geographical site selection, and unsuitable site design, e.g. due to poor feasibility studies and microdesign of wind farms and evaluation systems, all have a detrimental effect on the incentive to invest in wind power, as ”[t]he domestic manufacturing quality and unprofessional design of wind farms made most developers’ financial returns unrealistic in the wind market” (Yu et al., 2009: 5221). That is, technical issues in wind turbines have detrimental effects on the efficiency, capacity factors, and lifetime of wind parks (Interviews; García, 2013: 137; Yu et al., 2009; Ru et al., 2012; Li, 2010: 1162; Nanjing, 2011; Cherni and Kentish, 2007: 3621; Zhao et al., 2012a; Lewis and Wiser, 2007: 1847).

Issues of grid connection and curtailment – an issue of transmission and dispatch issues

A critical issue in China’s wind power industry is that while capacity numbers of new installations, i.e. numbers of wind turbines installed and measured in accumulated GW have increased, this has not been followed by corresponding increases in electricity generated from wind power (Li et al., 2014; Yang et al., 2012), measured in GWh. That is, although thousands of wind turbines have been installed in the ground, around 30 per cent of installed capacity remains dormant, ”while the other 70% may be operating with minimal efficiency” (García, 2013:129). Thus, it is widely acknowledged that between one third and one fourth of Chinese wind farms are idle or underperforming, with a grid connection rate at 75 per cent or below (Bloomberg, 2012; Fang et al., 2012; Zhao et al., 2012a: 222; Yang et al., 2012; Li et al., 2014). These numbers reflect how wind power is overflowing; yet, it remains somewhat unclear how much of this reflects grid connection or curtailment issues, respectively. That is, the grid issue is constituted by two entangled phenomena, namely, *transmission issues* and *dispatch* issues, the latter denoting the downrating/curtailment of wind power. That is, the issue is either related to situations where the grid cannot transmit the wind power (largely due to technical issues), or where wind farms are simply not allowed to dispatch the available wind power to the grid. Basically, curtailment is a matter of being able to produce wind power, but not being allowed to connect to the grid and dispatch it:

”So this is curtailment. Wind is available, the turbine machines are available, but the dispatching authorities, they say no, no load...you have to shut down” (Int. 8, 2013).

At the same time, the reasons for these entangled issues are diverse (refer also to *Chapters 11 and 12*). Some of these are related to technical (quality) issues and power system coordination issues (Li, 2010: 1156; Yang et al., 2012). Even though the rate of curtailment seems to be decreasing slightly[42], in some areas the rate still goes up to 25-35 per cent at certain periods of time (GWEC, 2014: 45), and the curtailment issue in general tends to produce resistance against wind power i.a. due to incurred economic losses. Indeed, the grid issue (grid connection and curtailment) “is a very complex problem. The grid issue in China, whether you look at it from a cost perspective or a technical perspective, it is a huge challenge. Last year by the end of the year, 25 per cent of the wind turbines installed were not connected” (Int. 3, 2011). In the following, some of the different explanations for the grid issue are outlined.

Overflowing wind power – the issue of grid connection

In terms of grid connection, this issue is primarily being constituted as a result of poor quality of wind turbines (Li, 2010: 1161) and lack of a grid code up until 2011. Accordingly, ”for example this year [2011] there is a lot of disconnected turbines from the grid. This technology is not very good. I think this is a problem” (Int. 4*, 2011). Having integrated

[42] In 2013 curtailment reaching 11 per cent nationwide, down by about 6 per cent from previous year (GWEC, 2014: 45).

large bulks of wind power into a weak grid with high pace without an established grid code has been detrimental to grid stability, resulting in ”massive quality problems, massive grid break downs” (Int. 1, 2013). That is, a grid code ensures grid stability, e.g. through requirement of a so-called ’low-voltage-ride-through’ (LVRT) technology, which ensures that wind turbines stay connected to the grid without tripping even while the grid experiences short voltage dips (Int. 15, 2012; Int. 2, 2012). Without having installed such control technology at the outset, it is predicted that

”a lot of the turbines, which are out here, are of such poor quality that they will probably never start running, before they are being adapted [with proper control technologies]” (Int. 2, 2012).

In addition, the issue of grid connection and curtailment is linked to the stochastically fluctuating, intermittent nature of wind, which does not resemble conventional (fossil fuel-based, often thermal) power plants, which can be easily controlled and deliver stable base load power (Li, 2010: 1161, 1165). With a lack of advanced forecasting systems and control systems for power output from wind turbines and wind farms, the random, intermittent power from wind has been detrimental to grid stability (Li, 2010: 1161; Li et al., 2014; Int. 2; Int. 16). In turn, combined with a weak electrical power grid infrastructure, which is largely unfit to handle the additional load from large amounts of wind power (Bloomberg, 2012: 2), large-scale wind power integration has impacts on power system related issues, and has resulted in grid fall outs and wind farm outages (Li, 2010: 1162). This means that even if the output from wind turbines and wind farms is stable, the frequency of the Chinese grid is fluctuating, as the grid in itself is unstable (Int. 2, 2012). Hereby, the grid connection and curtailment issue is not only linked to poor quality of wind turbines, but also to an insufficient grid capacity:

“Because the grid...the grid is very...很弱,很小 [hen ruo, hen ruo / very weak, very small). So when the wind farm is bigger and bigger, so integrating into the power grid...the power grid cannot [absorb]” (Int. 17(*), 2012).

When not being able to absorb the additional load from the wind energy, wind farms are required by the grid company to disconnect from the grid or downrate/curtail their production. This can e.g. be done by pitching the blades of the wind turbine (Int. 15, 2012). However, the generating company is not compensated for the lost production, even though

“he would have been able to produce it if the grid had allowed him to. And that’s a problem here, that they are downrating them all. Then we are going to decide in our wind park whether we will stop some turbines, or whether we will reduce it by pitching the blades (Int. 15, 2012).

As grid companies focus on maintaining grid stability, many wind farms are curtailed as a matter of securing grid stability. Consequently, ”[i]t is widely believed that the ratio of wind power in the network should not be more than 5-10% of its capacity" (Yu et al., 2009: 5224). The weak grid structure in China is linked to the way in which wind power must be transmitted over long distances from the wind power supply bases in the 'Three Norths' of China, whereas power demand (load centres) are placed in large cities along the Eastern coastline of China. In this way, most wind sites are far away from demand centres and built at the weak ends of power grids in order to maximise output (Yu et al., 2009: 5224). The weak grid infrastructure and problems of interregional transmission make the transport of wind power over long distances highly inefficient and costly. Overall, "many installed capacities [in China are] actually sitting idle (Li, 2010: 1156).

Overflowing wind power – curtailment as a matter of power sector coordination

In addition to technical issues of wind turbines and grid infrastructure, lack of coordination can also help explain issues of grid connection and curtailment. Overall, apart from a weak grid infrastructure, there has been a lack of coordination and planning between central and local governments and authorities with different responsibilities for wind power (García, 2013; Korsnes, 2014). This has created a bottleneck "due to the limited national infrastructure of the entire grid, so it could not be consumed, could not absorb the large amount of wind power emitted by the wind power industry" (Int. 12*, 2013). Amongst other things, lack of planning and coordination has resulted in overcapacity, as local governments have made speedy approvals of new wind farm projects on the one hand, while there has not been corresponding investments in the power grid at the central level on the other hand (Korsnes, 2014: 186). As expressed by a foreign component supplier,

"from, let's say from 2005 till today, that's about eight years, in that period they have produced wind turbines so they are now the largest producers in the world. But if you look at grid connection, and if you look at efficiency, well, then it's an entirely different picture that you get. Because they don't work as they are supposed to, and they haven't extended…[the grid]. It's not just because the turbine is not good enough, I have to say, because there's also this thing about them lacking to expand the grid properly. So they can't connect them at all…well, it's like…it began in the wrong way" (Int. 13, 2013).

For instance, between 2003 and 2011, more than 90 per cent of constructed wind farms had been approved by local governments. Yet, this led to a mismatch between local wind farms and the centrally planned power grid construction (Li et al., 2012 in Korsnes, 2014: 186). That is, while local governments have been very efficient and fast in rolling out new projects, in their quest for stimulating local economic growth (Korsnes, 2014: 187), building out new power grid lines takes longer time.

“The grid development is really several years behind the development of wind farms, so the energy [generating] companies keep complaining, ‘ah! Our wind farms cannot be connected to the grid!’” (Int. 5, 2012).

The delay in expansion of the electrical power grid has created an urgent need for long-distance transmission grid networks from supply to demand/load centres (Li, 2010: 1161; Bloomberg, 2010 June: 1; Liu and Kokko, 2010: 5520). Further, the delay is related to resistance from ministries with responsibility over different parts of the energy system, which prefer more stable power sources (RAP, 2012: 4; Zhao et al., 2012a: 230).

The configuration of a qualification struggle?

In the above, the chapter has so far depicted a story of rapid growth in China’s wind power industry. At the same time, it illustrates how rapid growth in installations have come at the price of quality issues, which e.g. is reflected in failing and underperforming wind turbines and wasted wind power, which is not being translated to the grid. As wind power is increasingly being qualified as a “trouble-maker” (Int. 8*, 2013), actors are in turn reluctant to invest in or absorb wind power. For instance, as generating companies, which are demanded to curtail, are not compensated for their losses, they have become more reluctant in terms of investing further in wind power in their energy portfolio (Li, 2010: 1161): “The curtailment of the wind power is very huge, so this makes the developers more cautious that the development cannot continue as fast as before” (Int. 19*, 2013). Further, underperforming wind farms and the relatively low FITs for wind power (Li, 2010: 1161) do not create sufficient economic incentives for grid companies to give priority to wind power over more stable and cheaper thermal power. At the same time, coal power plants lose revenues and potentially profits if making more space for wind power in the grid, which leads to resistance to wind power from not only grid companies but also thermal power plants (Zhao et al., 2012a; Interviews).

In this way, the quality crisis has produced economic concerns, which produce further resistance against wind power, which is seen e.g. in terms of resistance against increasing wind power grid integration and in regard to the decrease in new wind power investments and installments. Hereby, the consolidation phase and quality crisis are deeply intertwined, intensifying each other. This has induced leading scholars to raise their concerns and make suggestions for China, in order to be able to be “escaping from the chaos market” (He and Chen, 2009: 2897). In the following, the configuration of a potential qualification struggle is outlined, i.e. a struggle for framing wind power as a reliable and sustainable power source.

Crisis of confidence and barriers to internationalisation

The emerging quality issues have created an issue of lack of confidence in Chinese wind turbines. Indeed,

"[w]ith respect to turbine development, China's manufacturers are confronted with serious technological as well as quality problems and, especially for larger high-output turbines, rely on foreign technology. Obviously, industrial policies, technology transfer and success — even in knowledge-intensive—production alone cannot provide the necessary conditions for developing cutting-edge technology and thus catching up with global technology leaders" (Klagge et al., 2012: 11).

This means that there is "little confidence in turbine quality, despite the rapid increase in sales" (Yu et al., 2009: 5224), as these wind turbines "are perceived as less reliable and of lower quality" (Int. 11, 2012). Also, as Chinese WTMs are increasingly looking to export wind turbines, due to overcapacity in the Chinese wind power industry, Chinese wind turbines are facing an issue of poor reputation. That is, the "weakness [of Chinese wind turbines] compared with [Western WTM] in the view of buyers is quality. They think we are new – we are young" (Int. 7, 2011). With lack of a track record and documentation of long-term performance, investors are reluctant to invest in a Chinese wind project:

"Then when they try to go overseas and sell them, they are like...you would like...even though they are inexpensive, they made so much less power that, you know, it was like - sorry...I don't wanna build like this bad project" (Int. 11, 2012).

Lack of confidence in Chinese turbines makes the internationalisation of Chinese wind turbines highly uncertain (Ru et al., 2012: 67), and export figures are still low (Int. 18, 2013)[43]. Thus, competing with foreign companies, "price only gets you so far"; that is, even though a Chinese wind turbine may be less expensive, often a foreign wind turbine will be preferred "because there's the idea of price, and then there's the idea of quality, [of] production" (Int. 11, 2012). Consequently,

"it is tough to explain to Europeans that we can make good quality here in China, and that is one of the barriers of entering the European market because they have a preconception that if it comes from China, then it is bad quality" (Int. 22, 2012).

Also Chinese investors prefer foreign technology due to the lack of experience and track-records, e.g. in terms of proof of tested lifetime performance and other quality-related features (García, 2013: 138-139; Int. 15, 2012). Indeed, Chinese wind power is undergoing a

[43] Nevertheless, this pattern is likely to gradually change. Thus, in year 2013, there was noticeable an increase in exports: 341 turbines totaling 692 MW, which were exported to 17 countries, including the US, Italy and Australia (GWEC, 2014: 42).

qualification struggle, fighting to improve the framing of Chinese wind power as a reliable and sustainable power source:

"The obstacle is about how you can change the perception […] You really need projects running in their backyard, in Europe, and let them see our solid promise. And then they say, oh, the numbers you showed me are real. It's not anything made [up]. […] [Nevertheless, the obstacle is] still the perception of the local companies. Still it takes time. You need to go through the process, to convince them" (Int. 23, 2012).

Accordingly, whereas Vestas for instance in 2012 considered Chinese WTMs as "serious competitors within 3-5 years, for sure" (Int. 1, 2013), in 2014, Vestas (at least officially in the media) did no longer fear the entrance of Chinese WTMs into the international market (Metal-supply.dk, Jun. 13, 2014). In this way, "[e]ven the perception of poor quality can severely limit market growth" (Lewis, 2013: 42). Further, the extensive focus on low price rather than quality has resulted in several foreign WTMs considering to leave or leaving the Chinese market, as it "is not suited for Western quality products" (Int. 24, 2013). However, the focus on quantity rather than quality has not only been detrimental to foreign companies who lose market shares in China, but also to Chinese WTMs, because the lack of incentives in terms of quality has resulted in under-performing Chinese wind turbines. Thus,

"if you really wanted to help your Chinese companies, you would have gradually changed your competition rules, or the tendering rules, or your requirements, to meet international standards…to bring your Chinese companies up to a level where they could actually compete against international players" (Int. 1, 2013).

Indeed, it seems to have become increasingly critical to raise the quality of wind turbines, as "[t]o build up an economical, efficient, and sustainable wind power market is crucial for the future development of wind power in China" (Wang et al., 2011: 140). Accordingly, there are recent indications that China's wind power industry is moving towards higher focus on quality, i.e., that 'new winds may be blowing' in Chinese wind power (Børsen, Sep. 19, 2014b). Amongst myriads of other initiatives, such potential quality turn is indicated in the theme of the annual grand wind power conference, China Wind Power 2013, which was quality:

"The main topic is how to improve the quality, because we have fast growth of the quantity, now we have to put much more attention on the quality" (Int. 8(*), 2013).

The pressure for such potential quality turn can also be seen in the way that grid companies who are facing the challenge of rapid increases in wind power shares in the grid system have started to demand higher quality. That is, grid companies are "demanding that larger requirements are put forth, for higher quality […] This is the entire new phase" (Int. 18, 2013). The following chapters of the analysis inquire into whether and how such turn to quality may be taking place in Chinese wind power, e.g. through changes in policies and incentive structures.

Conclusion and theoretical considerations – emergence of a wind power-TEN in China?

Chapter 6 has illustrated how a wind power-TEN is under construction in China. At the same time, it has been displayed how its translation has not yet been stabilised. Hereby, it is not possible to talk of the Chinese wind power market as stabilised. In the formative years of the (potentially) emerging wind power-TEN, the Chinese political pole has attempted to install itself as 'translator-spokesperson'. That is, in order to mobilise the market, the scientific, and the technical poles, the political pole has employed i.a. targets, fiscal tools, and other incentive policies, as well as discursive and narrative interessement devices. As regards narrative interessement tools, the notion of China's Sustainable Development towards a Harmonious Socialist Society, to be achieved largely through Scientific Development, denotes a temporal aspect of China's development path. In the envisioned path, memories of China's past and anticipations for its future renaissance and revitalisation are laid out. This narrative device is characterised by a sense of urgency in regard to ensuring indigenous innovation and industrial upgrading within strategic sectors, and in regard to becoming independent from foreign technologies. This urgency of indigenous innovation is particularly critical in terms of technologies, which are construed as 'core' to upgrading and catch-up as well as Sustainable Development. In this way, sustainability "is not only about sustainability per se – it is about continuing the founding project of modern China" (Christensen, 2013: 92), as it combines ideas about China's sustainable development with "Deng's modernization project through the 'Scientific outlook on Development'" (Christensen, 2013: 92).

The analysis has displayed how the narrative device of Sustainable Development is being constituted as a stem issue, as it is neither a "strictly (or primarily) political, [nor] economic or scientific issue" (Callon, 2009: 542). The political pole thus problematises the need to solve the stem issue of Sustainable Development and, in doing so, has succeeded in mobilising different concerned poles to help fragment the stem issue into distinct problems, such as the construction of a wind power market. A market pole (e.g. myriads of domestic and foreign WTMs and component suppliers as well as grid companies, power generating companies) has been assembled with a particularly high pace, resulting in a rapid rise in installed capacity. Paradoxically, the rapid emergence of a market pole threatens to destabilise the overall framing of the potentially emerging wind power-TEN, as the emerging wind power-TEN has started to overflow. That is, as quality issues abound, resulting i.a. in wasted, curtailed wind power, the market pole seems increasingly unstable. For instance, while the grid increasingly resists wind power, foreign WTMs consider leaving the Chinese market, and Chinese wind turbines are met with resistance to exports. Framed as a unreliable, unviable power source, it is depicted how framing processes can have comprehensive exclusion effects. Linked to China's comprehensive notion of sustainability, while wind power has been framed as sustainable in diverse policies and plans, the quality issues indicate that the framing of wind power as economically, technically, and scientifically sustainable is falling apart. That is, while wind power has been framed as a means of Scientific Development towards China's 'Sustainable Development', there is a risk that Chinese wind power cannot be framed as such, as long as quality issues abound, revealing the lack of indigenous technical and scientific capabilities. If adopting the Chinese comprehensive notion of sustainability as linked to Scientific Development, the framing of wind power as i.a. technically, scientifically, economically, or even environmentally sustainable can thus be threatened.

Facing a quality crisis, the potential wind power-TEN is undergoing a qualification struggle. That is, the framing of wind power as sustainable must be reestablished, if the potentially emerging wind power-TEN is to be stabilised. In the following chapters, the analysis inquires further into the issue of a potential turn to quality in the marketisation of Chinese wind power, looking into China's ability to adjust to "the ups and downs involved in any sustainability journey" (Garud and Gehman, 2012: 985). First, *Chapter 7* inquires into indications of a potential turn to quality in the potentially emerging wind power-TEN.

Chapter 7. Winds of Change – on the Potentiality of a Turn to quality in China's Emerging Wind Power-TEN

My respondent pauses. His account of the volatile development of China's wind power industry takes a twist as he continues his story. Whereas focus previously was on price and industrial growth in manufacturing,

"this has [now] completely changed. They are gradually making it [quality] a priority in China. And they have moved fast to remedy the damages. Also, the rationale of having a lot of land for non-performing wind turbines has totally changed. Nobody talks like this anymore, due to all the quality issues that have emerged. They knew too little about it back then, and now they have learned their lesson...the initial strategy resulted in enormous damages and accidents, very big damages and costs, and also conflicts, and everything… So now the goal has changed, and the mantra is quality […] What happened is that, after a while, they have decreased support, and they made it more difficult to meet the requirements, and then a consolidation is taking place between manufacturers. And this is what is happening now. I talked with a Chinese expert who predicted that it would take China ten years from around 2005…to reach this phase. So actually that fits pretty well with how it looks now. Already a while ago, they [the Chinese Government] intervened with requirements for the productivity of wind turbines and wind farms. And new restrictions keep coming all the time".

On my way home, I think about the development of China's wind power industry, and how the story of boom and bust in Chinese wind power as a matter of pure scale-up may be more complex than at first sight. Are winds of change blowing in Chinese wind power? And is the story of Chinese wind power – and of China – changing in ambiguous and maybe paradoxical ways that we have not yet quite understood?

Qualitative reconfiguring in China's potential wind power-TEN?

Chapter 6 has rendered an account of the potential genesis of a Chinese wind power-TEN, as a matter of rapid 'boom and bust', resulting largely from a focus on low-cost industrial scale-up. The rapid quantitative growth has had repurcussions for quality, however, and wind power is increasingly being qualified as a 'troublemaker'. With technical issues and large shares of wasted wind, the framing of wind power as sustainable and as a means of Scientific Development towards a Harmonious Socialist Society risks being destabilised. In *Chapter 7*, the thesis inquires further into the ongoing qualification struggle in China's potentially emerging wind power-TEN. First, the chapter points to seemingly changing means of the political pole in the construction of a market for wind power, indicating an ongoing ‘turn to quality’. Second, the chapter illustrates how the emerging market pole in terms of Chinese WTMs and component suppliers are changing their business models and priorities. Third, it is illustrated how Chinese actors – while having upgraded rapidly – still tend to lag behind in terms of technologies, which are framed as ‘critical’ and ‘core’ to improving wind turbine quality and to framing wind power as technically and economically sustainable.

Changing priorities and means of the political pole?

As quality issues are increasingly threatening to destabilise the potential wind power-TEN, the Chinese Government now seems to “take [...] control because of the quality issues that we have seen. Simply – the market wasn’t well run” (Int. 1, 2013). For instance, the Chinese Government has started to *“*talk about higher quality turbines, reliable turbines, turbines that will not break down, turbines that are adjusted to the grid*”* (Int. 3, 2011). In the following sections, the chapter inquires further into the characteristics of potentially changing priorities and means of the political pole as a ‘quality crisis’ seems to be facing the potential wind power-TEN.

Priority of Scientific Development for a sustainable development of wind power

First, the chapter looks into the priorities of the Chinese political pole in terms of the ‘sustainable development’ of wind power in China.

China’s transformation from a large to a strong wind power nation

Although the Medium and Long Term Plan for Renewable Energies (MLP RE, 2007) already emphasises the concern for the scientific and technological development of the renewable energy sector, it was only with the relatively recent 12th 5YP for the Scientific and Technological Development of Wind Power (hereafter, 5YP S&T Wind Power (2012*)) issued by the Ministry of Science and Technology in 2011 (MOST) that a dedicated plan for the scientific and technological development of wind power was issued. The plan outlines in detail particularly critical areas, which require upgrading and focus. Additionally, the 5YP S&T Wind Power (2012*) proclaims as its guiding ideology the doctrine of “scientific development” (5YP S&T Wind Power, (2012*) 3, 1), and accordingly adheres to the doctrine of independent/indigenous innovation and research (5YP S&T Wind Power (2012*), 2, 1(1); 1(1)). Hereby, the 5YP S&T Wind Power (2012*) explicitly brings itself in alignment with the principles of the general 15-year National Plan 2006-2020 for the Development of Science and Technology in the Medium and Long Term (2006-2020)

(MLP S&T, 2006-2020) as well as the 12th 5YP for the economic and social development of China (5YP S&T Wind Power (2012*), 3, 1). With the inscription of the doctrines of Scientific Development and indigenous innovation into the 5YP S&T Wind Power (2012*), science and technology is construed as a critical means for achieving the sustainable development of China's wind power industry (5YP S&T Wind Power, 2012*, 3, 1). Hereby, it is indicated that a main priority has become the issue of quality as a matter of 'sustainable development' of Chinese wind power.

Further, the 5YP S&T Wind Power (2012*) is concerned with 'transforming China from a large wind power nation into a strong wind power nation', in order to ensure the goal of the 'healthy and sustainable development of China's wind power industry' (5YP S&T Wind Power (2012*), 3, 1). To succeed in transforming itself from a 'large' to a 'strong' wind power nation, science and technology (S&T) and upgrading within core technologies are the key means. This concern for upgrading in S&T is further framed within a context of competitive pressures from leading international players (5YP S&T Wind Power (2012*), 3, 1). In other related plans, the concern for the relative backwardness of Chinese wind power is also raised as an issue (MLP RE, 2007; Energy Policy 2012). For instance, China's Energy Policy (State Council, 2012) argues that China is lagging behind, e.g. due to a weak background in independent innovation and core technologies as well as due to dependence on foreign key technology and equipment:

"China still lags behind the developed countries in this field [of basic scientific research and frontier technological research in the energy field], particularly marked by its flimsy basis for independent innovation, backwardness in core technology, and dependence on imports for some key technologies and equipment" (Energy Policy 2012, VII. Accelerating Progress of Energy Technology).

Overall, the 5YP S&T Wind Power (2012*) ascribes priority to the development of a 'sustainable future' for wind power in China and delegates agency to technology in terms of solving this matter of concern (most.gov.cn., May 4, 2012). Accordingly, the 5YP S&T Wind Power (2012*) outlines a long list of critical areas for further development of core technologies and frontier scientific areas, which are critical to the sustainable development of Chinese wind power.

Means to achieving the emerging priority of quality

The 12th 5YP S&T Wind Power (2012*) is the first plan devoted to the scientific (and sustainable) development of wind power. This can be seen to indicate a potential shift in priorities in the Chinese emerging wind power-TEN, since earlier focus was instead on rapid increases in installments of capacity. As priorities seem to gradually shift, the chapter in the following dives further into potentially shifting means to achieve such turn to quality. This is done by looking into policies in regards to (1) certification and standardisation, (2) a potential shift from capacity targets (GW) to targets of generated electricity (GWh), (3) centralisation attempts, (4) rebalancing of priorities between cost and quality, and (5) media awareness.

Raising quality by setting new access standards – wind power under encouraged development

First, a means of raising quality and overcoming the relative backwardness in technologies is the introduction of industrial and technical standards. Amongst other things, by early 2010, the Ministry of Industry and Information Technology (MIIT) released a draft circular on *Wind Power Equipment Manufacturing Industry Access Standards* (Lewis, 2013: 57)[44]. These standards aim

”[to] ’promote the optimization and upgrading of the industrial structure of the wind power equipment manufacturing industry, enhance enterprises’ technical innovation, improve product quality, [and] restrict the introduction of redundant technology’ [to] ’guide the industry’s healthy development’” (MIIT in Lewis, 2013: 57).

The access standards of the MIIT draft include requirements for WTMs that they should have the capability of producing a 2.5 MW or larger turbines, have at least five years of experience in a related industry, and meet various financial, R&D, and quality-control requirements (Lewis, 2013: 57-58). In addition, the 2011 edition of the so-called *Guideline Catalogue for Industrial Restructuring* by the National Development and Reform Commission (NDRC) came into effect in June 2011. The 2011 edition of the guideline catalogue emphasises the role of access standards. That is, whereas wind power in 2011 is listed as an industry under ‘encouraged development’, which makes wind power eligible for preferential treatment, these preferential policies are not extended to companies producing wind turbines with a 2.5 MW capacity or lower (People’s Daily Online, May 11, 2011)[45].

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[44] In ”March 2010, the Ministry of Industry and Information Technology (MIIT) issued a circular in which it asked for public opinion about the management of the country's wind power industry. In this document, the MIIT stated that new WTMs must have the ability to produce wind turbines with 2.5 MW power generating capacity or higher” (People’s Daily Online, May 11, 2011).

[45] In an earlier 2005 edition of the guideline catalogue, wind power was listed as a ‘new energy’ source, grouped together with traditional power sources. In the 2011 edition, wind power was instead grouped in a separate category of ’*encouraged development*’. This implies that companies behind an investment in a new energy project (e.g. wind power) can enjoy preferential treatment such as floating shares in the stock market, lighter requirements for new bank loans and tax breaks (People’s Daily Online, May 11, 2011).

Thus, in alignment with the MIIT access standards, the guideline catalogue's preferential policies also seek to solve the issue of continued overcapacity of low-quality wind turbines. Accordingly, in order to spur independent innovation and restructuring in the Chinese wind power, the development of larger capacity wind turbines as well as components for e.g. control systems and converters for these turbines are promoted (People's Daily Online, May 11, 2011). This has led to predictions that following the NDRC policy guidelines, "China's wind turbine manufacturing industry will undergo significant changes" (People's Daily Online, 11 May 2011). For instance, the China Wind Energy Association (CWEA) stated in 2011 that

"[t]he MIIT access standard is fairly high. No more than 10 of China' s 80-some WTMs can meet the standard" (People's Daily Online, May 11, 2011).

Nevertheless, according to the NDRC,

"[i]f we don't regulate these sectors, companies will encounter problems in production and management. This will hinder independent innovation and restructuring" (People's Daily Online, May 11, 2011).

Indeed, the progressively stricter guidelines and access standards can be seen as a means of "fine-tuning its [China's] wind turbine manufacturing industry's policies, and that the production of outdated wind turbines will be eliminated" (People's Daily Online, May 11, 2011). Hereby, new access standards and construing wind power as an industry under 'encouraged development' are attempts to raise quality through technological capabilities.

Technical standards to improve regulation of technology development – improving grid connection

In addition, 18 new technical standards were issued by the National Energy Administration (NEA), also in 2011, to improve the regulation of technology development in the wind sector (Lewis, 2013: 58). This included e.g. a Notice on Strengthening the Management of Wind Power Plant Grid Integration and Operation and the Provisional Management Methods for Wind Power Forecasting (NEA, with the China National Standardisation Commission) (Lewis, 2013: 58). Concerned with improving grid connection and with "prevent[ing] further wind-related disruptions to the power grid" (Lewis, 2013: 58-59), the notice introduces a new grid code (Lewis, 2013: 74). In addition, the Provisional Management Methods for Wind Power Forecasting aims at improving wind power integration through better prediction, and consequently requires all grid-connected wind farms to install forecasting systems (Lewis, 2013: 74). The introduction of new grid codes includes e.g. low-voltage-ride-through-capability (LVRT) (Wu et al., 2010; Basit et al., 2013), which ensures that wind turbines do not disconnect from the grid despite short disruptions in the voltage of the grid. Overall, grid codes require wind power plants to have more or less the same operating capability as conventional power plants (Wu et al., 2010; Basit et al., 2013), and overall to ensure the security and reliability of the power system. This has become increasingly critical as the penetration of wind power into the power system has increased.

With the myriads of new, smaller, and inexperienced WTMs, which have emerged since the REL in 2005, these standards are claimed to have altered the growth of new wind farms in China considerably (Korsnes, 2014: 187). Thus, with new stricter standards, the goal is to ”facilitate consolidation within the country's wind turbine manufacturing sector” (Renewableenergyworld.com, Sep. 22, 2011). With new and stricter standards for turbine quality introduced again as late as in October 2014, it is increasingly acknowledged that Chinese wind power is moving away from its earlier focus on quantity rather than quality (Børsen, Sep. 19, 2014b; Børsen, Oct. 20, 2014). Overall, grid codes and other technical standards can be seen as an attempt to qualify wind power as more technically reliable and stable. In general, the construction of a strong testing and certification system and introduction of standard requirements are construed as critical means of meeting the need for higher quality[46] and for a ‘sustainable development’ of wind power.

Promoting generated electricity rather than capacity

Second, a change in China’s wind power policies and regulations in terms of a potential turn to quality is seen in a gradual shift towards targets for generated electricity (GWh) rather than just capacity installations (GW). As indicated in the previous *Chapter 6*, the focus on targets of installed capacity (GW) has overflowed into issues of quality and lacking grid connection and wasted, curtailed wind power, since actors have not been encouraged to actually generate, dispatch, and transmit wind power. A move towards generation targets is considered to be an important incentive measure for raising turbine quality (e.g. in terms of turbine availability and turbine loading factor) (Yu et al., 2009: 5225; Gosens and Lu, 2014*)*. Indeed, it seems to be widely recognised that if *‘*feed-in electricity proportion’ had been quoted at the outset, instead of ‘installed capacity’, it could have created a “different but much more sensible picture” (Yu et al., 2009: 5224) for the development of Chinese wind power.

[46] E.g. mentioned in the Energy Policy (2012) as well as in the 5YP S&T Wind Power (2012*) as a key priority.

Promoting wind power generation through the Renewable Portfolio Standard

While recommendations abound, there seems to be an actual shift in policies to ensure generation of wind power. First of all, financial incentives have been changed, so that investors cannot receive subsidies for investment in new wind projects but can only receive a subsidy per kilowatt hour (kWh) generated electricity (Int. 18, 2013). In addition, a draft design of a Chinese Renewable Portfolio Standard (RPS) has been released in December 2012 by the Chinese National Energy Administration (NEA) under the National Development and Reform Commission (NDRC) and is currently in hearing (Bloomberg, 2012)[47]. The RPS is expected to be introduced in 2014 (GWEC, 2014: 45). The drafted RPS will ”not boost project development further, but instead improve grid connection” (Bloomberg, 2012) and actual wind power generation. To ensure renewable energy generation, the RPS is meant to provide incentives for compliance, by rewarding power companies through Renewable Energy Credits (REC) for generating electricity rather than just installing capacity. That is, ”[w]ithin RPS programmes each MWh of electricity generated from renewable energy produces one Renewable Energy Certificate (Bloomberg, 2012: 5)[48]. Importantly, the REC is only issued if electricity is actually generated, and not based on capacity installments. In this way, the approximately 25 per cent of renewable capacity, which is currently not connected to the electricity grid, would not be eligible to receive a REC (Bloomberg, 2012: 1).

The RPS draft sets renewable energy quotas for electricity consumption, generation, and transmission for China’s provinces and key municipalities, top power generating companies, and grid corporations (Bloomberg, 2012: 1, 2). That is, power companies will have to ensure the capacity is built, while grid corporations will have to connect them to the grid, and local authorities will have to consume it (Bloomberg, 2012: 1). To some extent, the RPS resembles the ’Mandatory Market Share policies’ (MMS) outlined in *Chapter 6*, which as quantity-based mandated and demand enhancing schemes seek to oblige transmission

[47] The RPS includes wind, solar, biomass, marine, and geothermal as renewable energies. The NEA released a draft design for the country’s first RPS on 2 May 2012. A new draft was released in December 2012 by NEA and is currently in hearing. The first draft met resistance from power companies and grid corporations, however (Bloomberg, 2012: 1, 4; Interviews).

[48] Whereas a RPS is usually combined with tradable renewable energy certificates (REC), so that suppliers can purchase renewable energy or renewable energy certificates (Cherni and Kentish, 2007: 3624; Bloomberg, 2012: 5), the NEA will issue non-tradable RECs to power entities for every MWh of electricity generated from renewable energy, which will become proof of renewable generation when the NEA evaluates the entity’s compliance (Bloomberg, 2012: 5).

companies and governments to provide each facility with connection to the grid and to purchase all renewable electricity respectively (García, 2013: 132)[49]. Yet, in contrast to the RPS, the MMS did not consider the hourly generation of electricity, but only encouraged installed capacity. In addition, due to lack of compliance by grid companies and power companies (Bloomberg, 2012), the MMS policies led to the issue of idle capacity and a lack of grid connection. In this way, the

"mandated market shares undoubtedly led to an increase in wind power investments. However, one downside was that the large power utilities only cared to fulfil their installed capacity criteria, and had less of an incentive to focus on the hourly production of electricity, which demanded more resources in terms of operation and maintenance" (Korsnes, 2014: 184-185).

Overall, by moving from capacity towards a focus on generated electricity and thereby seeking to improve coordination, planning (Bloomberg, 2012: 4), and compliance, the RPS constitutes an indirect means to raise quality, and potentially also to stabilise the framing of wind power as sustainable, in terms of aligning it with qualities of technical and scientific upgrading.

Readjusting the balance between autonomy and centralisation

Third, another indication that the means of the political pole may be changing over time, adjusting to the overflowing, is the centralisation of approvals of new wind farm projects to counter overheated investment activities. That is, whereas larger projects above 50 MW (such as concession projects) have consistently been subject to central approval by the National Development and Reform Commission (NDRC), smaller projects and government contracts (below 50 MW) have been approved by local governments (Development and Reform Commissions/DRC) (Yu et al., 2009: 5223; García, 2013; Korsnes, 2014)[50]. Consequently, numerous projects have been sized exactly at 49.5 MW. Further, as local governments tend to be motivated to spur local GDP growth, which is possible through wind farm installations regardless of electricity production, many of the large wind farms have been installed right next to each other, making the actual size much larger (Jiang, 2011 in Korsnes, 2014: 187) and exceeding demand. In addition, realising that the wind power industry suffered from overcapacity and overheating, the State Council listed wind turbine production as an 'excess capacity sector' in August 2009. This caused the Ministry of Land

[49] (1) Grid corporations should source at least 1 per cent from non-hydro renewables by 2010 and 3 per cent by 2010, (2) large power generators should have 3 per cent of non-hydro renewable capacity by 2010 and 8 per cent by 2020. These goals were not met, as only 7 out of 14 power companies and 2 out of 4 grid corporations met their targets (Bloomberg, 2012: 2).
[50] According to García (2013), this limit was not 50 MW, but 100 MW (García, 2013: 130).

and Resources to “reportedly deny all applications for new wind turbine manufacturing facilities in an effort to slow down growth in the sector” (Lewis, 2013: 57). As expressed by a foreign expert on wind power in China,

”I guess it was in ’11…when administration practice was changed from the province approving wind farms below 50 MW…then they made like a call-in decision, where they at least had to get in hearing at NEA [National Energy Administration]. Above the 50 megawatt mark, it had been NEA always, which was supposed to approve of quite a lot of them…so they made this, kind of a decision to make a halt” (Int. 18, 2013).

Further, as of 2011, decision-making was being centralised, and all wind projects – including those below 50 MW – were required to obtain central approval from the NEA under the NDRC (Korsnes, 2014; Interviews)[51]. Overall, the Chinese Governments seems to oscillate between what can be termed ‘decentralised fragmentation’ and ‘centralised authority’ in order to reach development targets (Korsnes, 2014). That is, decentralisation of authority was beneficial for the rapid growth of China’s wind industry, while centralisation of authority in 2011 was slowing growth in a period of severe overcapacity (Korsnes, 2014: 196). This is reflected in how,

“[u]ntil 2011, China’s wind industry saw a rapid expansion; yet, since 2011, there has been a slowdown. This slowdown is highly relevant for the governance of the wind sector; as coordination premised its rapid development in 2003, it was also coordination that led the expansion to a halt in 2011, by centralising the approval of new wind farms” (Korsnes, 2014: 186).

The continuous oscillation is further indicated in a recent promulgation on the “Decision of the State Council on Cancelling and Delegating the Power of Approval of a Batch of Items Requiring Administrative Approval and Other Issues” in May 2013 (State Council Decision, 2013). This decision seemingly removes a number of administrative approval items and delegates the power of approval to authorities at the lower administrative levels. Amongst other things, the list includes energy and power projects, in turn including wind power and power grid projects (Jun He Bulletin, 2013). Concern is raised, however, in an analysis on this issue that delegating ”power of approval for most of related energy projects […] to the provincial level or the local investment authorities [while] conducive to the development of the related sectors and [able to] lower the threshold for private enterprises [can] give rise to reckless investment” (Jun He Bulletin, 2013). Overall, the picture seems muddled, yet, what remains clear is that China’s wind turbine industry seems a case of alternating waves of

[51] The previously mentioned Notice on Strengthening the Management of Wind Power Plant Grid Integration and Operation (2011) also required all wind farms to obtain approval from the central NEA in order to receive the FIT subsidy (Lewis, 2013: 74).

consolidation and liberalisation (Korsnes, 2014; Jun He, 2013; lexology.com, Jul. 31, 2013; rieti.go.jp, 2013).

Readjusting the balance between price and quality

Fourth, in addition to changes in the above-mentioned policies and practices, price setting has also changed over time, increasingly moving towards higher focus on quality. In the following, the chapter briefly outlines how a shift may be taking place in terms of price setting.

From lowest bid to more criteria and consideration of life cycle costs

In terms of price setting, a shift from exclusive focus on competitive bidding for the lowest kWh price towards other criteria is witnessed in China's concession projects. Whereas the first three rounds were based on price, criteria such as quality of inputs, management capacity, size of wind turbines, domestic content, overall capability, technical planning, grid price, and economic benefit (Korsnes, 2014; García, 2013: 130) have been added over time as well. Nevertheless, price still tends to remain the decisive factor (García, 2013: 130). To avoid unacceptably low prices, which have been detrimental to the quality of wind turbines, criteria changed in 2005 where the lowest price was set to weigh 40 per cent of the bid-win decision, and in 2006 further reduced to 25 per cent (Korsnes, 2014: 185). In the last round (the 5th) of concessions, the best price was redefined not merely as the lowest price, but as the price closest to the average offered by bidders (García, 2013: 130; Liu and Kokko, 2010: 5524). In 2009, when the FIT was finally introduced, bidding was prohibited (Liu and Kokko, 2010: 5524; Wang et al., 2012; Korsnes, 2014; García, 2013).

Having succeeded in rapid scale-up of the wind power industry, prices have been adjusted over time (finally resulting in the FITs), and as overflowing occurred, more quality criteria have come into play. In addition, whereas the overall focus has tended to be on the upfront investment in the MW capacity of the turbine, rather than the long-term life cycle costs and cost of energy (MWh), a gradual move of the political pole towards including life cycle costs seems to be noticed in the industry:

"In the policies, there seems to be a gradual move towards an understanding of including the life cycle costs…This is interesting, as the Chinese wind turbine companies have successfully competed against Western wind turbines since the focus on the product costs [i.e. not on the life cycle costs per Megawatt hour, but the turbine in terms of Megawatt capacity] makes the Chinese products cheaper in the short-term, but not in the long-term" (Int. 25, 2013).

Overall, the balance in priorities – and means of evaluating – between price and quality seems to be negotiated and changing.

Controlling media

Lastly, state-controlled media have gradually opened up to bringing stories on the quality issues within the Chinese wind power industry. Although quality problems had emerged prior to the downturn in 2011, stories about quality issues and poorly functioning wind turbines started surfacing in the largely state-controlled Chinese media only in 2011 (Korsnes, 2014: 188-189). Only gradually allowing the media to highlight quality issues can be seen as a measure by the Chinese Government (and the CPC) to steer growth in Chinese wind power, as the largely state-controlled media serve to either legitimise or delegitimise the wind turbine industry (Korsnes, 2014: 188-189). Due to the central role of state-support in Chinese wind power, "To be sure, highlighting the challenges that the industry faces regarding turbine quality or grid connection issues is important for the overall performance of the industry" (Korsnes, 2014: 188-189). Increasingly, blogs on the development of China's wind power industry have emerged as well, e.g. under the auspices of China's National Renewable Energy Centre (CNREC) under the National Energy Administration (NEA)/NDRC, in which a variety of quality issues are outlined and discussed, e.g. the issue of grid connection.

Reconfiguring China's potential wind power-TEN?

Along with changing priorities and goals of the political pole, China's wind turbine industry seems to be reconfiguring as well, although subtly and gradually. Overall, it is widely acknowledged that a reorganisation and consolidation of the industry is taking place and will continue for some time, since it is predicted that the Chinese wind power market can only sustain a few major corporations (Interviews; e.g. Yu et al., 2009). However, although "the Chinese customers are starting to pay more [for equipment] there is a long way from words to implementation in China. The quality discourse will take a long time before it gets into actual action" (Int. 24, 2013). For instance, it seems that the transition towards life cycle costs will take time before it is implemented:

"We still need a shift in the policy. The price is still the most important factor. It should be the lowest price of Megawatt per hour and life cycle costs and not of Megawatt" (Int. 24, 2013).

In the following, it is outlined how Chinese WTMs may be moving towards a higher concern for quality.

Adding intelligence to wind turbines – on forecasting tools, diagnostics, and main controls

While priorities in Chinese policies and plans related to wind power gradually turn towards higher focus on quality, the Chinese wind turbine industry also seems to be changing priorities and strategies, i.a. moving towards the 'intelligent' turbine' (Int. 2, 2012; Int. 26, 2012; Int. 6, 2013)[52]. This emphasis on the intelligence of the wind turbine is a general trend, not just in China, but globally, as technologies are becoming more advanced and 'intelligent' (Int. 2, 2012). That is, in order to raise efficiency of wind power and reduce the cost of energy to improve its competitiveness against conventional fossil fuels, and to improve grid connection to make it act more like stable conventional power sources, which is relatively predictable (Int., 28, 2013; Int. 2, 2012), wind power experts, scientists, engineers, and other actors around the world are working on developing advanced 'intelligent' tools for wind turbines. Hereby, technical and industrial experts argue that "the pure technological solution, which is to define the future, that's predictions…predictive systems" (Int. 2, 2012). Acknowledging the vast quality issues in the Chinese wind turbine industry, Chinese industry experts as well as manufacturers also seem to gradually focus on "increasing the turbine's intelligence and adding other means etc. In reality, this is the general trend of the entire industry" (Int. 6*, 2013). In particular, the work on the wind turbine's intelligence involves improvements in forecasting and predictive systems, smart diagnostics, and advanced control systems. Such tools can help predict the wind, optimise the turbine's output, and make grid integration more 'smooth' (Int., 28, 2013; Int. 2, 2012). Hereby, such advanced tools can help construe associations of 'intelligence' and 'grid-friendliness' to wind power. The development and integration of advanced predictive systems, diagnostic tools, and sensors into wind turbines in turn raises demands on the computational capability of the main control, which functions as the 'brain' of the wind turbine. Through diagnostic and forecasting tools, as well as sensors, the

"turbine actually can sense the change, get this information processed in a central controller, and you are adjusting yourself afterwards. It can do both things […] Like it has a brain. […] And all these things require a huge computational capability in the controller (Int. 27, 2012)

In addition, forecasting systems are critical for increasing efficiency of wind turbines.

[52] Normally, 'intelligence' in the wind power sector is referred to in terms of knowledge built into the blades, advanced predictive systems, meteorological systems, forecasting systems, and advanced sensors. In the thesis, the notion of 'intelligence' refers to the high degree of 'computerisation' of wind power and the critical role of software programmes in these computer systems, such as forecasting tools, simulation tools, main controls etc.

"What will make a difference, that's a predictive pitch system, which people have talked about, with a light laser system on top, and which predicts the wind maybe ten seconds ahead, in order that you can adjust accordingly. That is going to be huge. It will generate up to ten percent extra output from each turbine" (Int. 2, 2012).

Together, such 'intelligent' systems can improve output and ease grid connection, which is crucial for the cost of wind energy to be reduced and for construing associations to wind power of economic and technical viability. If adopting the Chinese comprehensive notion of sustainability as linked to Scientific Development, increasing the intelligence of wind turbines can help frame wind power as economically, technically, as well as scientifically sustainable.

New strategies? In search of a balance between cost and quality

As policy priorities and means seem to be shifting, a change in strategy priorities of Chinese WTMs may thus come about as well. For instance, the introduction of new grid code standards has exploded the demand for low-voltage-ride-through (LVRT) technologies from foreign suppliers, and "in 2011, everybody could suddenly talk about LVRT" (Int. 18, 2013). In terms of strategy and business models, one of China's younger WTMs has consistently attempted to find the 'right balance' or 'trade-off' between the Chinese cost-out strategy and concerns for quality, mainly focusing on developing software tools (Interviews). This is seen e.g. in a focus on investments in R&D and in hiring the 'best talents' within wind power and related fields (e.g. software) in order to produce a sustainable product (Int. 23, 2013):

"I think that Chinese companies are very good at cost management. And not only just cost reduction…we want to find the best balancing point, between cost and quality. It's not only making a large investment - spending a lot of money - to make a very high-quality product…but it's hard to commercialise […] It is very important that you find the right balance… Because in the process, if you waste a lot of money...you want to have a very fantastic technology, spend a lot of money. But it's not sustainable" (Int. 23, 2013).

The search for the 'right' trade-off between price and quality of Chinese WTMs also seems to spill over into supply chain management. In terms of governance of the supply chain, Chinese and foreign WTMs have in general used different technology sourcing models. That is, foreign WTMs have followed a component sourcing mode of vertical integration, internalising both design, production, and specialisation to ensure high quality (Interviews; Li, 2010: 1161). When sourcing specific core components, foreign WTMs tend to source from only one core supplier, engaging in a close relational mode of governance (Interviews). Consequently, key component suppliers of foreign WTMs have tended to follow their customers to the Chinese market, e.g. blade suppliers and control system suppliers (Haakonsson and Slepniov, forthcoming). Further, although many foreign component suppliers have followed their customer to China, the falling market shares of foreign WTMs in China have implied that foreign suppliers increasingly supply to Chinese WTMs instead (Haakonsson and Slepniov, forthcoming). Whereas the technology management model of Western WTMs may result in easier control of quality and core technologies, this internalisation/insourcing model results in more costly products due to high internal investments in R&D. Consequently, in "the first half of 2010, the cost of imported wind turbines was roughly RMB 10,000 (USD 1,200) per kilowatt, about 50 per cent more than that of the domestic equivalent" (Klagge et al., 2012: 376).

In contrast, Chinese WTMs have tended to externalise most of their components, acting more like 'assembly companies' (Interviews). The modularisation of the wind turbine also implies that it has been possible to have many different suppliers for the same component, which increases price competition amongst suppliers (Int. 1, 2013). In addition, there has been a tendency to consider internal R&D irrelevant within certain large Chinese WTMs (Int. 14, 2013; Int. 18, 2013). Whereas the Chinese model of component outsourcing may help reduce costs and investments in R&D, it has turned out to be risky in terms of quality, due to a lack of overview of the wind turbine. Thus, as some Chinese WTMs have acquired more experience over time, some of the leading Chinese WTMs have moved towards integrating more key technologies (e.g. Goldwind). Conversely, facing severe price-competition from Chinese WTMs, Western WTMs experiment with more outsourcing of components (Int. 1, 2013; Int. 3, 2011; Int. 18, 2013), which implies that the technology sourcing strategies of Chinese and Western WTMs are gradually converging.

Upgrading and catch-up of equipment manufacturers and reconfiguration of relations

The above-mentioned changes in terms of moves towards more 'intelligent' turbines, a sustainable balancing between price and quality, and changes in the technology sourcing modes have come along with increased experience and capabilities of Chinese WTMs and component suppliers. In the following, the chapter inquires into how capabilities and upgrading are reconfiguring relations between Chinese and foreign actors in the potentially emerging wind power-TEN. In this account, the legacy of China's wind power market as based on foreign technology licenses is taken into account.

Upgrading of Chinese wind turbine manufacturers and component suppliers

Since its beginning, China's emerging wind power-TEN has realised a series of rapid technological advances and achievements, e.g. including larger turbine design with multi-

MW capacities (1-5 MW) with variable speed, and attempts at moving into large offshore projects (Ru et al., 2012; Klagge et al., 2012; Lewis, 2013). For instance, whereas the maximum unit size developed by Chinese enterprises was only 750 kW in 2005, and MW-scale wind turbines accounted for only 21.5 per cent of all newly installed capacity in China, today, larger Chinese WTMs, such as Goldwind, Dongfang, and Sinovel, have all developed MW-scale wind turbines, and the number of patent applications by Chinese actors has increased dramatically (Ru et al., 2012: 60). In terms of component equipment manufacturing, Chinese companies are claimed to be catching up, e.g. already boasting ”auxiliary industries such as blade, wheel hub, gearbox, generation, yaw system and electric control systems specializing in the production of plant parts, though some key components are still heavily dependent upon imports” (Li, 2010: 1159). Overall, the number of local component suppliers has risen, and China did already by 2009 have 52 local Chinese blade manufacturers, 16 bearing manufacturers, 10 gearbox manufacturers, and 12 converter manufacturers (Zhao et al., 2012b). As regards control systems, Chinese component suppliers have particularly upgraded in hardware parts (e.g. control cabinets, programmable logic controllers (PLCs), and converters):

“Of course the Chinese companies are catching up, starting out with the least complex components, towers, and major parts...and I think they are picking [catching] up from the gearbox...that’s also good” (Int. 5, 2012).

These technological advancements are also pinpointed in the 5YP S&T Wind Power (2012*). For instance, the plan argues that due to support from the Chinese State, Chinese companies can now supply the domestic Chinese market with e.g. converters and control systems. In addition, Chinese companies are argued to have made advancements in key technologies for large-capacity wind turbines, including machine design, manufacturing, testing, certification and operation of such technologies, as well as within advanced control system technologies for pitch regulation and transmission (5YP S&T Wind Power, 2012*).

A legacy of heavy industry and technology transfer

The impressive pace of catch-up and upgrading within wind turbine technologies can find part of its explanation in China’s long legacy within heavy industry. Many of the areas, in which Chinese component suppliers have upgraded capabilities, have their roots in heavy industry. Thus, many of China’s WTMs already possessed know-how from related industries such as electric power generation equipment (e.g. coal power or hydro power equipment manufacturing industry) or heavy machinery and equipment (Klagge et al., 2012: 376; Liu and Kokko, 2010) when they entered the business of wind turbine technologies [53].

While boasting a long experience within heavy industry, Chinese WTMs started out without specific knowledge and know-how on wind turbine technologies. In order to quickly develop capabilities within wind power, Chinese WTMs and China's emerging wind power-TEN in general has relied heavily on transfer of foreign technologies, foreign direct investment (FDI), and cross-border technological learning in general. This strategy has made it possible to upgrade relatively fast. Hereby,

"[i]n its early years (before the mid-1990s), China's wind industry was rather weak in manufacturing; it mainly relied on imported equipment as well as on technical support through development aid for clean technologies, specifically from Denmark and Germany" (Klagge et al., 2012: 376).

The strategy of attracting FDIs and ensuring technology transfer was i.a. seen already in the 'technology for market' policy of the 'Riding the Wind Program' (Klagge et al., 2012; Li, 2010; Lewis, 2013) (described in *Chapter 6*). Overall, the attraction of foreign technologies, know-how, and technology acquisition (Li, 2010: 1159) has been an integral part of China's strategy for gradually building up a Chinese wind turbine industry:

"Yes, it comes as a directive from the Government. There has been this rule that first of all…when the turbine industry started, then they wanted foreign technology to China in order to get started quickly. That's the strategy" (Int. 2, 2012).

The process and means of technology transfer has primarily taken place through acquisition of finished wind turbines and wind power technology, signing technology transfer contracts with foreign owners in order to obtain production licenses of mature technologies, and through imports of developed design drawings and technologies from foreign WTMs (Zhao et al., 2012b: 423; Lewis, 2007; Lewis, 2013; Lema et al., 2013; Klagge et al., 2012; Chen et al., 2014). In this way,

"*Import of equipment, licenses and FDI provided access to technology, know-how and skills, and consequently contributed to the fast development of China's wind industry. With utilizing mature technology through licensing and thus avoiding high R&D expenditures, Chinese turbine manufacturers were able to produce turbines at much lower costs than their foreign counter parts" (Klagge et al., 2012: 376).*

[53] The three largest coal power equipment manufacturers, Shanghai Electric Group, Harbin Electric Corporation, and Dongfang Electric Corporation, which provide nearly all the advanced coal power equipment in China, all have subsidiaries in wind turbine manufacturing (Korsnes, 2014: 191).

Imitation and reverse engineering – on being keen to learn

In this way, Chinese WTMs have used design drawings from foreign wind turbine design firms to engage in imitation and reverse engineering (Zhao et al., 2012b: 423; Lewis, 2007; Lewis, 2013; Klagge et al., 2012; Chen et al., 2014). This is by Chinese actors coined as a matter of being "very open to learn from outside. Chinese people are very keen to learn" (Int. 16, 2011). In the upgrading process, foreign suppliers of design licenses for mature designs such as the Austrian engineering firm Windtec[54] or the German company Aerodyn[55] have played a critical role (Lewis, 2013). For instance, Windtec can design wind turbines from the ground up, but can also step in and help a company interested in building their own turbines to scale up for operation (Interviews; www.windsystemsmag.com). In addition, foreign certification bodies such as the international DNV GL (Det Norske Veritas-Germanischer Lloyd)[56] have played a central role in the build-up of expertise of Chinese WTMs, component suppliers, as well as China's certification bodies.

[54] In 2007, American Superconductor (AMSC) acquired the Austrian engineering firm Windtec, which has provided technology and licenses to third parties who wants to manufacture their own wind turbines, establishing the subsidiary AMSC Windtec GmbH. Today, "AMSC's Windtec Solutions include a host of electronic controls and systems as well as wind turbine designs and engineering services" (amsc.com). AMSC has been selling electrical systems and core components such as its PowerModule power converters for wind turbines for many years, whereas Windtec has developed complete electrical and mechanical designs for wind turbine applications and has begun incorporating the AMSC systems into the wind turbines it designs (windsystemsmag.com).

[55] Aerodyn is a German company whose development activities focus on the design of entire wind turbines for onshore and offshore applications. It specialises in e.g. control system technology, load case calculation, rotor blade design, tower design, design of machine components, electrical engineering, and documentation for production and certification (aerodyn.com). The company can assist and support "from the initial research done during the concept study to the end of commissioning of the prototype and, if required, even during the series production of the wind turbine" (aerodyn.com).

[56] In 2009, GL and Garrad Hassan merged into GL Garrad Hassan, and functioned as an international renewable energy consultancy based in the UK. GL was a certification society based in the city of Hamburg, Germany, while Garrad Hassan conducted consultancy work and developed software for renewable energies. In renewable energies, the merger of GL with Garrad Hassan provided a software solution set for turbine design (GH Bladed), wind farm design (GH WindFarmer), and a SCADA System (GH SCADA) that can integrate data from all major turbine manufacturers. In 2013, GL merged with Det Norske Veritas (DNV) (dnvgl.com; gl-garradhassan.com; Interviews). Today, DNV GL claims to deliver "world-renowned testing, certification and advisory services to the energy value chain including renewables and energy efficiency [and] world-renowned testing and game changing expertise for the energy value chain, including renewables and energy efficiency", such as wind power (dnvgl.com).

An assimilation and absorption strategy

The practice of technology transfer and learning from foreign expertise is referred to as an ‘assimilation and absorption strategy’ by Chinese actors as well as in Chinese policies (MLP S&T 2006-2020; Interviews). For instance, as explained by a Chinese research institution, ”the software was bought from a foreign company, and then we have absorbed and assimilated it. For instance, in 1984, MOST [Ministry of Science and Technology] went to Europe, i.a. Denmark, where they saw wind turbines for the first time. Soon after you could find wind turbines in China” (Int. 16*, 2011). The assimilation and absorption strategy forms an integral part of China’s S&T strategy. For instance, as expressed in China’s Medium and Long Term Development Plan for Science and Technology (MLP S&T 2006-2006), ”[i]ndigenous innovation refers to enhancing original innovation, integrated innovation, and re-innovation based on assimilation and absorption of imported technology, in order improve our national innovation capability” (MLP S&T 2006-2020, II,1).

Collaborative innovation and mutual learning

As Chinese actors have improved their capabilities rapidly within wind power, the traditional technology transfer mode of licensing is increasingly overtaken by more cooperative innovation through collaborative design and codevelopment, e.g. through joint ventures (Ru et al., 2012: 65). This reflects how collaborative relations between Chinese and foreign actors are shifting along with China’s upgrading in capabilities. In addition, Chinese WTMs increasingly engage in outward FDI, e.g. through mergers and acquisitions (M&As), establishment of overseas R&D centers, and cross-border collaborative R&D linkages (Lema et al., 2013; Lewis, 2013; Klagge et al., 2012; Li, 2010; Ru et al., 2012). For instance, the Chinese WTM Shanghai Electric has engaged in a strategic alliance in the form of a joint venture with Siemens (Korsnes, 2014: 191). Further, in 2008, Goldwind acquired Germany’s Vensys Energy, and in 2009, XEMC Windpower took over Darwind (Klagge et al., 2012: 376; Lewis, 2013). The Chinese privately owned WTM, Envision, has established its Global Innovation Centre in Silkeborg, Denmark, engaging in various R&D collaborations with the Danish so-called ‘wind power hub’ (Andersen and Drejer, 2006), amongst other things working with Danish universities. With its headquarter in Shanghai, China, Envision has further set up facilities in Japan and the US and has succeeded in hiring high-level domestic and foreign employees from leading WTMs as well as related industries, e.g. software (Envision.com; Interviews).

Taking the example of the large domestic WTM Goldwind[57], the company has adopted a variety of different modes for technology and know-how acquisition, along with processes of gradual learning. In 1989, Goldwind first helped to import and install 13 Danish Bonus 150 kW turbines in Xinjiang, to form the largest wind farm in China at the time (Lewis, 2013: 123). Later, in 1996, Goldwind bought a license from the previous German small WTM Jacobs Energie, which in 2001 merged with another company into Repower Systems Group, in order to manufacture 600 kW wind turbines (Lewis, 2013: 123). In 2001, Goldwind acquired a license from Repower Systems Group for a 750 kW turbine, and in 2003, a technology license was acquired from the German wind turbine design company Vensys Energiesystems GmbH, for a Vensys (direct-drive) 1.2 MW turbine (Lewis, 2013: 123-124). After its collaboration with the German company Vensys, in 2008 Goldwind acquired Germany's Vensys Energy directly (Lewis, 2013: 124; Zhao et al., 2012b: 428; García, 2013: 139; Ru et al., 2012: 65). After its acquisition of Vensys, Goldwind has begun to jointly develop several new wind turbine designs in partnership with Vensys (Lewis, 2013: 124). This has helped Goldwind to add 2.5 and 3 MW turbines to its production and later also 5 MW and 6 MW turbines for offshore applications (García, 2013: 139; Lewis, 2013: 124). Overall, Goldwind has established a positive reputation amongst industry stakeholders based on this strategy of absorption and assimilation, and gradual learning:

"Goldwind is a good story. They are one of the oldest WTMs. They used to be at an institute for wind energy in Xinjiang. So they know wind turbines from a very small size to a very huge size. So the development for Goldwind is knowledge and technology assimilation. First, they want to copy Bonus and Siemens and Vestas. Then they developed their own. So Goldwind is a good case" (Int. 10, 2012).

Today, Goldwind's wind turbines are almost entirely sourced within China, although some core technologies are still imported (Lewis, 2013: 124). Hereby, the strongest Chinese WTMs have been able to build capabilities and/or acquire technologies from an assimilation and absorption strategy, gradually involving mutual learning in increasingly equal partnerships (Silva and Klagge, 2013; Lewis, 2013; Chen et al., 2014). As the stronger Chinese WTMs are moving towards more indigenous and collaborative innovation, they gradually align themselves with the government agenda of acquiring core technologies and indigenous innovation capabilities. Hereby, wind power can be framed as a means of China's *Scientific Development* towards achieving *Sustainable Development*.

[57] Goldwind, or, 'Goldwind Science and Technology Company Limited', has its origins in the Xinjiang Wind Energy Company (XWEC), which was established as the first Chinese WTM in 1986 (Lewis, 2013: 122).

Learning from the Chinese – on shifting roles?

As Chinese WTMs and component suppliers are building new capabilities, relations between Chinese and foreign actors in the emerging wind power-TEN are also changing. For instance, leading foreign WTMs recognise that they can learn from the Chinese cost-out strategy:

"[Western WTM] can do a lot of improvements on innovation. First of all in terms of reducing the cost. [...] The question of outsourcing and insourcing is part of the answer. But it also has a lot to do with how to manage innovation and production. [Western WTM] has recently introduced lean concepts, but the company is not very lean. So the company has a lot to learn in terms of organising production more efficiently. Doing more cost-out. Chinese companies are more lean, good at cost-out strategies (Int. 31, 2012).

This indicates a general convergence between Chinese and Western WTMs in terms of the balancing of cost versus quality. Thus, Western WTMs are

"learning from the Chinese. We always talk about how the Chinese are copying us, but the reality is that we should all learn from the Chinese…not copying poor quality, but copying a cost-out mentality. And that is definitely something where we should learn. Because at [Western WTM], we definitely had the mentality for many years to produce only a Mercedes Benz when it comes to turbines, and only the best quality in all parts of the value chain. But the reality – that is taking it a bit too far [...] That's [focus on cost-out] important for the company's long term survival. So, taking learning from the Chinese is very important" (Int. 1, 2013).

In addition, there is an increasing recognition of the danger of underestimating the Chinese WTMs (Int. 11, 2012).

"But basically they can do what they have to do. So we learn something along the way. I think there are some prejudices that fall apart. And there are some Chinese companies who make something bigger than they are used to. And they learn something from it" (Int. 32, 2012).

Overall, the respective roles and positions of Chinese and foreign WTMs seem to be reconfiguring.

Reconfiguring relations – the case of control system hardware

The reconfiguring of relations between Chinese and foreign actors is also seen in the case of the wind turbine's electrical control system, this is considered one of the more advanced and critical components of the wind turbine (Interviews). Western control system suppliers started out delivering the entire control system – including both hardware and software parts – like a 'plug and play' module system for the Chinese customer.

"What we brought to them in the beginning…if we go back five years, what we supplied was a complete system, which the Chinese needed. So we didn't need to adjust anything, the Chinese just wanted it. And then they buy it, then they buy it in huge amounts" (Int. 15, 2012).

Increasingly, however, foreign suppliers only deliver specific smaller modules, as Chinese WTMs have established indigenous capabilities of building e.g. control cabinets (hardware) themselves:

"There are many who have begun…well, the development, which has been there, is that from we delivered the entire cabinets, then now they have begun to only buy the modules and then build the cabinets themselves" (Int. 15, 2012).

Some Chinese WTMs and component suppliers have hereby gradually learned to produce the hardware parts of electrical control systems. That is, while the quality was not so good in the beginning (Int. 33, 2012),

"they [have] also learn[ed] many things – from us, [XX/foreign control system supplier], and from experience. So they are [im]proving themselves" (Int. 33, 2012).

Such learning has often taken place through training and assistance from foreign component suppliers, design houses, and/or certification and testing bodies, and via collaborations with research institutes. For instance, the Chinese WTM, Windey, which has a long background in research due to its background as a spin-off from a Chinese research institute, has collaborated with Siemens on a test/experimental platform and has e.g. sent some of its employees to study in Germany. The company has also received training, advice, and testing assistance from DNV GL (formerly Garrad Hassan) (DNV GL homepage; Int. 17*; 2012). Today, Windey has developed "the electrical components [of control system cabinets] by ourselves [based on] own indigenous technological development" (Int. 17*, 2012) in addition to conducting research on control systems for "the overall design" of the wind turbine. Furthermore, a number of Chinese control system suppliers have emerged, e.g. Corona Science and Technology Co. etc.[58]. As Chinese customers have built up own capabilities, some foreign control system suppliers gradually focus on only supplying software for the wind turbine control system(s), instead of the hardware parts (Interviews).

Suffering from a short background in wind power

With such rapidly rising capabilities, the 'technology for market' policy has had its benefits. In regard to some of the most advanced areas of wind turbine development, such as blade design and control systems, the 5YP S&T Wind Power (2012*) argues that "[a]s regards blade design and control systems, China has achieved the basic level in indigenous design and the demonstration phase respectively" (5YP S&T Wind Power (2012*), 1, IV, 2(1b)).

[58] Corona is a spin-off company of the Chinese Academy of Sciences (CAS) involved in aerodynamics, research and design, as well as production; further, CAS has its own industrial chain for electrical control systems.

Further, China has already engaged in design and production of MW-scale wind turbines and offshore wind turbines (Lewis, 2013; Chen et al., 2014). These advances are remarkable, as most of China's WTMs and component suppliers did not engage in wind until after 2005. For instance, with more than 50 years in manufacturing in heavy-duty machinery and equipment (e.g. steam and hydro-turbine generators), the Central Government administered SOE Dongfang Electric (DEC), which is the largest steam turbine producers in China, only engaged in the wind power market in 2005, beginning cooperation with European turbine design companies (Korsnes, 2014: 191; Zhao et al., 2009). Also Chinese WTMs such as Sinovel, Mingyang, and Envision have only emerged since 2005 or later.

While China has indeed made rapid advances, many young WTMs still tend to suffer from technological limitations both in manufacturing and in innovation, however (Li, 2010: 1161; García, 2013: 138). In general, China lags behind in e.g. design of MW-scale wind turbines, key technical R&D of wind turbines, manufacturing technologies of key components, as well as in testing and certification, equipment system design, integrated technology, and R&D in and design of key parts (Zhao et al., 2012: 4249). Accordingly, China's 5YP S&T Wind Power (2012*) raises concern that China's advanced wind power equipment design and independent innovation capability need to be strengthened (5YP S&T Wind Power (2012*), 2, 1(1)). Other areas selected for improvement are e.g. the need to perfect basic data on wind resources and upgrading of key technologies, such as wind farm design, operation, and grid connection (5YP S&T Wind Power (2012*), 2, 1(2)). Amongst other things, the plan raises concern that China should improve its wind power standardisation, testing, and certification system (5YP S&T Wind Power (2012*), 2, 1(3)). Further, it argues for improved basic research in general within wind power in order to solve the issue of lacking independent innovation (5YP S&T Wind Power (2012*), 2, 1(4)). It is further mentioned that intelligent process manufacturing technologies and technologies of quality control are relatively weak. In the following, the chapter looks further into some of the implications of entering the field of wind power relatively late for Chinese upgrading. This is done by zooming in on a few advanced core components, which are construed as particularly critical to improving turbine quality.

Entering wind power in a phase of increased 'intelligence' demands

As indicated above, in spite of the rapid pace with which Chinese WTMs and component suppliers have upgraded within a number of wind power-related fields, most of them are still lagging behind their Western counterparts in terms of the most advanced designs and core technologies. This issue of lagging behind within core technologies tends to be exacerbated by the pressure for developing increasingly larger, advanced, and ‘intelligent’ wind turbines. Today, wind turbines are increasing in scale (MW) in order to extract more energy from the wind, with the largest models producing around 7.5 MW (Knight, 2010 in Garud and Karnøe, 2003). Yet, such larger designs require more robust turbine performance design and component production, e.g. as the rotor blade diameter increases (Garud and Karnøe, 2003). As a system for extracting kinetic energy from the wind and converting it into electricity, a wind turbine is a complex wind energy conversion system. This integrated system consists of myriads of subsystems and hundreds or even thousands of components, with the main components being blades, gearbox, tower, brake, generator, principal axis engine casing, bearing, yaw, and (electrical or hydraulic) control system (Zhao et al., 2012b: 429; Li, 2010; Interviews). The wind turbine nacelle houses all of the generating components in a wind turbine (i.e. generator, gearbox[59], drive train, and brake assembly). Overall,

”a turbine is not...it's a quite complicated machine, right, compared to what is seen from the outside. There are a lot of components, hardware, and also the software components, that control, manage, and monitor the turbine itself” (Int. 34).

With myriads of components, a wind turbine requires interdisciplinary skills, e.g. within civil engineering, mechanics (e.g. gears), electronics (e.g. generators), wind site mapping, hydraulics, advanced materials, or aerodynamics (blades) (Li, 2010: 1164; Garud and Karnøe, 2003). In turn, this implies a need for a tight interconnection and collaboration between turbine design, manufacturing, installation and operation and maintenance (Li, 2010: 1161). Whereas wind turbines previously were less ’intelligent’, wind turbines have now become high-tech assemblages of customised components (Garud and Karnøe, 2003). With increased penetration of wind into the power grid, modern wind turbines require a high degree of intelligence, not only to find ’smart’ ways to reduce cost of energy and increase the capacity factor, but also to make wind turbines more ’controllable’ and ‘grid-friendly’, and generally making wind farms more comparable to conventional power plants, which is crucial for the diffusion and deployment of wind energy (Int. 18, 2013). This requires that a great deal of knowledge is built into the increasingly computerised wind turbines, e.g. integrating knowledge into the blades through sensors and prediction tools, as also touched upon briefly above. Whereas early entrants such as Denmark could start with small-scale experiments for less advanced wind turbines (Garud and Karnøe, 2003), Chinese WTMs are

[59] Whereas most modern wind turbines contain a brake, a number of China’s WTMs (in particular Goldwind) have based their wind turbine design (Aerodyn design license) on a gearless design, i.e. a so-called direct drive.

facing new demands and pressures, as they enter the wind power industry in a phase of high technological and scientific complexity.

Critical core components for raising the quality of wind turbines

Evidently, all components within a wind turbine are crucial to its proper and optimal performance. That is, there are many aspects of the wind turbine system and its structural design that must be considered and carefully optimised before wind energy can be produced at a cost competitive price. Amongst other things, these include turbine siting, installation and foundations, manufacturing processes, design, operating and maintenance costs, and turbine payback periods (Interviews). In this way, ”a lot of things are important; that is, [for instance] the control system doesn't make any critical difference, if you are not capable of producing a wind turbine which does not fall apart” (Int. 20, 2013). Nevertheless, some components are generally considered more ‘critical’ than others, in terms of raising quality as regards improved performance and a stable output. In the following, the chapter inquires into the role of the control system for raising quality and for stabilising a framing of wind power as technically and economically sustainable.

The ‘master’ and his ‘slaves’ – on control systems

Amongst its multiple components, a wind turbine contains different control system technologies with responsibility for controlling a specific system and/or component of the wind turbine. These distributed/decentralised control systems (‘sub-controls’) control – i.e., monitor and regulate – different components of the wind turbine. A critical sub-control system is found in the pitch control, which enables the pitching of the blades according to shifting speeds and directions of the wind. Above these decentralised sub-controls, the central main control, monitors and regulates the interplay of the various sub-controls. Since the main control contains the overall design principle of how the wind turbine and its components should be regulated, the main control is generally considered the most critical ‘core’ part of the wind turbine's different control system technologies, and also one of the most ‘core’ components of the wind turbine in general[60]. Overall,

”the main control has something to do with output, but it is also related to security. Because…the turbine – if some dangerous situation occurs, then the turbine's control system must react accordingly. Because, what's the thing about a turbine, that's…if you just let it spin freely when the wind blows – no turbine could ’survive’ that” (Int. 14, 2013).

[60] The specific design concept (‘regulation strategy’) of the wind turbine is i.a. dependent on whether it is a gearless/direct drive versus gear-based wind turbine, and whether it uses a hydraulic or electronic pitch.

One of the most critical functions of the main control is that is ensures the regulation of the pitch angle of the blades and the rotating speed of the generator, in addition to a number of other things, e.g. the yaw system, the start-up and closing down of the turbine, as well as turbine supervision and monitoring (Int. 35, 2013). In this way, "[e]verything in the turbine needs to be controlled by the main control system [as it] makes the mechanics work [together]" (Int. 2, 2012). As the centralised control, the main control receives information from the constituting distributed/decentralised control systems and sensors, communicating to different units through protocols, and in this way ensuring the proper exchange of information. That is, through the main control, the control system supplier or WTM "receives information from another unit and tells the other unit what to do" (Int. 2, 2012). Overall, the main control is framed as

"the top component of the [turbine's] intelligence, whereas the others [sub-controls] are the 'slaves'. We [the main control (supplier)] are the master" (Int. 2, 2012).

In turn, as indicated above, control system technologies contain both hardware and software parts. That is, the electronic and mechanical hardware parts (e.g. control cabinets such as industrial programmable logic controllers (PLCs), converters, switches, and sensors) ensure the mechanical and electronic functioning of the wind turbine. In turn, the control system contains myriads of software programmes, basically consisting of thousands of lines of algorithmic codes. In general, hardware is framed as relatively 'simple', while the software parts are qualified as 'key' and the most advanced parts. That is, "it is not the control cabinet…this is very standard…but it is the control software systems, which are core. […] Software is key!" (Int. 31, 2012).

Adding intelligence through software – framing software as 'core'

As displayed briefly in the above, wind turbine designs have become increasingly complex over time. This, amongst other things, involves more advanced control systems – and in particular of its software parts. Apart from control system software, software tools for turbine design, such as simulation tools which simulate the aerodynamic forces from the wind on the blades, are critical to raising wind turbine performance through optimised designs. Further, advanced wind farm control system software is critical to raising and controlling the output of wind farms. Apart from conventional supervisory, control, and data acquisition control systems (SCADA) for wind farm monitoring and control, which help diagnose technical issues and minimise maintenance costs in the wind farm (Int. 2, 2012), wind farm simulation and forecasting tools to avoid destabilisation of the grid have become increasingly critical along with the larger penetration of wind into grid systems. As wind turbines have become increasingly 'intelligent' or "computerised" (Lewis, 2013: 28), R&D for modern wind turbines is "focused on continued design improvements to increase the resilience and the efficiency of the turbines, as well as on improved power electronics that facilitate smoother integration with the power grid" (Lewis, 2013: 28). Overall, particular components such as software tools seem to be framed as 'critical' and 'core' to constitute wind power as a reliable power source, and thus not only for improving quality, but also for associating wind power with technical and economic sustainability.

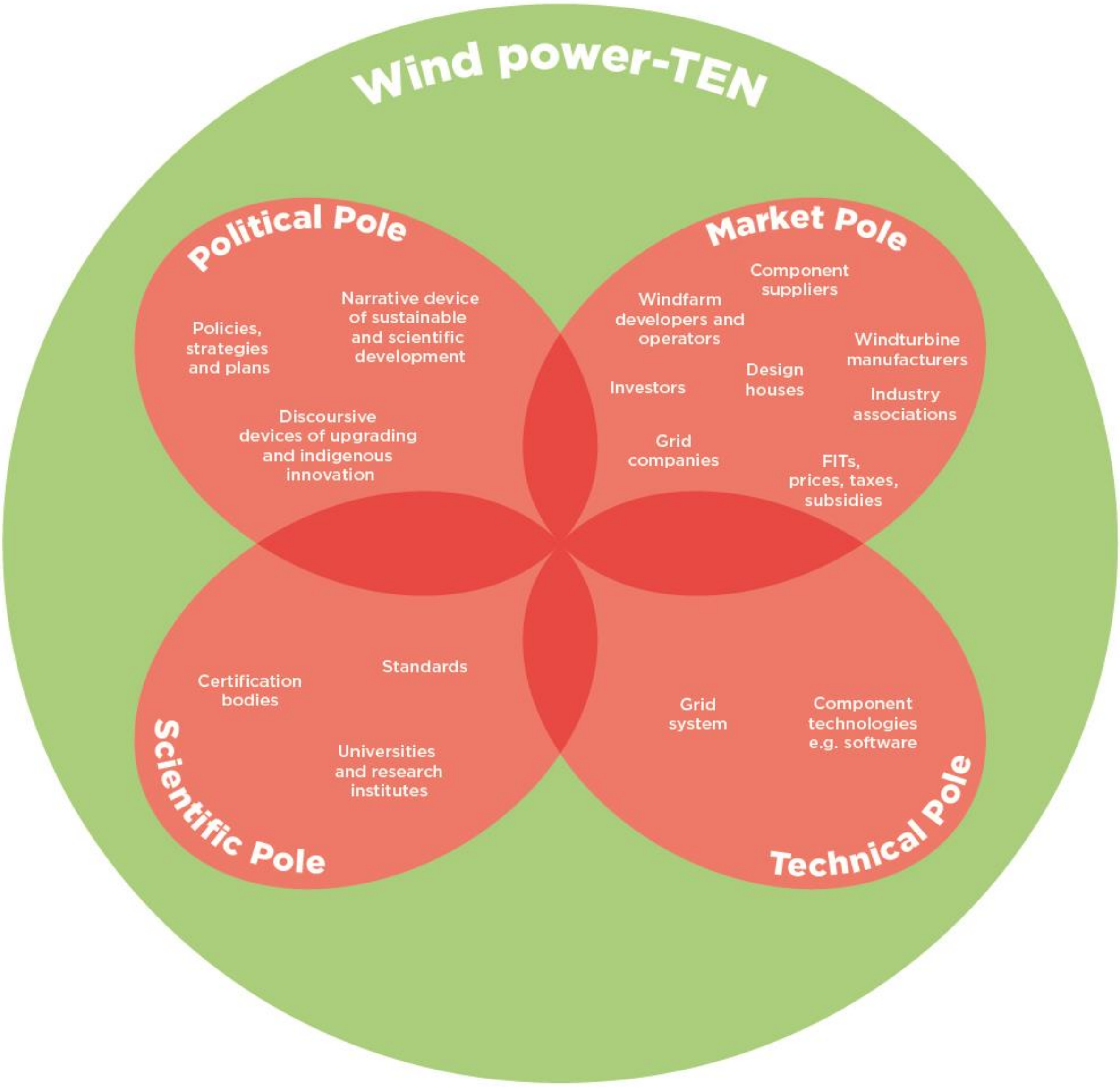
A potential transition towards quality – and the need for 'catch-up' within software

It has been indicated above how China still lags behind in particular within 'key components' for advanced wind turbine designs above the MW-scale (Li, 2010: 1161; Klagge et al., 2012). Additionally, although several Chinese WTMs increasingly claim their designs to be indigenously developed, according to foreign wind power experts (i.e. engineers and scientists), these designs often rely on foreign core components such as critical software tools. This makes a foreign expert claim that "there is still not one single, completely Chinese indigenous design" (Int. 36, 2013). While there may exist differing viewpoints on this issue, there is no doubt that Chinese wind turbine designs and control systems are generally framed as less advanced (and 'intelligent') by foreign experts, suppliers and WTMs. In this way, China is construed as 'lagging behind' in terms of all the 'soft areas', such as siting and design, intelligent forecasting systems, and control (Int. 1, 2013). A central matter of concern of the political pole is consequently that Chinese actors should upgrade within those core technologies and become independent from foreign technologies (MLP RE, 2007; 5YP S&T Wind Power (2012*); MLP S&T 2006-2020). Facing overflowing from poor quality turbines, the issue of upgrading within core components such as software tools – as well as independence from foreign technologies – seems critical to increasing the 'intelligence' of new large-scale turbines and to building associations of e.g. quality and sustainability in comprehensive terms to China's potential wind power-TEN. With the seeming 'turn to quality' in Chinese policies of the political pole within wind power, upgrading within specific components is still a growing concern.

Conclusion and theoretical considerations – a turn to quality in the wind power-TEN?

Together, *Chapters 6* and *7* have illustrated rapid emergence of a potential Chinese wind power-TEN and its following quality crisis, as well as pointed to a potential 'turn to quality'. Below, *figure 12* illustrates some of the different actors of the different emerging poles within the wind power-TEN.

Figure 12: Examples of actors in poles of emerging wind power-TEN



Source: Own design

While *Chapter 6* focused on the rapid growth in Chinese wind power, *Chapter 7* has focused on the potential 'turn to quality' evolving in the emerging wind power-TEN. To contain the overflowing of the emerging wind power-TEN, a variety of new means – policies, plans, standards, targets, and regulations – have been employed. This indicates that not only are the priorities of the Chinese leadership in transition, but also the means. Amongst other things, there are indications that the political pole seeks to spur quality, indirectly, by encouraging generated electricity (measured in GWh) rather than just installed capacity (GW). In turn, the issue of raising quality is framed as a matter of upgrading within core technologies, as well as a matter of enabling a transformation of China from a 'large' into a 'strong' wind power nation. In this way, the potential turn to quality is coupled with the concern for China's sustainable development through Scientific Development. Largely led by the political pole, the chapter has displayed how a potential market pole seems to be shifting its strategies, moving away from an exclusive focus on low prices towards higher focus on quality, e.g. through improving R&D capabilities. Indeed, winds of change, although ambiguous, have started to blow in the potentially emerging wind power-TEN. The chapter has also displayed how Chinese WTMs have upgraded rapidly within a variety of scientific and technological fields related to wind power. In particular, based on an assimilation-and-absorption strategy, a number of Chinese WTMs have engaged in collaborative relations in China and abroad with both domestic and foreign partners. Further, as Chinese actors have upgraded, relations between Chinese and foreign WTMs and component suppliers are being reconfigured, which e.g. involves increased mutual learning. While the potential wind power-TEN so far primarily has been illustrated through the rapid emergence of a market pole, mobilised through the interessement devices of the political pole, the increased focus on quality may induce an increased focus on the strengthening of the scientific and technical poles, which can be translated into the potentially emerging wind power-TEN.

When it comes to components framed as 'core' and thus critical for raising the quality and 'intelligence' of wind power, such as advanced software tools, Chinese actors are still seen as lagging behind, however. Thus, the political pole has begun to problematise the need for actors to assemble into scientific and technical poles, which may solve the quality issues. Entangled in increasing demands for 'intelligent' turbines and an ongoing quality crisis, core technologies (e.g. software programmes) are increasingly being constituted as critical for the requalification of wind power as sustainable and for aligning the potential wind power-TEN with the overall framing of Scientific Development. Having indicated how certain components of today's complex and highly computerised wind turbines are being constituted as critical, particularly software tools, for the qualification of wind power as sustainable, ***Chapter 8*** inquires into the potential emergence of a software-TEN in Chinese wind power.

Chapter 8. Emergence of a Software-TEN?

Later, I recall another talk I have had earlier with an industry expert on the case of China and wind power. According to him, the development of China's market is a matter of foresight:

"What is characteristic about China is that they always have some hidden plan. Nothing comes as a surprise for them. They have this idea about where they want to go, and they see everything in that light. And that's why they began with joint ventures…they want to let someone in who doesn't run away with everything, but where some knowledge is transferred […] It's about technology, it's also about management and know-how etc., and that's how they started out […] It's learning and know-how and technology transfer and experimentation with some economic model compared to what they had before. That's simply…they have had this perspective the entire time".

Pondering this hidden plan of China, I wonder how China's catch-up strategy will play out within core technologies, such as software, in the current qualification struggle that faces China's wind power market.

Qualifying wind power as sustainable through software?

The two previous *Chapters* 6 *and 7* have illustrated the rapid increase in installed capacity of wind power in China, the overflowing quality issues from the focus on manufacturing scale-up, as well as the potential 'turn to quality' in the potentially emerging wind power-TEN in China. Further, it has been depicted how China has upgraded within a host of wind turbine components, yet, still lags behind in terms of more advanced software programmes. These software tools are 'core' to the qualification of wind power as 'intelligent', which can align wind power with the doctrine of China's Scientific and Sustainable Development.

To inquire further into the potential quality turn in the emerging wind power-TEN, *Chapter 8* zooms in on the critical component of software and its role in framing the potentially emerging wind power-TEN as sustainable. Depicting how a potential software-TEN is being constructed, the chapter begins by outlining the role of different critical software tools for framing wind power as sustainable. Next, the chapter depicts the matter of concern for the Chinese political leadership to ensure the establishment of indigenous innovation capabilities within core technologies such as advanced and 'intelligent' software tools to qualify wind power as sustainable. This leads on to a mapping of different poles in a potentially emerging software-TEN. The chapter concludes by illustrating how relations between foreign suppliers and Chinese WTMs are being de- and reconfigured and negotiated, as roles and positions are contested when Chinese actors have improved capabilities. In this way, the emergence of a ’competitive catch-up game’ is being illustrated. In this catch-up game, concerns – and potential controversies – on issues of intellectual property right(s) (IPRs) and standardisation related to core software algorithms, are indicated in the configuration of the potential software-TEN.

The role of software tools for framing wind power as sustainable

In the following section, the chapter outlines how different software tools are construed as ’core’ to the technical and economic performance of wind power.

Framing the main control as the wind turbine’s brain – and the main control core algorithm as spine

First, communicating with the various different sub-control systems, the wind turbine’s main control is critical to the functioning of the wind turbine:

”It is known as the king of the wind turbine. Because it is very…the nerve centre. The other parts are all some of the hardware parts, but in regard to the extent of the entire turbine’s intelligence, or the size of its power output, this depends on the big brain. And we are the suppliers of the big brain” (Int. 2, 2013).*

The main control system’s software contains thousands of lines of algorithmic codes, so-called source codes. Moving all the way down through the different layers of source code, *“*you get down to the bottom where the core algorithm [of the main control] is, [which] connects all the information of the different parts*”* (Int. 2, 2012), e.g. containing the pitch regulation strategy and the regulation strategy for how the turbine should react when the frequency of the grid suddenly changes (Int., 2, 2012; Int. 15, 2012). The main control’s core algorithm is hereby framed as “the spine in the system*”* (Int. 2, 2012). Additionally, *“*on top of that source code we have something called the pitch algorithm, which controls the blades”, together with a range of other algorithms for different functions/components (Int. 2, 2012). Overall, ensuring the interplay of different components, the main control is being framed as a critical core component. In particular, the core algorithm of the main control’s software is being constituted as ‘critical’ to wind turbine performance.

The ‘critical’ quality of the main control is related to the way in which the main control system contains the principles of the wind turbine regulation. Previously, the dominant wind turbine design was stall-regulated, while today’s advanced wind turbines tend to be pitch-regulated. Compared to the stall-regulated turbine design, which was marked by constant speed and involved higher loads on the tower and blades from the forces of the wind, pitch-regulated wind turbines can through smarter design[61], e.g. longer and thinner blades and pitching of blades to obtain the optimal effect from the wind, reduce the cost of energy, and reduce the load on the turbine. While optimisation of the pitch-regulated wind turbine can lower the cost of energy, developing a control system for pitch-regulated turbines is relatively complicated. As an integrated system, the regulation strategy of the main control must be prepared for a number of different abnormal situations in the environment, e.g. typhoons and other extreme climatic conditions, to ensure stable functioning of the wind turbine:

”Because the wind turbine is closely related to the external environment, to the wind. But if the wind constantly changes, then the wind turbine must adjust to this new status of the different external environmental conditions. In this way […] it must have a control system inside, which can adjust and protect, making it more reliable and ensuring its safety” (Int. 37, 2013).*

In this way, the functioning of the different control system technologies and sensors are important to the functioning of the turbine, because if:

”you don’t trust in the sensors, if you don’t trust in the measurements, and don’t trust whether the pitch-control works as it should, then you have to close it [the turbine] down, and a lot of different things…like…to make sure that things don’t get out of control because something is wrong, which the main control did not capture properly. So there has to be a number of different layers catching these issues” (Int. 35, 2013).

Not only is the main control/regulation critical to the performance of wind turbines, but also some of the subsystems, in particular the pitch control, are critical to wind turbine performance. As expressed by a foreign control system supplier, ”they [the Chinese WTM/the customer] don’t want to tell us what happened [when the turbine collapsed]. But we know very well what can make a turbine collapse…that’s the pitch system” (Int. 9, 2012). Hereby, poor quality of control systems in wind turbines – and in their software – can lead to damages as well as unstable output, which results in the destabilisation of the grid.

Simulation programmes for wind turbine design

Second, related to the issue of the reliability and performance of wind turbines are also software programmes used in simulation tools, when new or modified advanced wind

[61] In regard to the pitch control of the blades, there exist two types of blade regulation, namely a design based on an electric pitch control regulation and one based on a hydraulic pitch regulation. Depending on whether the blade/pitch regulation is electric or hydraulic, the flow of the main control system will differ (Interviews).

turbine and blade designs are to be tested and certified. The simulation tool, consisting basically of ”computational calculations telling you how to simulate a turbine” (Int. 14, 2013), must contain the main control's core algorithm, which reflects the turbine's overall “regulation principle”, e.g. how to regulate the blade (Int. 14, 2013).

”When you calculate [simulate] the turbine, then…how you regulate the turbine, that is part of the overall modelling of the turbine, right. Modelling…when you develop the simulation [tool], right, then you must describe the [regulation of the] turbine” (Int. 14, 2013).

That is, the simulation tool must e.g. ”know how to pitch the blades [e.g. to reduce the load on the blades from the forces of the wind], how much to turn up or down for the generator. And for this we have the control system, whereas [the simulation tool] is just simulating the model of the turbine” (Int. 38, 2013). The core algorithm of the simulation tool is an aeroelastic code for the modelling of the pitching of the blade, ensuring the optimal relation between the aerodynamic forces and mechanical loads on the blades (Int. 14, 2013*;* Int. 32, 2012). Modern, advanced wind turbine designs involve highly complex aeroelastic design of the blades. For instance, as blade structures have become more elastic with flexible fibre structures, the influence on the aerodynamic forces and loads on the blade, when blades are pitched, have become more complex.

Overall, as simulation tools are needed in order to certify and document new wind turbine designs and assist in the development of ‘elegant’ high-performing structural designs, they are critical in terms of reducing the cost of energy of wind power. That is, ”all this is in the end measured through cost of energy. How many kroner [DKK] does it cost. How much does it cost to produce one kilowatt hour produced by this turbine” (Int. 38, 2013). In this way, simulation tools are important calculative devices, employed to optimise and ’prove’ the performance of wind power, and thus also potentially to ascribe associations of technical and economic sustainability to wind power.

Predicting and controlling wind farm output and grid connection

Third, apart from being critical to wind turbine performance and optimal design, software tools also play a critical role in wind farm control and grid connection (Int. 2, 2012). That is, “you have a whole range of controls, all the way out to [the consumer]…it's not only in the wind farms…and we don't even talk about wind farms anymore – now they are ‘power plants'. And internally in this power plant, and internally in the main turbine [the wind turbine, which collects data from all other wind turbines in the wind farm], and internally in the yaw, you find control systems” (Int. 2, 2012). With higher wind power penetration ratios, high quality wind farm controls have become more important to improve grid connection, and was introduced as a new requirement by the Chinese Government in 2011. In this way, grid companies can

”send you [the wind farm] a Megawatt target, and you need to control your whole wind farm to meet that requirement, so those are [some of] the examples of what they [the Chinese Government] came up with as requirements to all the wind farms, before they [wind farms] can in fact integrate with the grid” (Int. 34, 2012).

Through advanced park power control systems, for instance, the wind farm operator can adjust the output up and down, as needed, and as requested from the grid operator. This makes the wind farm operate as an integrated utility, and

*“heigthens the quality of the produced electricity in every single park…it becomes much, much higher, and grid compliance of course becomes much, much better” (Int. 2, 2012)**.***

Other systems, such as SCADA systems and their condition monitoring systems, can help identify problems in the wind farm, by sending

”warnings coming from the equipment, and we are going to display them on the computer screen, so that the operation people [the wind farm operators] can see if something is going wrong…then they need to take action, or they need to schedule, you know, maintenance, or checking, or things like that. So that's the foundation of the, from the IT-side, about running a wind farm” (Int. 34, 2012).

To be able to control the output from the wind farm, advanced forecasting tools and other advanced tools are also increasingly needed, as the share of wind power into the grid has become larger. That is, in order to schedule the operational work of the wind farm and the routine maintenance of the equipment,

“one must know as much as possible about the wind for the next 24 hours, or even after the next 10 minutes. The forecasting is critical for the grid to manage the integration of the wind farms to the power system, as they need to allocate power generation based on the load, at different times of the day, and to do the allocation, they also need to know what kind of forecasting and how much you are going to produce, and whether the grid needs so much or not” (Int. 34, 2012).

These forecasting tools can help increase shares of wind power in the grid without destabilising it, since, sometimes, “you are not producing electricity...and sometimes very high, sometimes very low...but this also depends on the wind, the wind coming in” (Int. 27, 2012). Further, through advanced forecasting tools curtailment rates may be reduced, as it becomes possible for grid companies to adjust the power load in the grid in time, according to the forecasted wind power, by regulating conventional power plants and wind farms. Apart from reducing the amount of wasted, ‘overflowing’ wind power, forecasting tools can raise revenues of wind farm operators, as these are dependent on generated electricity. Overall, wind farm controls are critical to construe associations to wind power of predictability, reliability, and profitability. Hereby, by improving control and predicting the output of all wind turbines in the farm, which is crucial to the stability of the grid as well as to minimising curtailment and rising revenues, a variety of intelligent wind farm controls and predictive programmes – including their software algorithms – play a crucial role in qualifying wind power as economically and technically sustainable.

Constituting core technologies as a major political concern

Facing a 'quality crisis', which threatens the framing of wind power as a sustainable renewable energy power source, components such as software tools are being constituted as a critical qualifying means, or calculative framing tool, to stabilise wind power as sustainable. In the following section, the chapter dives further into how upgrading within core technologies is being constituted as a matter of concern for the political pole.

Upgrading within core technologies as matter of concern

In general, indigenous innovation capabilities within core technologies play a central role in China's catch-up and upgrading strategy. This was most explicitly outlined in China's MLP S&T (2006-2020). However, the concern over core technologies in the energy and the renewable energy sectors is also reflected in the Energy Policy 2012 and the MLP RE (2007), respectively. These two plans articulate concern that China is lagging behind in terms of science and technology and suffers from the dependence on foreign core technologies. Thus, a central goal in the Energy Policy 2012 is to advance indigenous innovation in key technologies and equipment (Energy Policy 2012, II. Policies and Goals of Energy Development). However, it was only with the 5YP S&T Wind Power (2012*) that a plan dedicated to the scientific development and development of core technologies, such as software tools within wind power, was issued, and where development of a number of carefully selected technologies and research areas were outlined in-depth. As previous plans, the 5YP S&T Wind Power (2012*) is concerned with how China is lagging behind in core technologies and in areas of basic research, such as software, aerodynamics, simulation tools, and advanced control systems. For instance, the plan emphasises how China lags behind in terms of independent research and development of advanced operational control (systems) and in regard to wind power prediction systems for wind farm operation and optimisation (5YP S&T Wind Power (2012*), 2, 1(2)).

Software as core technology – control system and simulation tools

In terms of modern large-capacity wind turbines, key technology directions in the 5YP S&T Wind Power (2012*) include i.a. turbine design, manufacturing, testing, certification, independent pitch, new transmission technologies, and advanced control systems (5YP S&T

Wind Power (2012*) 4, 2). In addition, the 5YP S&T Wind Power (2012*) articulates concern that China is lacking indigenous intellectual property in regard to software tools for wind turbine design (5YP S&T Wind Power (2012*), 1, IV, 2(1a)). The plan accordingly problematises how dependence on foreign design tools has been detrimental to China's capabilities in developing indigenous wind turbine design adapted to Chinese environmental conditions, and thus emphasises the need to reduce China's dependence on imports of foreign core technologies such as design tools. Overall, this reflects how software is positioned as a core technology for the sustainable development of wind power. The MLP S&T (2006-2020) already mentioned the role of software as central to China's upgrading; however, this is not being linked to wind power. In the case of the manufacturing sector, of which the wind power equipment industry forms part, the MLP S&T argues that China's manufacturing industry must be upgraded through IT and software, as well as through intelligent design approaches and technologies, computer-aided engineering analysis, and process design and integration technologies (MLP S&T (2006-2020), III, 4(27)). This reflects an overall concern for upgrading within IT and software to enable upgrading within China's manufacturing (MLP S&T III (2006-2020), 6(40, 42, 43). Accordingly, IT and software (termed the *'Information Industry and Modern Service Industry'*) are also categorised as a 'main area' for prioritised development, and the plan lists a number of IT and software related *'frontier technologies'* (MLP S&T (2006-2020), V, 2 (6, 7, 8)).

Algorithms, core mathematics, and aerodynamics as 'frontier' areas

To improve capabilities within software tools and indigenous design, the 5YP S&T Wind Power (2012*) outlines a number of basic research areas to be promoted. Since software is composed by thousands of lines of algorithmic codes, upgrading of software tools is closely related to basic research in algorithms and core mathematics, such as aerodynamics and aeroelasticity. For instance, aeroelastic codes within simulation tools require algorithmic codes based on in-depth basic research in aerodynamics, which demands high capabilities within mathematics. The need for general upgrading in algorithmic mathematics is already indicated in the MLP S&T (2006-2020), which mentions core mathematics and its application in cross-disciplines as one of a number of 'frontier scientific basic research issues' (MLP S&T (2006-2020) VI, 2(4)). It argues that to improve the scientific basis of the development of IT,

> *"[p]riorities will be given to studying new algorithms and basic software theory; mechanisms of virtual computation environment; theory and methods for mass information processing and knowledge mining; interactive theory; network security and credible and controllable information security theory" (MLP S&T (2006-2020) VI, 2(10)).*

Although not directly related to the wind power sector, a concern for cross-disciplinary excellence within mathematics and algorithmic codes for software programming is indicated, which is critical to developing and optimising software tools in the emerging wind power-TEN. With the 5YP S&T Wind Power (2012*), aerodynamics is mentioned directly as a central research area for wind power. That is, the 5YP S&T Wind Power (2012*) emphasises a number of areas for basic research, which e.g. include research in blade design and aerodynamics, including development of software simulation tools and testing equipment (5YP S&T Wind Power (2012*), 5(II,4)). According to the plan, China must foster indigenous capabilities in the development and application of technology for blade design. The plan emphasises wind turbine aerodynamics, theoretical modelling and simulation of wind turbines and key components, as well as wind power systems engineering theory to be the most critical basic research areas for wind power (5YP S&T Wind Power (2012*),4,1). Overall, a central concern of the political pole is i.a. the development of simulation tools and software tools, e.g. for aerodynamic simulation (5YP S&T Wind Power (2012*), 5, 2(4)).

Core technologies for large-scale wind farms and grid connection – forecasting systems

The 5YP S&T Wind Power (2012*) further highlights the need for research in control system technologies to ease grid integration of large-scale wind farms, without destabilising the grid (5YP S&T Wind Power (2012*), 5, 2(6)). That is, the plan is concerned with promoting basic research in the design, construction, and operation of large-scale wind farm development, which amongst other things requires development of wind farm design and optimisation, as well as software systems adapted to China's environmental conditions (5YP S&T Wind Power (2012*), 5(II,5)). Accordingly, the plan emphasises the urgent need for developing technologies and improving independent research in advanced operational control (systems) and wind power prediction systems for wind farm operation and optimisation (5YP S&T Wind Power (2012*), 2, 1(2)). Closely related to the issue of large-scale wind farms is the concern for grid connection. In this area, core technologies, such as wind farm power prediction research, active/reactive power control regulation, wind farm control strategy optimisation techniques, integrated power prediction, and LVRT key technologies, should be developed and improved to ensure stable and reliable interaction of large wind farms to the grid (5YP S&T Wind Power (2012*), 5 (II,5)).

Intellectual property rights and testing and certification technologies

Above, it has been illustrated how software tools are framed as critical to wind turbine performance, design, and to wind power integration, and to the development of indigenous innovation capabilities and the attempts at reducing dependence on foreign technologies. The 5YP S&T Wind Power (2012*) accordingly emphasises the issue of developing independent intellectual property rights (IPRs) in regards to wind power design tools and software systems, which are in accordance with China's environmental and topographic conditions (5YP S&T Wind Power, 2012*), 2, 2(3)). Lastly, core technologies for testing and certification, in particular for turbine and blade design as well as for large-scale wind farms, are mentioned as critical tools for the upgrading of China's potentially emerging wind power-TEN. In turn, improvements of China's standardisation system and its adaptation to local conditions hinges e.g. on improvement of certified wind power equipment software tools (5YP S&T Wind Power (2012*), 5, 5(2)).

Mobilising poles of a potentially emerging software-TEN

The previous *Chapters 6 and 7* have illustrated the rapid mobilisation of a potential wind power-TEN, in particular the rapid mobilisation (and overflowing) of a market pole by the political pole. In turn, *Chapter 8* has illustrated how the political is positioning itself as translator-spokesperson on behalf of potentially emerging scientific and technical poles as well, e.g. by enlisting frontier technologies and scientific areas for basic research. Further, it is displayed how the political pole is problematising the need to establish a software-TEN within wind power, which can help qualify the potentially emerging wind power-TEN as economically, technically, and scientifically sustainable. That is, with an overarching goal of China's Sustainable Development through Scientific Development, the 'core technology' of software (and a potential software-TEN) is being constituted as a critical means to potentially frame the emerging and overflowing wind power-TEN as sustainable. In the following, the chapter inquires into how poles of a potential software-TEN may be enrolled.

Core technology collaboration and the sustained, stable growth of the wind power-TEN

Apart from framing specific technologies such as software as 'core' to the stabilisation of wind power's overflowing framing, the political pole also articulates concern for the construction of collaborations on software technologies. While the MLP S&T (2006-2020) and the MLP RE (2007) have already highlighted the need for such collaborations, the 5YP S&T Wind Power (2012*) links the issue of such collaborations directly to the 'sustainable development' of wind power. That is, to ameliorate some of the challenges and areas of backwardness of China's potential wind power-TEN, the 5YP S&T Wind Power (2012*) encourages the deepening of targeted joint development or cooperative research and development with foreign international organisations, research institutions, as well as technical cooperation with enterprises. In particular, collaborations on e.g. wind turbine design and manufacturing, design and operation of wind farms, and on wind power grid access technologies is emphasised (5YP S&T Wind Power (2012*), 5(VII, 2)). In terms of international S&T cooperation, the plan highlights specific basic research areas for encouraged international S&T cooperation, e.g. within wind resource assessment (5YP S&T Wind Power (2012*), 5(VII, 1)). In addition, in terms of interdisciplinary collaboration in areas where China is lagging behind, the plan promotes collaboration between science and the manufacturing industry of key components. That is, in order to achieve technological breakthroughs and synergies between industry, academia, and research, the plan encourages cross-disciplinary research within advanced software tools for wind turbine and blade modelling and simulation, for wind farm design, and for grid connection (5YP S&T Wind Power (2012*), 2, 2(3)).

In this way, the 5YP S&T Wind Power (2012*) is employed as an interessement device to motivate interested parties to engage in collaborations on core technologies such as software. In addition, the plan frames cross-disciplinary collaboration as a key means for optimisation and development of independent design, and "overall help to protect the sustained, rapid and steady growth of China's wind power industry" (5YP S&T Wind Power (2012*), 2, 2(3)). Hereby, optimisation and independent design of China's equipment manufacturing as well as cross-disciplinary – and potentially international – collaborations are being linked to the sustainable development and scientific development of China's potential wind power-TEN. Hereby, while mobilising technical and scientific poles in the emerging wind power-TEN, the political pole at the same time attempts to institute itself as translator-spokesperson of a potential software-TEN.

Nascent scientific and technical poles of an emerging software-TEN?

In regard to control system software, large foreign WTMs like the Danish WTM Vestas and foreign control system suppliers have had decades to develop and optimise their software systems[62], main controls, and control algorithms. In contrast, most Chinese WTMs have emerged by basing their wind turbines on mature foreign design licenses, and have often based their control systems on relatively mature control system technologies (hardware and software) acquired from foreign suppliers. Increasingly, however, Chinese control system suppliers have emerged, as have Chinese research institutions with capabilities in the field of control software. For instance, the Chinese Academy of Sciences (CAS) and the Chinese

[62] Several of the foreign control system suppliers have only recently entered the wind power business from other businesses such as the marine industry, however.

Academy of Science and Technology for Development (CASTED) conduct research in control systems. CAS has a spin-off producing electrical control systems and is engaged in collaboration with Chinese WTMs, who often buy control systems (co-)developed by CAS.

In addition, in regard to both control system and simulation software, China is witnessing the emergence of a comprehensive testing, certification, and standardisation system. This is e.g. seen in the work of China General Certification (CGC) and China Electrical Power Research Institute (CEPRI) of the State Grid. CEPRI conducts research on a number of software tools and grid codes in regard to grid connection. For instance, research is conducted in regard to generation, grid connection, prediction, and dispatch and operation for renewable energy (Interviews). Further, the CGC is involved in the development of indigenous simulation tools, which are important for the certification of new wind turbine designs (Interviews). In the process of building capabilities within software in Chinese wind power, myriads of international collaborations have emerged over time as well (Interviews). Amongst other collaborations on certification and standardisation, collaborative research activities have been established between CEPRI, CGC, and CAS. Further, as regards grid connection, i.a. the Technical University of Denmark/Risø (DTU) has for many years collaborated with and assisted CEPRI in developing the Chinese grid codes (e.g. the low-voltage-ride-through (LVRT) standard), i.a. by offering courses and technical assistance (Int. 20, 2013; Int. 37*, 2013). CEPRI and CGC have also been involved in collaborations under the Sino-Danish Wind Energy Development programme (WED) as well as under the World Bank CRESP programme (Int. 14, 2014; Int. 20, 2013; Int. 37*, 2013; Int. 19*, 2013; Int. 21*, 2013). In addition, certification companies such as DNV GL and foreign design companies have offered technical assistance and training to Chinese actors i.a. in regard to software.

Increased acknowledgement of the need for advanced control systems

Above it has been illustrated how concerns on quality issues and the proposed means of core technologies such as software to contain the overflowing are translated into nascent scientific, technical, and market poles of a potential software-TEN within Chinese wind power. Still lagging behind in the most advanced control system technologies, and increasingly recognising their importance for quality, trans-national customer-supplier relations on control system technologies have become increasingly critical in the qualification of Chinese wind power as sustainable. Thus, in the explosive growth phase of China’s potential wind power-TEN, Chinese WTMs tended not to pay much attention to control systems. While foreign design licenses have required that Chinese customers buy specific foreign control systems, Chinese customers have been focused on getting independent from such foreign and often more expensive control systems as soon as possible (Int. 15, 2012)[63]. With lack of experience of Chinese control system suppliers, this has however had detrimental to the quality of Chinese wind turbines:

"Well, overall they need some proper control systems, right. Regulation systems. But, overall, they are way too simple. And they have been built on a philosophy of being cheaper" (Int. 18, 2013).

As priorities are shifting from low prices to quality in the ongoing (potential) 'turn to quality' in China's wind power-TEN, Chinese WTMs have gradually acknowledged the complexity of wind turbine technologies, realising the need for strong and advanced control systems:

"The Chinese very much looked at wind turbines as some simple technology, so they were surprised at how complex it is, and how wrong it can go. The control systems are central in this, but this only dawned on them very late" (Int. 24, 2013).

A change in attitude towards the importance of control systems can hereby be noticed amongst Chinese actors in the wind power-TEN. For instance, Chinese investors in wind farms sometimes "actually require that some key components are foreign, e.g. control systems, converters, bearings" (Int. 39, 2011) due to the higher stability of foreign components (Int., 1, 2013).

Increased demand for retrofit – an emerging market pole for software

Over time, an increased demand for advanced quality control systems can be noticed as the emerging wind power-TEN is facing a quality crisis. This can e.g. be seen in the increased demand for retrofitting of wind turbines, which means that already installed wind turbines are having their (failing) control systems changed. Thus, demand for advanced control technologies for grid compliance, park control, retrofit, and forecasting etc. has increased (Int. 34, 2012; Int. 2, 2012):

"Well, right now all forecasts are positive, very, very positive, and it's exactly going in the direction, which I had imaged…what we are to do now…we are to work on Smart Grid, park control, retrofit" (Int. 2, 2012).

This increased demand for retrofit is linked directly to the new concern for and mantra of quality in the industry:

[63] For instance, a variety of Chinese WTMs have based their wind turbine design on an Aerodyn design license, which has listed the Danish control system supplier Mita Teknik's electric control system as a mandatory component.

”This will be the market for the coming years. I’m sure they will continue focusing on it, but also that they will increase focus in order to…quality, quality, quality! There’s no point in constructing a new turbine, when you’ve got 10,000 out there, which are not working” (Int. 2, 2012).

As new policies on park control and new grid codes demanding i.a. LVRT technologies have been introduced, foreign control system suppliers are increasingly getting a more positive outlook on the Chinese wind power-TEN, after a number of challenging years in China:

”And we just have to be ahead, and we are. There are thousands, thousands of turbines, which we can do this with, take out the old control system and then install a park control system” (Int. 2, 2012).

While foreign control system suppliers frame themselves as being ‘ahead’, several Chinese WTMs and component suppliers have begun experimenting with developing their own indigenous software tools. As Chinese WTMs and control system suppliers are gradually building indigenous capabilities within control systems, demands by Chinese customers to foreign suppliers of control system technologies are changing. For instance, foreign control suppliers face increased pressure to supply increasingly better, smarter, and cheaper control systems, which are adjusted to the Chinese environmental conditions:

”Grid compliance, Smart Grid, park control, retrofit…and then of course still new control systems for new turbines…but it must be updated, and it has to be…it has to become smarter, and cheaper, and cheaper” (Int. 2, 2012).

”But then the market changes. Now it’s a question of giving them what they need and not…well, what they need at the present moment […] And that’s something new. That’s not, what we’ve got. We may have it in some sort of shape, but we need to adjust it. In order that it works out here” (Int. 15, 2012).

As Chinese actors are increasingly building their own capabilities, Chinese WTMs and control system developers and Western main control suppliers have started to compete. Increasingly, Western suppliers acknowledge that their present role in the Chinese wind turbine industry is going to change in the coming years, and that they risk losing their market share, if not consistently changing their technology platform:

”I don’t think that we have got a role…on our existing platform, we don’t have a role out here more than 10 more years. And that’s basically how it is, because we also have to develop and adjust, and we try to do that through our strategic collaborations. And then we have to make it so attractive for them to keep our system so that it can’t pay off to make their own. But of course they will try to anyhow. But if we don’t keep that in mind all the time, then we will lose…then we will lose the market at some point” (Int. 2, 2012).

While Chinese actors are indeed upgrading rapidly, “they have difficulties with that [the main control]. Because that’s where you have to have it all linked together. And you [they] don’t have any experience” (Int. 9, 2012). On the other hand, while the control system may still be an obstacle to upgrading, Chinese WTMs are in general convinced that ”we will catch-up, because we are integrating lessons from our global resources” (Int. 27, 2012):

“I am sure that this will happen, surely. In the not too far away future, Chinese companies will be able to...reach the level of European companies, and become stronger” (Int. 17, 2012).*

In the above, it is indicated how relations, positions, and roles of Chinese and Western actors are under negotiation, being increasingly contested. At the same time as Western actors are attempting to ’stay ahead’, ”you can sense that they [the Chinese WTMs] want a larger and larger slice of the pie” (Int. 15, 2012). Hereby, Western actors are acknowledging that they must “administer this [advantage] properly, right? In order that you can…also in the companies…there is no guarantee that a company just keeps on being ahead” (Int. 35, 2013).

An emerging competitive space

Having indicated the de- and reconfiguring of relations between Chinese and foreign actors, the last section of the chapter inquires into how a so-called ‘competitive space’ is emerging between Chinese and foreign actors in the potential software-TEN within Chinese wind power. This competitive space construes a boundary between developed and developing countries and technologies, and constitutes core algorithms as critical actors.

Competitiveness as a matter of core algorithms

In the competition on prices, Western wind turbines are more expensive in up-front investments. Yet, in the longer run, they are less expensive due to their long-term performance and lower cost of energy (Int. 35, 2013). Unable to *”*compete on prices*”* in terms of up-front investments, Western WTMs, suppliers, and research institutions thus emphasise the need to conduct basic research and R&D, constantly “generating new knowledge”, so they can constantly “stay some generations” ahead (Int. 35, 2013). That is, Western actors struggle to remain cheapest in terms of cost of energy through generating new knowledge on the continuous optimisation of wind turbine performance. This can i.a. be done through optimised control systems and simulation design tools. In contrast, Chinese actors are often framed as lagging behind, as they have not had a tradition of generating new knowledge themselves (Interviews). In this way, “the Vestas turbine will have beaten this [Chinese] one in terms of cost of energy. And then the Chinese are forced to buy licenses” (Int. 35, 2013).

Issue of Intellectual Property (Rights) and certification and standardisation

In the struggle to keep ahead and lower cost of energy, core algorithms in critical software tools are framed as the most critical. Thus, “there are two ways to differentiate your company and technology, that is, through the blades [implying aeroelastic codes in the blade simulation tools] and the main control algorithm” (Int. 22, 2012). While critical to wind turbine performance, core algorithms are the cornerstone of control system companies (Int. 2, 2012). As foreign main control system suppliers have longer experience and better expertise within main control software, they protect the core algorithms as much as possible. Indeed, this is

”simply a factor of competitiveness. Of course they [the Chinese] want this knowledge [on main control algorithms]. If they have a supplier, then they want to see how much they can get out of him of these things, and that’s because in the back of their mind they want to be able to produce it themselves, or to give it to another supplier who can do it cheaper. Well…a lot of people want our source codes for our programme [simulation tool]. But we don’t give it away” (Int. 35, 2013).

Hereby, the essential intellectual property (**IP**) contained in the core algorithms of the main control is being framed as critical to competitiveness. At the same time, this intellectual property is being ‘black-boxed’, as a matter of IP protection, sometimes through legal IPRs, and sometimes through other means. There is great concern amongst foreign actors, however, that Chinese actors will finally succeed in accessing these core algorithms from foreign suppliers: “If the Chinese companies ever gain access to the core algorithm”, ”and they are keen to do that” – at least “they are trying hard!”, then Chinese companies would be able to install the software on other controllers and systems. However, ”if they get there, then the race is over for the rest of us, I’m sure” (Int. 2, 2012). In addition to main control software, Chinese customers do not have access to aeroelastic codes of foreign simulation design tools, which are critical tools in the certification of new wind turbine designs. Largely reliant on foreign design tools, Chinese actors are struggling with understanding the underlying aerodynamic principles of the simulation tool, and thus for indigenously improving and certifying own wind turbine designs.

A competitive space entangled in a zero-sum game of catch-up

Overall, a competitive space around core technologies, in which algorithms are being positioned at the very centre, seems to be emerging. In this competitive space around core algorithms, concerns over IPRs and certification and standardisation are evolving in the emerging software-TEN. While foreign actors are afraid of losing their competitive advantage, Chinese actors are concerned with how traditional technology transfer may produce barriers to China’s development of indigenous innovation capabilities. This concern is also reflected in various Chinese policies and plans, which pinpoint that ”core technologies cannot be purchased” (MLP S&T (2006-2020)). This is explained at length in China’s MLP S&T (2006-2020):

”[O]ne should be clearly aware that importation of technology without emphasizing assimilation, absorption, and re-innovation is bound to weaken the nation’s indigenous R&D capability, which in turn widens the gap with world advanced levels. Facts have proved that, in areas critical to the national economy and security, core technologies cannot be purchased. If our country wants to take the initiative in the fierce international competition, it has to enhance its indigenous innovation capability, master core technologies in some critical areas, own proprietary intellectual property rights, and build a number of internationally competitive enterprises. In a word, the improvement of indigenous innovation capability must be made a national strategy that is implemented in all sectors, industries, and regions so as to drastically enhance the nation’s competitiveness” (MLP S&T 2006-2020, II,1).

Also the 5YP S&T Wind Power (2012*, 2,1) argues that ”compared with the international advanced level, there are still large gaps [between Chinese and foreign actors in the wind power sector]” (5YP S&T Wind Power (2012*), 2, 1). These concerns for owning core technologies are further reflected in President Xi Jinping’s speech on S&T in June 2014. Urging “Greater Innovation in ‘Core Technologies’, Xi Jinping argues that “Only if core technologies are in our own hands, can we truly hold the initiative in competition and development” (Sinosphere, Jun. 10, 2014). Construing core technologies as a matter of competitiveness and development, the speech refers back in time ”to China’s past as a victim of invasion and subjugation as a lesson in the price of scientific backwardness” (Sinosphere, Jun. 10, 2014). Emphasising, how “[w]e cannot always dress up other people’s yesterdays as our own tomorrows” (Sinosphere, 10 June 2014), Xi Jinping emphasises that “[s]cience and technology are the foundation of national strength and prosperity, and innovation is the soul of national advancement” (Sinosphere, Jun. 10, 2014). Hereby,

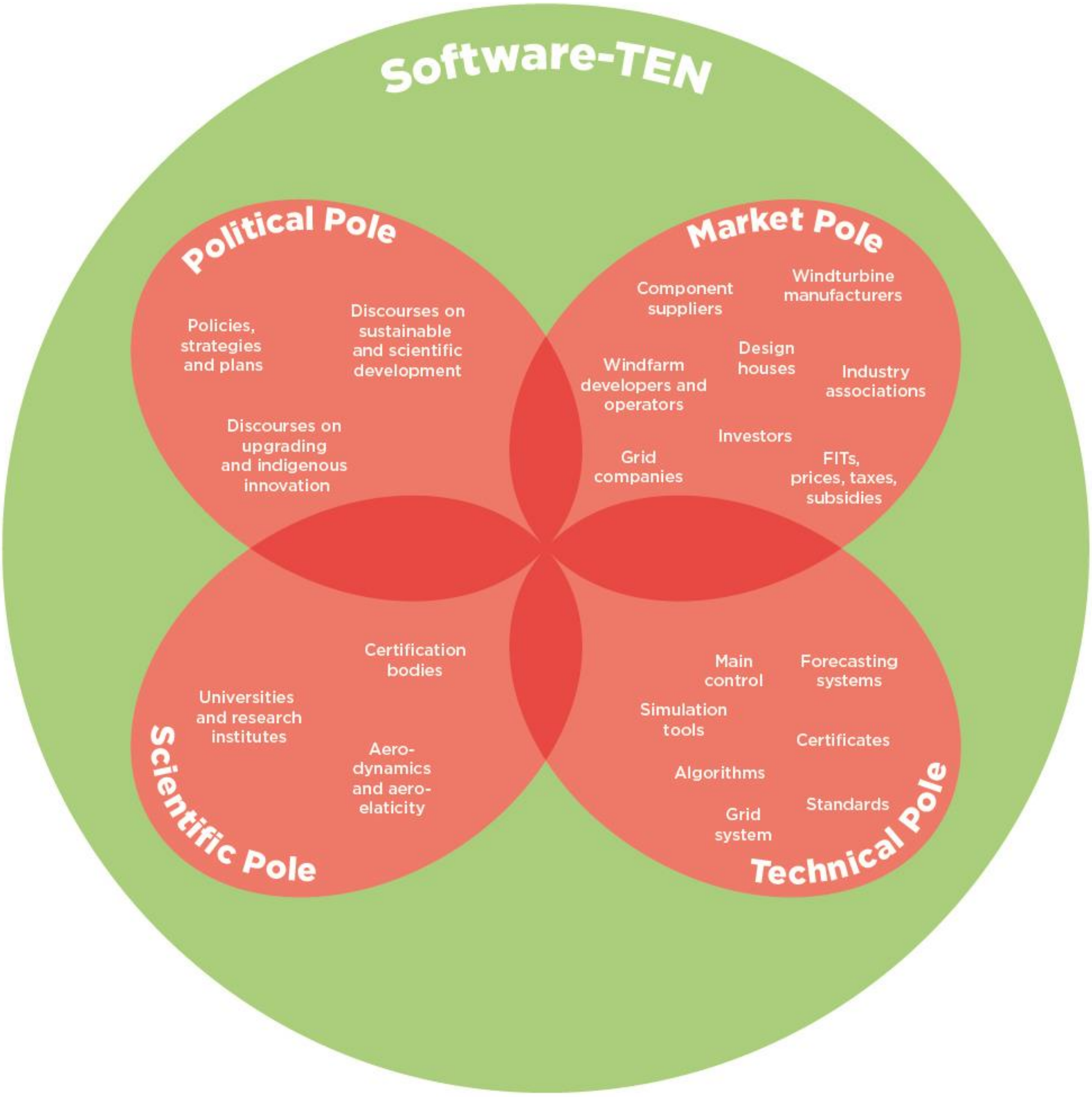
“[i]n a certain sense, scientific and technological strength determines changes in the world balance of political and economic power, and determines the fate of every nation” (Sinosphere, Jun. 10, 2014).

Going back and forth in time, and employing a comprehensive framework of discursive and narrative devices on China’s Scientific Development, science and technology is being framed as a critical means for China’s development, upgrading, and catch-up. As control of core technologies is framed as a matter of deciding “the global economic and political winners and losers of coming decades” (Sinosphere, 10 June 2014), the emerging ’competitive space’ within the software-TEN and wind power-TEN seems entangled in a zero-sum game of catch-up.

Conclusion and theoretical considerations – emergence of a software-TEN?

Chapter 8 has illustrated how a potential software-TEN is being assembled, constituted as a partial solution to the qualification of the emerging wind power-TEN as technically, economically, and scientifically sustainable. In *figure 13* below, some of the many actors in the potential software-TEN are shown.

Figure 13: Examples of actors in poles of emerging software-TEN



Source: Own design

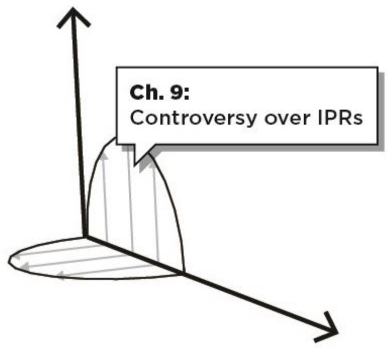
Construed as ‘core’ to improving the quality of wind turbines and minimising overflowing, in terms of i.a. curtailed wind power, software tools and their core algorithms have been constituted as particularly critical entities. That is, core algorithms are emerging as what may be termed an obligatory passage point for industrial upgrading and for catch-up, as they create passage (or not) for acquiring indigenous IPRs and international certification. Meanwhile, core algorithms in advanced software tools tend to be ‘black-boxed’ in collaborative relations between Chinese and foreign actors. These seemingly socio-technical barriers to accessing core algorithms can potentially threaten the framing of wind power as a means of China’s Scientific Development. With the conclusion of *Chapter 8*, the first three chapters of the analysis have provided a background for understanding the volatile development of the potentially emerging wind power-TEN, characterised by rapid growth in capacity installments, subsequent overflowing, and a potential shift from quantity to quality. Intent on rapid catch-up, and already having upgraded within numerous fields with tremendous pace, it has been shown how relations between Chinese and foreign actors are being reconfigured, as Chinese actors gradually increase their capabilities and fight against the framing as ‘laggards’. That is, framed as a catch-up country, a boundary has been construed between China as a newly industrialised country and Western developed countries, as well as between inferior and superior quality technologies. However, Chinese actors seem to refuse this framing, as they seek to “carve out for themselves a degree of autonomy from the network prescriptions” (Murdoch, 1998: 363).

Having provided an historical background for understanding the disruptive development of a Chinese wind power-TEN, along with the construction of a software-TEN, the analysis in the following dives into the mappings of the different controversies which unfold, as a qualification struggle takes place in Chinese wind power. Having illustrated the configuration of a competitive space taking shape around core algorithms, and how these produce concerns over IPRs and standardisation, *Chapters 9* and *10* zoom in on controversies over IPRs and certification and standardisation respectively, i.e. looking into the dynamics of the *pacification of goods*. These controversies are unfolding around core algorithms in critical software tools (the main controls and simulation tools) in the potentially emerging software-TEN within Chinese wind power.

Chapter 9. Controversy over Intellectual Property Rights in the Emerging Software-TEN

We meet in the middle of the Kingdom of Denmark, in an office at a train station, right in-between our respective residences, after we talked briefly over the phone yesterday. Pouring a cup of coffee, he starts explaining the development of the Chinese wind power industry:

Figure 14: Controversy over IPR



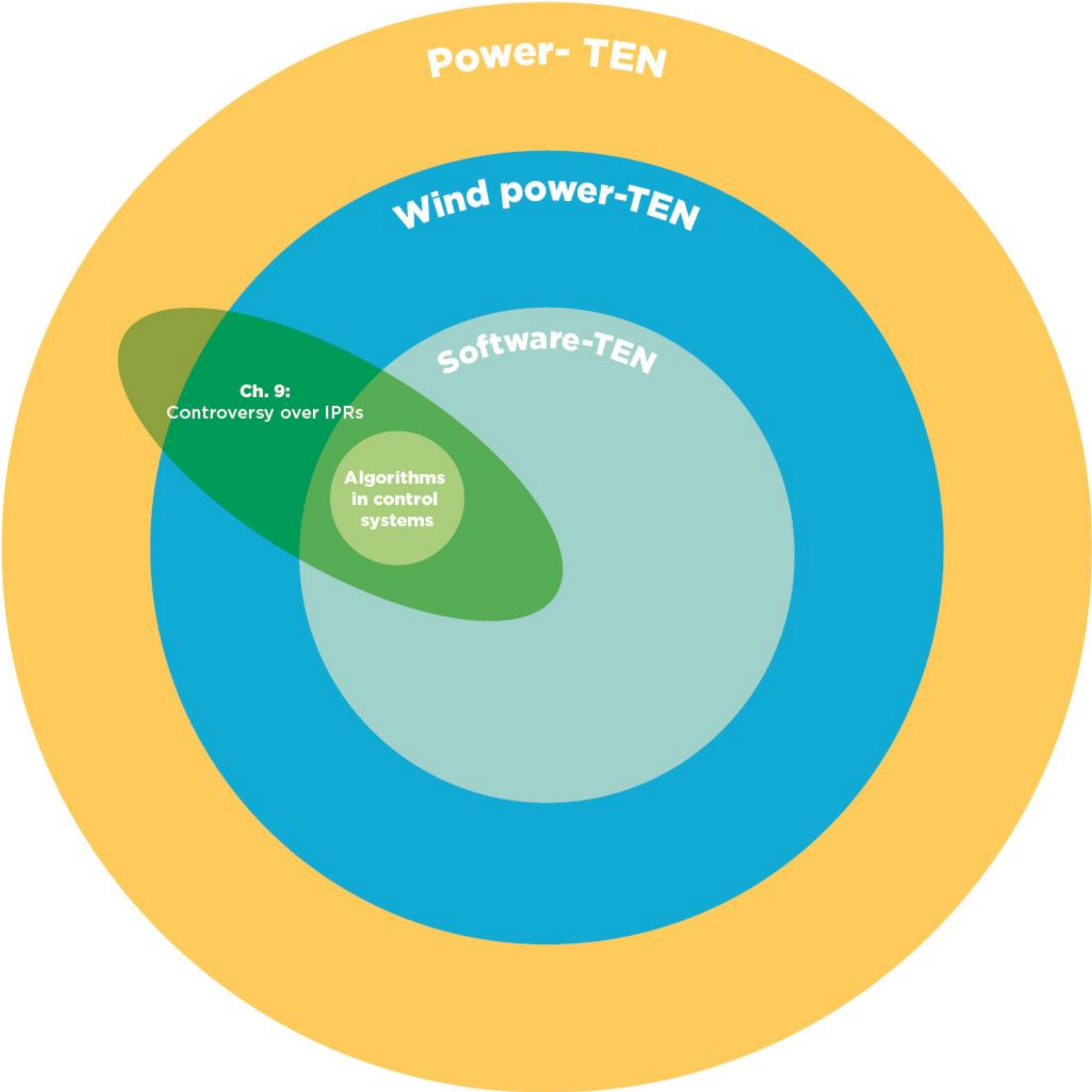
"As I see it, now the second phase is coming, now that they have realised that it was too poor quality…it was cheap, the prices have been pushed all the way to the bottom, which has harmed the Western manufacturers, because they couldn't sell their turbines. They had decided that the price level per kilowatt had to be this low. But nobody can sell a quality turbine at that price. And then around one and a half years ago, the government went in and changed their standpoint. 'Okay, now we have to recognise that they are not good enough. They are not as they are supposed to be, so we have to do…focus on quality'…And that's actually the situation that we are witnessing now. So, two things could happen now. The first thing is that you continue buying licenses in the West, and that you just continue looking at what the license tells you. The other thing could be that you start paying what it costs to produce a quality turbine… Eh, I don't know whether that's the way they are going. I'm not sure. Because the Chinese want to do it themselves, just as the Danes want to do it themselves. What I think will happen is that they will focus more on [research and] development [R&D]. They will focus more on innovation. They will focus more on leveraging knowledge. And start to understand what's going on. And start designing their own turbines. Personally, I think that's what will happen".

On the train on my way home, I wonder whether and how this potential transition from low price and high quantities to quality may create new complex dynamics in regard to issues of intellectual property rights (IPRs) in Sino-foreign collaborations around core technologies.

Concerns over IPRs to core algorithms

In the previous *Chapters 6-8*, the historical backdrop for understanding the current qualification struggle taking place in China's potentially emerging wind power-TEN has been rendered. To qualify wind power as economically, technologically, and scientifically sustainable, in alignment with the narrative of China's Sustainable and Scientific Development, the construction of a software-TEN has been constituted as critical. Having displayed the fragile framing of China's emerging wind power-TEN and the entangled construction of a potential software-TEN within wind power, *Chapter 9* conducts an 'algorithmic controversy-mapping', zooming in on the configuration of relations around control system software algorithms in the potential software-TEN. Below, this is indicated in *figure 15*.

Figure 15: Zooming in on controversy over IPRs



Source: Own design

Set into the context of China’s WTO accession in 2001 and China’s emphasis on IPRs in its innovation strategy, *Chapter 9* will in other words map an emerging controversy over IPRs, which configures around access to core algorithms in control systems. China’s emerging wind power-TEN has been founded on a ’trade market access for technology’/’technology for market’ policy (Lewis, 2013: 115; McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009). That is, ”[t]echnology transfer has always been the key priority in China’s wind energy sector”, e.g. by the use of license agreements and joint venture partnerships (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 33). Taking this into account, the analysis hereby narrows down the inquiry into the potential construction of a software-TEN to a particular part of the potentially emerging software-TEN within Chinese wind power, namely dynamics of customer-supplier relations between Chinese WTMs and foreign suppliers of control system software. Overall, the chapter hereby dives into dynamics of the *pacification of goods* in the marketisation of Chinese wind power, namely by looking into the employment of the framing tool of IPRs and the controversies it produces.

China’s accession to the World Trade Organisation (WTO) – and the role of IPRs

In the first part of the chapter, the analysis inquires into the conventional perspective on the role of IPRs in international trade and technology transfer, and China’s attempts at World Trade Organisation (WTO) compliance since its WTO accession in 2001. That is, China seems to “have come increasingly to the view that greater linkages to globalization processes through access to technology and information is critical for growth and that stronger IPRs can play an important role in providing that access” (Maskus, 2002: 146). This is e.g. reflected in China’s MLP S&T (2006-2020), which states that

”[p]rotecting intellectual property rights and safeguarding the interests of IPR owners is not only necessary for perfecting the nation’s market economy system and promoting indigenous innovation, but also important for establishing the nation’s credibility and image in international cooperation (MLP S&T, VIII, 4).

When it comes to wind power (and software tools), the 5YP S&T Wind Power (2012*) also emphasises the importance of a stronger IPR system for the sustainable development of Chinese wind power (5YP S&T Wind Power, 2012*, 5, 7 (4(6)).

The role of IPRs for international trade and innovation

Internationally recognised standards and regulations on the protection of IPRs (namely patents, copyrights, trademarks, and trade secrets) are generally considered to play a critical role for encouraging foreign direct investment (FDI) and technology transfer (Maskus, 2002). That is, IPRs such as patents serve to protect technological inventions[64] by giving exclusive rights to the inventor of the invention. In this way, a patent for technological inventions functions as a 'limited monopoly', which is granted by a national government to patent holders on their inventive ideas, and typically lasts for 20 years (Kaya, 2007: 45, 51). In addition to patents, copyrights serve to protect original[65] works (fixed in a tangible medium of expression), such as novels, films, and computer programs, by preventing people from copying or commercially exploiting them without the copyright owner's permission (Kaya, 2007: 49). Consequently, firms that hold IPRs, and which consider to invest i.a. in an R&D facility abroad, will have to pay attention to IPRs in the respective country, to ensure that its IPRs will be protected (Mansfield, 1994, 1995 in Maskus, 2002).

Due to the limited monopoly right that IPRs grant to inventors, IPRs are furthermore conventionally perceived to encourage technology transfer. That is, the patent owner can *license* the patent through patent licensing agreements, which are contracts in which the patent owner (the licensor) agrees to grant the licensee the right to make, use, sell, and/or import the claimed invention, in return for a royalty or other compensation (Kaya, 2007: 44). In addition to furthering international trade and technology transfer, IPRs are generally perceived to further investments in R&D and innovation, since the inventor's guarantee of a monopoly right to the idea of the invention for a certain period secure compensation for his/her investment in R&D, as IPRs minimise the risk of immediate copying by others (Maskus, 2002: 144; Liebeskind, 1996, 1997 in Spencer, 2003: 217; Kaya, 2007: 64). That is, IPRs (e.g. by filing a patent) serve to ensure a return on investment and recouping of development costs (Kaya, 2007). This rationale is also seen in the Chinese wind turbine industry:

"To me, patents are a complete pain...but to me, they are almost mandatory to innovation, because otherwise you have no business reason to innovate, because someone could just take it from you" (Int. 11, 2012).

Acknowledging the critical role of IPRs in furthering international trade, IPRs were already introduced into the WTO in 1995 with the signing of the *Agreement on Trade-Related Aspects of Intellectual Property Rights* (TRIPS)[66]. By then, "[intellectual property rights]

[64] as well as utility models and industrial designs
[65] Copyrights work by granting the creator of an original work the exclusive rights to its use and distribution, and they last during the creator's lifetime and a minimum of 50 years after his/her death (Kaya, 2007: 44, 50).
[66] At that time (1994), negotiations took place within the framework of the General Agreement on Tariffs and Trade (GATT). In 1995, GATT was reorganised into today's World Trade Organization (WTO).

became, on the part of WTO member states, obligations of commercial policy that cannot be escaped" (Maskus, 2002: 135). Setting minimum standards for different forms of IPR regulation in WTO countries, the TRIPS introduced a new standard for IPR protection in international business (Yang and Clarke, 2005: 549).

Lax Chinese IPR enforcement – the case of wind power and software

After 15 years of negotiations, China entered the WTO in 2001 (Yang and Clarke, 2005; McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009; Wang, 2004: 258). According to the TRIPS Agreement, any developing country compliant to the TRIPS Agreement must introduce and enforce IP protection of the same standard as developed countries within a period of five years following the accession (Zheng, 1996 in Bosworth and Yang, 2000: 461). Working consistently on building an IPR system in accordance with the TRIPS agreement (Yang and Clarke, 2005: 549; Wang, 2004)[67], China has now succeeded in creating the "laws and tools necessary to have respectable IPR protection" (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 24).

However, China still suffers from lax IPR enforcement, as well as from weak IPR regulation and implementation (Liu, 2005; Yang et al., 2004: 459; Wang 2004: 253; Bosworth and Yang, 2000). As "there is widespread counterfeiting of nearly every type of product in the PRC" (Zimmerman and Chaudhry, 2009: 309), foreign companies in general consider IPR infringement an 'inevitable curse' of doing business in China (Yang et al., 2004: 459). Hereby, foreign companies often express concerns about bringing their "crown jewels", i.e. core technologies, to China, as they risk seeing their own technology coming back at them from Chinese competitors (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 7). In the following, the chapter inquires into concerns and consequences of such lax IPR enforcement in China in general, as well as within Chinese wind power and software in particular.

Risk of losing Intellectual Property in Chinese wind power

Despite considerable improvements in China's IPR system, IPRs in China are generally constituted as 'weak' by foreign actors (Int. 11, 2012). From the perspective of Western companies, China's 'technology for market' approach in the construction of a wind turbine

[67] A member of the World Intellectual Property Organisation (WIPO) since 1980, China has since then ratified many IP-related international treaties and conventions, e.g. on trademarks, patents, and copyrights (Bosworth and Yang, 2000; Yang and Clarke, 2005; McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 24; Wang, 2004; Yang, 2003).

industry is often framed as a matter of Chinese WTMs being intent on 'reaping' foreign technologies. That is, according to a Chinese expert,

"you know, when China is not able to do something, then they want to, you know, work on the foreign companies, to come here and you can get a better treat[ment], and we will reap your technology, ha ha!" (Int. 5).

The so-called Chinese strategy of 'reaping foreign technologies', e.g. through licensing agreements and joint ventures, is often being framed as a Chinese means of "always pushing for the 'crown jewels of technology from companies that want access to China's exploding marketplace'" (GE executives in Lewis, 2013: 115). So even when the intellectual property of Western MNCs has been protected through means of formal IPRs, the risk of IPR infringement persists. Accordingly, it is argued that Western WTMs "will actually become even more protective" in China (Int. 11, 2012):

"I think a lot of companies are hesitant to come here to share knowledge, because China has not demonstrated the ability or desire to protect intellectual property" (Int. 11, 2012).

Hereby, the issue of IPRs in China "is really stifling innovation collaboration in the country. Not just in our company, just in general" (Int. 11, 2012). To protect their 'crown jewels', i.e. core algorithms, foreign control system companies within wind power will often – instead of doing real R&D in China – instead tend to only localise sales offices in China and/or establish offices, which do redesign or product improvements of older platforms (Interviews). Lax implementation and enforcement of IPRs as well as a historically relatively weak R&D capacity (Zimmerman and Chaudhry, 2009; Chow 2002: 339) is often being explained as a matter of China's cultural background, in both the Confucian tradition of '*rule of man'* rather than '*rule of law'*[68] (Bosworth and Yang, 2000: 457; Zimmerman and Chaudhry, 2009) and in the communist so-called *rule by law* (Keyuan, 2006), which both tend to view IP as public property[69]. Culture is also employed as an explanation in the case of wind power and the propensity to copy rather than innovate:

[68] Lax implementation of rules may find an explanation in the tradition of the rule of man (人治) as opposed to the rule of law (法律) (Chow, 2002: 339). The rule of man is founded in Confucian philosophy, where relationships are contextual, hierarchical, interpersonal, and reciprocal. In this context, obedience by the subject towards the ruler depends on the fulfilment by the ruler of his obligations, and not of a universally acknowledged set of rules. Hence, obedience to law owes more to informal constraints than formal law (Chow, 2002).

[69] Confucianism requires control of information, and a traditional Chinese belief is that inventions draw on past knowledge that belongs to all citizens (Zimmerman and Chaudhry, 2009: 309). Consequently, "[t]he concept of IPR has always been at odds with the teachings of Confucianism. On the one hand, IPRs are government-sanctioned monopolies that seek to

"Why is innovation not so good in China? Cultural issue. IP is a problem. We are used to copying – we copy everything from the US, Facebook, Apple…we lack the capabilities. It's a huge challenge" (Int. 40, 2012).*

When it comes to the specific case of software, additional complexity is added to the issue of IPRs, however, as the adoption of legal means to protect intellectual property may turn out to be more dangerous than abstaining from legal means. In the following, the analysis therefore looks further into the specific case of IPRs in regard to software.

Ambiguity of IPRs in regard to software – on trade-offs between patents, copyrights, and trade secrets

The issue of IPR is in particular ambiguous and sensitive in regard to software. While software invention requires considerable investment in time and money, it is easily copied, and how to protect it further remains a contentious issue within the TRIPS Agreement (Kaya, 2007). Copyrights and patents are the two main intellectual property forms, under which computer software might be protected (Kaya, 2007: 44). While the TRIPS agreement places computer programmes under the copyright section, the question of whether or not computer programmes can be patented has not been solved, however (Kaya, 2007), and it is instead to be decided by the individual signatory countries (Kaya, 2007: 46, 56).[70] In addition, it might be considered safer to abstain from filing patents on software by software developers. In the following, the chapter inquires into the ambiguities of IPRs on software, and the trade-offs between patents, copyrights, and trade secrets that companies are facing, when choosing specific means of IPR protection of their software.

The algorithmic nature of software

The ambiguity of patents on software is related to the way in which software lies at the very borderline of copyrights and patents. Basically computer software is "an algorithm or a mathematical formula" (Kaya, 2007: 64). In turn,

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protect, by forbidding free copying, the 'original thought' of the IP-owner. On the other hand, Confucianism considers that learning takes place through copying and that imitation is a form of flattery" (O'Connor & Lowe, 1996 in Bosworth and Yang, 2000: 457). In addition, Communist tradition views IP as public property (Bosworth and Yang, 2000: 453; Zimmerman and Chaudhry, 2009).

[70] Based in a debate on the 'the common good', opponents to software patents emphasise how software patents will put limits to competition, as competitors are excluded, and stifle further software development. In contrast, proponents in favour of patent protection for computer software argue that it promotes investment in software development (Kaya, 2007: 45).

"[a]n algorithm is a series of steps to solve a problem and a computer program is an implementation of that algorithm, which is like an implementation of the mathematical equation E=mc2" (Kaya, 2007: 64).

Software code can be written in different classes of computer languages, one which more qualifies as an original expression (qualifying for copyrights), and another which qualifies more as a functional work of technology (qualifying for patents). That is, source code is the category of computer language instructions, which is most frequently written and read by software programmers. This automatically qualifies for copyright protection. In contrast, software in object code can be argued to qualify for patents. This is due to the way in which object code, which is the software code readable by the computer (basically consisting of numeric codes), gives the computer instructions on what actions to execute, i.e. which functional tasks to perform. Since patents have always been available for functional subject matters, object codes (constituting a functional work of technology) could qualify for patent protection (Kaya, 2007). However, whether a line of object code qualifies for a patent, remains an ambiguous issue, as expressed by a foreign control system supplier:

"It is possible to take a patent on some software, but it is a bit tricky…it's easier with the hardware stuff, which is something that you can see. Where it's possible to see that somebody else has done the same [copied]…with software, it's very, very difficult to prove [the 'newness' of the invention]" (Int. 41, 2013).

While there is international disagreement on the patentability of software, software companies at the same time are facing a strategic dilemma in their choice of IPR of software. In the following, the chapter inquires into the strategic considerations of software developers of whether or not to file for a patent in the case of software.

To lay algorithms open or not lay open, that is the question – patenting software or not

First of all, companies must decide whether it is worthwhile the money and time that it requires to file a patent application for software, or whether a copyright, which is automatic and free, is to be preferred instead (Kaya, 2007). Second, another more critical difference between patents and copyrights is the way in which patents require a higher degree of openness as to the contents of the invention or the original work. In Latin, *patere* means "to lay open", thus, the meaning of *patent* is basically to make it available for public inspection (Kaya, 2007: 45). This means that the inventor filing for a patent must describe the invention in detail and make it public (Kaya, 2007: 51). In the case of software, this implies that to file for a software patent, the software inventor must lay open the software algorithms. However, development of new software is time-consuming. Taking the case of companies developing software for control systems in China, for instance, "we used forty years to develop it [the main control]. And all the others [foreign companies] have also done that" (Int. 2, 2012). If just laying open the source codes and/or object codes, software companies will hereby see their company's competitive advantage depleted. Thus, foreign software suppliers for main controls and control systems are worried about opening up their core algorithms, as this would imply that they "give away the entire business for free" (Int. 2, 2012). Consequently, most foreign software developers for control systems do not take out patents on the software of the controller, neither in China, nor elsewhere:

"Sometimes it's actually better, when you talk about software, not to take out a patent on it, because then nobody can see it…because when you take out a patent, then you write…then you actually make…how…[…] Then you write in details how it functions. Then you give it all away. Then it's actually better simply not to say anything about it" (Int. 41, 2013).

In addition to this precaution, patents on software in China are not legally possible. That is, as indicated earlier, patent regulations in regard to software differ between countries. Thus, while patents on software are e.g. widespread in the U.S., they are less widespread in the European Union (Kaya, 2007: 46), and in China only copyrights can be taken out on software (Interviews). Having illustrated the inherent risks of patenting software, the following inquires into alternative ways of protecting software.

Ambiguous and weak protection of software through copyrights – and the alternative of trade secrets

In contrast to patents, copyrights are free and automatic and do not require companies to lay open software codes, since copyrights do not require a formal application. The only thing required, is that the work is fixed in a physical medium of expression. In this way, software, both the source code (in human readable form) and the object code (in machine readable form), automatically qualifies for copyright protection (Kaya, 2007: 44). As expressed by a Chinese WTM involved in developing software indigenously:

"For our software modules, we don't give source codes to customers [...] That is our intellectual property rights […] All the software modules we produce, we get copyright" (Int. 34, 2012).

However, copyright laws are ambiguous and only offer partial protection for software. That is, the scope of protection is limited compared to patents. This is due to the way in which copyrights only offer protection against direct copying of an original expression, while the idea itself (or the procedures, methods of operations, or mathematical concepts) is not protected (Kaya, 2007: 44). In turn, the framing of 'original expression' is itself ambiguously defined. In the TRIPS agreement, it thus remains a "major question in connection with computer programs […] whether and how far copyright protection should extend to the nonliteral or functional elements of the programs, such as program behavior and structure, or if these aspects of the programs should be protected by another form of IP rights, specifically patents" (Kaya, 2007: 57-58). Consequently, copyright protection for source and object codes of the programmes cannot prevent second comers from imitating the *functional* aspects of the programme:

"The problem of protecting copyright is that although the object code exists as written text, it serves a utilitarian function which is traditionally protected by patents. Therefore, copyright cannot prevent second comers from recreating the same work or producing similar work using different expression. In other words, there is no copyright infringement when a competitor uses the same idea in constructing his/her work provided that his/her creation is independent" (Kaya, 2007: 44).

Not providing an effective means of protection for the functional aspects of computer programmes, competitors can, through reverse engineering practices of the programme and without access to the source code of the programme, imitate the programme's functional elements (Kaya, 2007: 50-51). In addition, copyright protection in China is considered particularly weak (Zimmerman and Chaudhry, 2009: 309), making copyright a risky strategy.

Lastly, an alternative IPR option to patents and copyrights in regard to software protection is trademarks and trade secrets. Trademarks make it possible to claim exclusive properties of a product or service, by use of a sign, which is capable of distinguishing the goods or services of one enterprise from those of other enterprises (wipo.int (a)). In turn, a trade secret is any confidential business information, which provides an enterprise with a competitive edge. The unauthorized use of such information by persons other than the holder is regarded as IPR infringement. As the trade secret is kept intentionally confidential, e.g. through different technical black-boxing means, the owner can enjoy unlimited monopoly rights on the invention without limits in time. To keep the information on the trade secret confidential, i.a. non-disclosure agreements between the involved parties might be signed to prevent information leakages such as breaches of confidentiality and corporate espionage (Kaya, 2007; wipo.int (b); wipo.int (c)). Trade secrets are generally not protected by law in the same manner as trademarks or patents. Trade secrets are protected only when the secret is not disclosed, and the key disadvantage of a trade secret is consequently its vulnerability to reverse engineering and leakage (Kaya, 2007).

Having outlined some of the concerns over IPR protection in China in general, within wind power, and in regard to software in particular, the following section inquires into the configuration of relations between foreign developers of software for control systems and

Chinese WTM customers in the potentially emerging software-TEN, with a focus on the issue of IPRs.

Controversy over IPR in the potential software-TEN – the case of main control core algorithms

In the following, the analysis first outlines how control system software from foreign suppliers is transferred through technology licensing. This leads to an account of strategies used by foreign control system software developers in order to protect core algorithms through legal and non-legal means and of the implications for Chinese customers in terms of upgrading potential. This provides the basis for an inquiry into the de- and reconfiguring of relations, as a controversy over IPR, entangled in concerns over technology transfer and limits to Chinese upgrading, unfolds in the emerging software-TEN.

Technology transfer and technology licensing of software in Chinese wind power

As depicted in earlier chapters, China's emerging wind power-TEN was in the early phase founded on a strategy of 'trade market for technology', and thus based on conventional technology transfer. Technology transfer often takes place through licensing of technology, which is a means to protect the IPRs to the technology. Licenses contain provisions which e.g. allocate rights, restrictions on the use of the technology and software (e.g. in terms of geographical boundaries), liability, warranty, and responsibility to the different parties. According to license agreements in which drawings of a wind turbine design are provided, a Chinese WTM might for example be obliged to buy and sell a certain amount of wind turbines based on the license and pay royalties as a percentage of the sales. When a specific controller (and the software it contains) is written into a wind turbine license, the supplier of the controller is thereby formally protected by patents, copyright, and/or trademarks and will receive a share of the royalties from the number of sold turbines.

In terms of technology transfer of foreign control systems and their software contents, these are often included into foreign design licenses for a full wind turbine:

"In the case of a full technology transfer, the transfer typically comes with some IPR in the context of a license arrangement for either components or a full turbine in the context of a license arrangement for either components or a full turbine model to be manufactured locally" (Lewis, 2013: 110).

When the design license contains a list of recommended or obligatory suppliers, e.g. of foreign control systems, the Chinese WTMs are often 'forced to buy hardware' from the listed suppliers, for a specific number of wind turbines, in accordance with the design license (Int. 43, 2013). An example of this is the Chinese WTM Dongfang Electric, which has been engaged in a manufacturing process license with the German company REpower. In this license contract, a number of conditions about technology transfer, learning, and rights to manufacture in accordance with the REpower design license have been signed. In addition, it involves a component list, which demands Dongfang to use specific control system suppliers (Int. 44, 2013). At other times, control system suppliers may sell a software license directly to the Chinese WTM[71]. When licensed, the software will most often be proprietary (and not free or open source) licenses, implying that the end user is not allowed to distribute or copy the software to other wind turbine controllers, but instead bound by non-disclosure agreements (NDAs) (Interviews).

The use of black-boxing locks of software codes

In addition, foreign control system companies also adopt trade secrets as a way of protecting their IPRs to the software (Interviews). In particular, the very ’spine’, i.e., the core algorithm of the wind turbine’s main control, is protected through different technical locks and cryptations, which black-box its contents. As technical locks and cryptations can help black-box the core algorithm and its source codes, it becomes impossible to copy it: “How it is technically protected, I don’t know, I just know that it’s protected and that’s there’s nothing they can do about it” (Int. 2, 2012). Another way to protect the most ‘core’ algorithms of the control system can be to sell parts of the object code, but not the source codes of the software. That is, fearing copying of the source codes, software developers for controllers “normally just send this as a binary file [in object code]. And that’s just some numbers of zeros and ones. You can’t see what it is. That’s what they got [in the initial phase]” (Int. 41, 2013).

Non-legal means of intellectual property protection

In addition to the above-mentioned legal means of IPR protection, as well as technical black-boxing, software developers of controllers may consciously choose *not* to localise software R&D activities and/or the main algorithm in China in order to protect their intellectual property (Interviews). For instance, the American control system producer, American Superconductor (AMSC), which produces ”computer systems that serve as the electronic brains of wind turbines” (and its software affiliate, Windtec) (Riley and Vance, 2012, Bloomberg/Bizweek), has sequestered its software abroad, meaning that the control

[71] A typical software license grants permission to use one or more copies of software in a way which, without a license agreement, would otherwise have constituted an infringement of the software owner's exclusive rights under copyright law.

system software sits on a secure server abroad, which is not accessible from the Internet in order to prevent attacks from hackers. This is based on the idea of ”dividing up the intellectual property part of the content and not having them in China” (Riley and Vance, 2012, Bloomberg/Bizweek).

Lastly, another non-legal form of IP protection in China is close personal relationships. As argued by a foreign actor, ”we have an NDA [non-disclosure-agreements]. We have the IPRs. And then again, we've got all that, but I think that when the light is turned off, I'd prefer having a close relationship” (Int. 13, 2013).

Concerns on protecting the core algorithm – and Chinese interest in accessing the 'gold'

As already indicated, what in particular is a concern for Western suppliers of control systems is how to protect the 'core algorithm' or the so-called 'spine' of the main control. Consequently, "the very control part, the core [core algorithm] we have closed, locked, and sealed in any possible way" (Int. 2, 2012). Protecting and black-boxing the core algorithm through means of a trade secret, effectively by means of technical locks, is framed as vital to the survival of foreign control system companies. Conversely, if another party gained access to the core algorithm, the software would be possible to transfer to another controller:

”They cannot get into this system yet, but if they could…they would like to…then they would be able to install our software on another controller, on another system” (Int. 2, 2012).

Due to the risk of 'losing their entire business', foreign control system suppliers abstain from engaging in a new customer-supplier (or any other) partnership with Chinese WTMs, when they sense that the only interest on the part of the Chinese partner is technology transfer:

”Because…when we talk controllers, then you also talk about software, and then you talk about source codes, and the source codes, that's our 'gold', I would say” (Int. 43, 2013).

Conversely, as software is still the "the component where it's most difficult" to upgrade (Int. 9, 2012) for Chinese WTMs, component suppliers, and research institutes, and as software is being constituted as a critical component in the potential 'turn to quality' in Chinese wind power, access to source codes has over time become more central in negotiations between Chinese and foreign collaboration partners:

”Well, in general, they would like to get everything [during negotiations]. They would like to get some source codes […] Source codes are defined by how things have been done” (Int. 41, 2013).

The interest from Chinese customers in regard to source codes (Int. 43, 2013) is seen already during negotiations as Chinese customers "ask[ed] about them [source codes] directly. 'When can we get them?'" (Int. 43, 2013). This creates a concern amongst foreign software developers of control systems that Chinese customers will leave them, as soon as they have found a way to copy the software:

"He [the Chinese customer] only has one interest. And as soon as he has got that, then he won't use us anymore" (Int. 43, 2014).

"I know the Chinese well enough to know that this [buying the controller] is not the only thing they want!" (Int. 9, 2012).

The increased interest from Chinese WTMs in source codes as a way of becoming independent from foreign suppliers is at the same time founded in a Chinese concern for getting access to cheaper controllers and controller software. That is, foreign suppliers acknowledge that "as soon as they [Chinese customers] have got something, they will try to find something cheaper" (Int. 43, 2013). While having focused so far on the perspective and concerns of foreign suppliers, in the following, the analysis dives into the perspective of Chinese actors in regard to accessing software core algorithms.

Difficulties faced by Chinese companies when algorithms are closed

In the following, the difficulties faced by Chinese WTMs when algorithms are closed by means of IPR and non-IPR protection, are illustrated.

The legacy of foreign licenses – contested roles of the 'student' and the 'teacher'

Chinese WTMs are struggling to reduce their dependence on foreign suppliers and wind turbine design license suppliers. That is, based on a legacy of foreign design licenses, Chinese WTMs "are students who learned from a teacher" (Int. 45, 2013). Yet, today, Chinese WTMs "have chosen to start designing their own turbines. So they are ready to design a new technology and to get independent from the old one" (Int. 13, 2013). Striving to design their own wind turbines, Chinese WMTs not only want to become independent from foreign design houses and consultancy firms "who have sold them their license" (Int. 35, 2014), but increasingly also "want to develop the software themselves" (Int. 9, 2012), and thus they "want to get rid of them [control system suppliers]" (Int. 10, 2012):

"They have produced the turbines based on a license, and that means that they have to pay for every turbine that they produce for that company. Of course they want to get out of that. So they want to develop their own turbines. That is what matters for Chinese turbines […] Simply. That's what it's all about. They want that technology transferred, and then…" (Int. 35, 2014).

As Chinese customers seek independence from foreign technologies, contracts (e.g. licensing agreements and NDAs) which have been employed as framing tools in customer-supplier relations have also become insufficient, since

“the Chinese are not as loyal to a components’ list as in other countries. Well, it’s written that there should be an [X]-controller and stuff like that. The Chinese look at it immediately and think: How can we get rid of this?” (Int. 9, 2012).

In the above, it has been indicated that Chinese WTMs have started to contest their role as ‘student’, wanting to redefine their own role.

Rapid service and localisation – the double-edged sword of protection

The heavy protection on software algorithms has destabilised relations between foreign suppliers and Chinese customers. This is partly a result of how lack of access to algorithms results in delays in the service that Chinese WTMs can offer their Chinese customers, i.e. wind farm owners and/or generating companies, when technical issues occur in the wind farm (Int. 10, 2012). In the perspective of the Chinese WTM, such slow service “will just create a very bad impression in the mind of the [WTM’s] customer”, i.e. the wind farm owner and/or generating company (Int. 12, 2013*), and has resulted in some Chinese customers leaving their foreign control system supplier in favour of someone else (Int. 12, 2013*; Int. 46, 2012*; Int. 10, 2012). In addition, relations between Chinese and foreign actors have been destabilised over time as foreign control system suppliers often do not localise R&D-activities in China due to fear of losing IPRs. Yet, in the perspective of Chinese customers, investment “in local design” and adaptation “to the customers' demands” is important (Int. 10, 2012). Acknowledging this, some foreign control system suppliers have changed strategy over time, gradually localising development activities in China to make their relations with customers more stable, and opening up some of the software to local employees (Int. 31, 2012; Int. 46, 2012*). Other control system companies have engaged in joint ventures with Chinese control system companies. Yet, as most foreign control system companies are considered too “tough on protection”, protection of algorithms seems “a double-edged sword” (Int. 40*, 2012). That is, it is “also very risky not to share anything” (Int. 31, 2012).

Dissatisfied Chinese customers – sweet relations gone sour

With improved capabilities and ambitions of Chinese WTMs, closed algorithms have created dissatisfaction amongst Chinese customers – making ‘sweet relations go sour’ – as it makes it impossible for the Chinese customer to make adaptations to the control system software in accordance with local environmental conditions:

”All the software for the wind farm...now the Chinese customer becomes more and more know about the industry...so they have their own ideas. They say, why not we can...because the low wind speed issue [in China making adjustments necessary]...they want to talk to [control system supplier], they want to change, but [foreign control system supplier] says no. We are...I heard from the customer” (Int. 10, 2012).

Dissatisfied with higher prices of foreign control systems, with lacking flexibility and access to software codes, some Chinese WTMs have gradually attempted to change their suppliers as collaborations have gone sour (Interviews):

“Their product and service is too expensive, they charge for everything, and very closed, not sharing anything. So the collaboration was closed. Apart from being closed, they are also too slow, their service is bad, and their control technology was old, not very fast and adaptable” (Int. 44, 2013).

Another way of becoming independent from foreign control system suppliers is sometimes sought through reverse engineering practices. Thus,

”I am convinced that the moment you sell them a prototype [for a controller], they will disassemble it and start analysing what they can do to make this one. And they are working on that still, and they have not succeeded yet [although] they are trying hard anyhow” (Int. 2, 2012).

However, reverse engineering is complex and can easily go wrong, and in terms of the software part of control systems, reverse engineering is not possible as long as it is efficiently protected (Interviews). Yet, there have been cases of IPR infringement of control system software. This is e.g. the case of the much-debated ”red-hot smoking gun example” of IPR infringement and industrial espionage (Riley and Vance, 2012, Bloomberg/Bizweek) between the Chinese WTM Sinovel and American Superconductors (AMSC). AMSC has served as Sinovel’s largest supplier for several years, yet, after Sinovel ”abruptly and inexplicably” turned away AMSC shipments in 2011, it was soon discovered that

”[t]he Sinovel turbine appeared to be running a stolen version of AMSC’s software. Worse, the software revealed that Sinovel had complete access to AMSC’s proprietary source code. In short, Sinovel didn’t really need AMSC anymore” (Riley and Vance, 2012, Bloomberg/Bizweek).

In addition, computer logs and messages showed that Sinovel had blackmailed one of AMSC’s employees working at AMSC’s research facility in Klagenfurt – who has since pleaded guilty and been sentenced to 12 months in jail – to quit AMSC and to help in China to

”create software that could go on existing turbines as quickly as possible, using source code taken from AMSC’s server in Austria” (Riley and Vance, 2012, Bloomberg/Bizweek).

This case has resulted in filings in a Beijing copyright infringement case, one of four theft-related cases filed by AMSC in China, where there is ”evidence that the stolen code was already in more than 1,000 Sinovel turbines by July” 2011 and many more since (Riley and Vance, 2012, Bloomberg/Bizweek). Hereby, Sinovel had ”succeeded in copying their [AMSC's] control concept like crazy” (Int. 9, 2012), which made it possible for Sinovel to adjust the software and make it fit any kind of controller, i.e. reducing dependence on AMSC:

”They did not have the software. Or they had it, but they were not allowed to have it […] And Windtec [AMSC's software company] said, you cannot get that” (Int. 9, 2012).

In many ways, this seems a case of Sinovel being unsatisfied with being dependent on AMSC controllers. Wanting to develop and adjust the software themselves, and having signed a multi-year contract with AMSC, AMSC's products accounted for a growing share of Sinovel's turbine cost, which can explain ”the motivation to acquire that technology” (Riley and Vance, 2012, Bloomberg/Bizweek).

Reconfiguring relations between customers and suppliers

So far, the chapter has inquired into how foreign control system (i.e. software) suppliers protect their core algorithms, as well as how Chinese customers react to closed algorithms. In the following, the chapter looks into how relations between foreign and Chinese actors in the emerging software-TEN over time have been de- and reconfigured, and how software algorithms – and their corresponding IPRs – have seemed critical in this de- and reconfiguration. As illustrated above, access to software algorithms is becoming increasingly negotiated between Chinese WTMs and foreign control system suppliers. Dissatisfied with lack of access to core algorithms, sometimes due to legal, and sometimes due to non-legal means of IPR protection, Chinese customers have started leaving their foreign suppliers. For instance, the Sinovel-AMSC case can be seen as a case of how IPRs, as a normal framing device, have started to overflow as Chinese actors contest the exclusion from algorithms and seek to upgrade capabilities by circumventing the framing device of IPRs. This is also seen in the way that Sinovel, in its attempt to become independent from AMSC, has apparently attempted to make a Chinese power converter company into “the Chinese version of AMSC” (Riley and Vance, 2012, Bloomberg/Bizweek). Involved in the creation of this company in 2010, the IPR infringement case with AMSC revealed how the AMSC power converter had been reinstalled by Sinovel with ”a nearly identical one made by Guotong [the Chinese power converter company]”, and was ”running on a version of AMSC's control system software obtained the year before by Sinovel and decrypted by its engineers" (Riley and Vance, 2012, Bloomberg/Bizweek). According to foreign actors, this case can be seen

"from different perspectives. I would also…if I were Sinovel, I would also have been angry due to that arrogant way of handling things […] Actually, I can see it from Sinovel's side. And they just couldn't get access to anything, so it's understandable that they did as they did" (Int. 9, 2012).

That is, Chinese actors "want to have their own strengths built up. Sooner or later you want this, you need to do this, so they try some...try some change on these IPR issues, which irritate [AMSC]" (Int. 10, 2012). While Chinese WTMs in the initial phase did not request access to source codes, this is a consistent request today. This indicates that Chinese WTMs have upgraded capabilities as well as changed their ambitions and priorities, e.g. by increasingly requiring access to see the source codes (and not just the object code).

"Because they think that when they buy something, then they want to see it…it's clear, then they want to be able to work on it [the codes] themselves […] With object codes, they don't know what's inside the box, but just hope that it works. That's how it [the object code] is. But we could sense that others…nobody really wanted to buy anything unless they could get this" (Int. 41, 2013).

In this way, relations, positions, and relative roles start to become contested and negotiated, as Chinese WTMs aspire to work on the codes themselves. In the attempts to upgrade in the potential transition of the Chinese wind power-TEN from quantity to quality, source codes have become framed as critical to make Chinese WTMs independent from foreign technologies, and thus also for building indigenous innovation capabilities. Accordingly, relations have become destabilised between Chinese WTMs and suppliers of software, when suppliers are framed as 'closed'; instead, more flexible and 'open-minded' suppliers have been chosen as suppliers. In turn, most foreign control system suppliers are gradually acknowledging that "a reputation for being closed" (Int. 2, 2012) can be detrimental, and that a competitive space is being opened up between different foreign software suppliers for controllers, where the key is to be framed as relatively 'open'. Realising the shifting relations, several suppliers of software for controllers are experimenting with opening up some of their source codes to associate themselves with 'openness'. In the following, the chapter looks into how customer-supplier relations are being reconfigured around source codes.

A new competitive space around source codes – 'no pain, no gain'

Acknowledging a new 'competitive space' opening up around source codes, some foreign suppliers stay protective around source codes, while others are experimenting with how far down into the 'spine' or 'nervous system' they dare to go, without threatening their own existence. Acknowledging that to the Chinese customers, “source-codes – that is everything” (Int. 45, 2013), different strategies of gradual opening up are applied in order to get orders:

”We have to give something for free, free of charge, open the technology, some of the algorithms. […] It is worthwhile to give. No pain, no gain. If you give me more, then they [foreign suppliers] get more orders (Int. 45, 2013).

As Chinese customers are evaluating the ‘quality’ of their control system suppliers, primarily in terms of how much they open source codes, foreign companies have e.g. engaged in modularisation of their control system software. This modularisation “makes it easier to control” what the Chinese customers get access to, and what they do not gain access to (Int. 43, 2013). That is, modularisation of software enables suppliers to bracket and disentangle the ‘core’ from the ‘non-core’. Hereby, framing certain algorithms as ‘core’, the ‘less core’ can be opened and sold as source code modules by engaging in exclusivity agreements with Chinese customers (Int. 45, 2013). By building the software as customised modules, Chinese customers can get access to some of the software source codes which are less core, while the core layer (the operational layer), which connects the different layers, will stay closed. Hereby, Chinese customers can buy selected software modules, while developing other modules themselves, as long as it is written in the same code. Hereby, the ability to share ‘openly’, while protecting and black-boxing the most ‘core’, becomes an important parametre of keeping Chinese customers in the Chinese market.

”But when it comes to exactly this product, this is very attractive to them, because no one else has dared to open up the source code in such an extensive way as we have, and that’s probably related to how the others can’t protect theirs…they cannot protect the most important” (Int. 2, 2012).

At the same time, as the only way to differentiate themselves is through the key algorithm and how the source codes have been built to regulate the wind turbine, foreign control system software companies find themselves in an ongoing struggle to find the limits as to how much can be shared without losing critical proprietary property, while maintaining or building new relations with Chinese customers.

Negotiating algorithmic boundaries

According to some foreign suppliers of control system software, they have now

“reached the limit, we are into the source code, where we…the only thing we lack is to give them access to the central nervous system [..What] they are getting access to, that’s all the different [sub-control systems], which are specific for the individual products, but the very main control, the core [algorithm] is protected” (Int. 2, 2012).

While limits to sharing algorithms are critical to the survival of Western suppliers, access to source codes is central to the upgrading of Chinese WTMs. That is, knowledge on source codes can provide knowledge on the regulation of the wind turbine, the interconnected nature of the myriads of turbine components, and reduce dependence on foreign technologies. This makes the boundaries of sharing algorithms – the ‘algorithmic boundaries’ – consistently negotiated and contested.

”It’s pretty obvious, that they are expecting us to open up to all the knowledge that we’ve got. That’s kind of the basic assumption. That’s a given. And that’s one of the interesting tasks, I’d say, to find out how to do it without harming yourself, but at the same time making sure that they find it a reasonable partnership between customer and supplier. And that’s a challenge” (Int. 13, 2013).

Accordingly, customer-supplier collaborative relations seem to be producing an ambiguous space of simultaneous collaboration and competition, which take shape around the boundaries of algorithms and corresponding limits to collaborations.

Competition around algorithmic boundaries

As a competitive space opens up around ‘algorithmic boundaries’, foreign suppliers of control system software at times mobilise the media, when new agreements are made, in order to frame themselves with associations of ‘openness’. An example of this is e.g. how the Danish control system supplier Mita Teknik has recently engaged in a partnership with Sinovel. While the two companies have had collaborative relations on technical development since 2008 (Wind Energy and Electrical Vehicle Review, Apr. 22, 2012), a new strategic partnership signed in 2012 has had quite a bit of resonance, since source codes have now been opened up more than ever, buying access to source codes (Interviews; Wind Energy and Electrical Vehicle Review, Apr. 22, 2012). According to the press release, in connection with a co-hosted press conference by Sinovel and Mita-Teknik at the China Wind Power 2012,

”Mita-Teknik has made all data from the control system available to Sinovel, allowing the Chinese company’s engineers to create unique solutions for their customers. One of the key features of the platform, which the Danish company said would boost its market appeal around the world, is the parametric grid object, which enables Sinovel turbines all over the world to connect using local grid codes” (Wind Energy and Electrical Vehicle Review, Apr. 22, 2012).

What has attracted notable interest in the media as well as amongst industrial actors is, in particular, how Sinovel under the agreement ”owns the intellectual property rights to the modified and upgraded versions of the software and source code, as well as the right to use the initial version in all products the company produces” (Wind Energy and Electrical Vehicle Review, Apr. 22, 2012; www.sinovel.com). This *"can strongly support Sinovel to develop more advanced control system platforms and solutions. Under the agreement, Sinovel will also purchase PLC hardware and the software with source codes of the control systems from Mita-Teknik. Sinovel can utilize, copy, modify and upgrade the control software and source code of the initial version delivered by Mita-Teknik, and will own the intellectual property rights of the modified and upgraded versions. Based on the contract, Sinovel can apply both original and modified versions to all its product lines" (Sinovel Managing Director of Sinovel Europe, www.sinovel.com).*

Having redefined the 'algorithmic boundaries', the partnership has created a large amount of interest from other Chinese WTMs in entering into similar agreements with Mita-Teknik.

Damage control – and aspirations for experimental learning

Making this type of agreement possible is, allegedly, the way in which Mita-Teknik and other control system suppliers have built up their systems as modules and use technical locks, and in this way still protect the 'most core'. Over time, the ability to deliver modules rather than closed code, which enables the Chinese customer to make adaptations to the programme themselves, has become more central. That is, as Chinese customers have built capabilities, they increasingly demand room for maneuvre to learn and experiment. Furhter, as a matter of protection of the intellectual property contained in control system software, opening up source codes only takes place on older platforms, which means that foreign control system suppliers already have a newer and more optimised control system, which nobody can get access to:

"This product that I am selling the source codes to, that is kind of old-fashioned. In that way the potential damage is limited" (Int. 43, 2013).

Further, the source codes can still not be installed on another controller without engaging in copyright infringement, e.g. due to technical locks. Hereby,

"a lot of them become disappointed because they find out that they won't be able to install the software on another controller" (Int. 2, 2012).

However, even when foreign suppliers have opened up source codes, there may be obstacles facing Chinese WTMs.

Challenges for Chinese companies after gaining access to core algorithms

As described above, Chinese customers have gained increasing access to source codes through ongoing negotiations. Hereby, some Chinese customers are gradually gaining access to make some, though limited, adjustments to the software in a running wind turbine; if they have not invested in acquiring parts of the source code, however, they will still be dependent on the assistance of the control system software supplier for all minor and larger adjustments to be made (Int. 2, 2012). At the same time, even when having acquired access to parts of the source code, such access requires the capability to absorb it, because ”if you don’t know about it, then you don’t know what to ask for” (Int. 9, 2012). Sometimes, foreign control system suppliers are

“in doubt, whether the source codes…and what they [the Chinese WTMs/customers]…whether they actually know what it is that they want. I’m not sure. Because, I’m not sure whether they know what it is that they are working with” (Int. 47, 2013).

Having heard about its ‘critical’ role to a wind turbine’s quality, access to source codes has become framed as ‘the mother of all solutions’:

“And then, it’s probably what we need to get […] just as if it was the Mother of all Solutions, right. But it might not be that” (Int. 47, 2013).

Accordingly, some claim that the absorptive capacity of Chinese customers is still limited, as some of them ”don’t know what they can use it [the source codes] for. So, actually, it’s safe enough to sell it to them, because they don’t know what they are doing” (Int. 42, 2012). An example of this is that when one Chinese WTM had been given source codes from a foreign supplier, it took the Chinese WTM two years even to realise that the core algorithm had been hidden. In addition, software codes can be full of errors and are generally in need of continuous optimisation in order to follow the trend for high-efficiency intelligent turbines. Hence,

”[t]here’s a good thing about software, namely that it’s full of errors. And if you don’t understand how it’s built, then it doesn’t have any particular value” (Int. 15, 2012).

In this way, while ”not a matter of who has the best brain” (Int. 9, 2012), the extent to which it is possible to share codes is related to “when you are ready to absorb it” (Int. 9, 2012).

Open it – and don’t change a thing, on limits to absorption and reverse engineering

Even though Chinese customers increasingly ask for access to the source codes, when they finally succeed in buying the source codes, which are much more expensive than the binary object codes, often, they do not make changes to the acquired source-codes. As expressed by a foreign control system supplier:

”None of our customers dare to do anything yet, haha […] I actually think they were kind of overwhelmed by it” (Int. 43, 2013).

Overwhelmed by ”its complexity” (Int. 41, 2013), as a change in the codes will change the parametres for everything else, often “the codes just lie there, but they call us [X] anyhow [...] because they are afraid of making a mistake” (Int. 43, 2013):

”You could imagine that if the blades are to be longer, then the tower also has to be taller, but that changes the load on your tower, right. And then you have to put in some new parameters. And we have not been willing towards opening that up. And maybe that has been a mistake. But now we have started opening up, so they can make these calculations, and then they can find out which parameters have to be adjusted in the software” (Int. 47, 2013).

Hereby, by changing source codes, there is a potential to “mess up everything” (Int. 48, 2012). This makes the gradual opening of source codes a mutual learning process, where foreign control system suppliers must learn to set limits as to where the ‘core’ is, while teaching their customer how to use the increased access to source codes, but equally, the Chinese customers must engage in learning (Int. 41, 2013). Overall, this makes it evident that technology transfer of source codes only has value when matched with the experience to be able to absorb it, which again requires basic research.

”This can give them a lot of other problems. They should…there’s a reason why we have built it, as we have. And if they start changing a lot of the foundation, then it might all fall apart. Then it’s kind of better first to build up some understanding of the different areas. I can be in doubt whether the Chinese have the insight and understanding for all of this…and, in reality, maybe also lacking the kind of patience that is needed” (Int. 47, 2013).

Hereby, there seem to be barriers to reverse engineering, even while having access to source codes. For instance, when the Chinese customers have attempted reengineering, it sometimes turns out that it does not work in the exact same way:

”So we have made…it was some guesswork, like I’ve never seen it before…and then we had to go to the wind turbine, the existing turbine, take out the existing system, and then by trial and error, trial and error […] But they just have no clue what they are doing. But they can see, that it’s not working exactly like the other one” (Int. 42 2012).

Yet, reengineering seems necessary in order to adjust and optimise the wind turbine software to the specific Chinese, environmental conditions:

“In [Chinese WTM] we also want to do these kinds of things [reverse engineering]. For example, since the wind conditions for Chinese and foreign wind turbines are not the same, then we will only get suboptimal results, if we copy the European mature core algorithms. If we instead learn from the Danish experience combined with China’s experience with reverse engineering, then we can get some unexpected results for China’s real conditions. When these results are applied elsewhere, we can become very successful (Int. 49, 2012).*

Legacy of foreign licenses and a tradition of copying

Overall, Chinese WTMs seem to face a barrier in terms of utilising their access to the source codes. This is being linked to China’s legacy on foreign licenses. This has largely led to lacking experience in basic research. That is, the Chinese WTMs are lacking ”knowledge and experience. They have not made enough mistakes. They simply haven't learned enough yet" (Int. 32, 2012). Dependence on foreign technologies means that they

"don't know the reason behind it. So if you want to change it, then you have no idea, because it's not you who developed it. But if you have 20 years, or 40 years like Vestas, you started from zero, then you actually know why you ended up with this number, and how we should change it. So that's the experience" (Int. 5, 2012).

According to a foreign control system supplier, "they can't reengineer. They open everything. They only know how to copy*"* (Int. 42, 2012). Yet, access to the key algorithm of the controller does not help, if Chinese actors do not "know the key technology" (Int. 48, 2012), in particular, the aerodynamics of the turbine and the aeroelasticity of the blades. That is, the main control (and the pitch control) contains critical information on how to regulate the blades. However, optimising a turbine design to local conditions requires an

"abstract way of thinking; you need to know what it [the coding] is based on [regulation principle]. One thing is to have some numbers delivered, which you must do your calculations on, and then you get a result. That's not how it's functioning. You need to know the dynamics [behind the codes/regulation principle]" (Int. 2, 2012).

The issue of worthless source codes – on lacking experience with aerodynamics

If lacking knowledge, experience, and basic research on the aerodynamics lying behind the source codes, the 'critical' key source codes are becoming 'worthless' as they are to no use:

"In regard to the controller…[…] if they don't understand the aeroelasticity…then they can have all the source codes delivered that they want to […] Well, the source code for the main control…it takes into account the aeroelasticity of the wind turbine, and if you don't understand the basic behaviour of the turbine, then you don't know why [a control system supplier] has written the regulation code in this way…so it is kind of a peculiar place to start out…when they are attempting to gain knowledge, because they need to understand the turbine first. And maybe they don't. I don't know the Chinese…but if you don't understand what a turbine is about, then you can't…" (Int. 35, 2013).

In this way, if long-term basic research lacks on the aerodynamics (aeroelastic codes) contained in the source codes, access to the "source code is not of any use" (Int. 35, 2013). Hereby, the case of software codes in control systems indicate how "[s]tealing [or buying] information, however, is not the same as being able to use it" (Riley and Vance, 2012, Bloomberg/Bizweek).

The ultimate interests of the game – an emerging controversy over IPR in the software-TEN

In the above, the contested boundaries of algorithms have been outlined. Overall, a 'game of interests' (Int. 40*, 2012) is being construed, as both Chinese and foreign actors in customer-supplier and joint venture relations want their "own voice". "It's [like] two big animals wanting to dance together, haha, it's not easy to coordinate" (Int. 10, 2012). Whereas foreign control system suppliers are afraid of opening up too many codes, Chinese companies are keen to 'change the IPRs' in order to reduce dependence on foreign core technologies:

"These are the ultimate interests of the game, the reason why the Chinese companies ask the Danish companies to open the source. Chinese companies do not want their own control system controlled by others, they hope to change the ownership rights, to optimise [/make adaptations to the codes]" (Int. 40, 2013).*

Entangled in a qualification struggle of the potential wind power-TEN, in which capabilities as well as goals and priorities of the Chinese WTMs have changed, roles and positions start to become negotiated between Chinese and foreign actors around control systems in the emerging software-TEN. In the following, the chapter inquires further into a potential controversy configuring over IPRs to core algorithms, which takes place in the emerging software-TEN in Chinese wind power.

The emerging software-TEN configuring a zero-sum '*catch-up game'?*

In the above, it has become evident how the transition from quantity to quality in the emerging wind power-TEN is neither smooth nor automatic, but rather stumbles upon socio-technical barriers to a 'turn to quality', such as IPRs, technical locks, and aeroelastic codes. These barriers to a potential 'turn to quality' are at the same time linked to socio-technical barriers for upgrading and to building indigenous innovation capabilities, which is not only linked to the role of IPRs and technical locks, but also to a background in technology licensing. Stumbling upon the exclusion effects of framing devices such as IPRs and technical locks, the emerging software-TEN is being destabilised, which is e.g. reflected in destabilised customer-supplier relations and infringement of IPRs. As illustrated in earlier chapters, the software-TEN is entangled in a concern for achieving China's Scientific and Sustainable Development. In this way, the issue of access to core algorithms to build indigenous innovation capabilities seems entangled in a 'zero-sum game' construed between Chinese foreign companies:

"If you look at the Ministry of Science and Technology, MOST, and their thoughts on this, their Medium and Long Term Plan for…the MLP [S&T 2006-2020], as it is called…Well – if you read it closely, then…where it really gets critical, that's regarding core technologies, and their analysis of this is...that it's a zero-sum game. You cannot buy core technologies, you have to develop them yourself" (Int. 51, 2010).

In an emerging game of interests, in which losers and winners are delineated in a 'zero-sum' game, Chinese and foreign actors are framed as either front-runners or laggards, in an intense struggle of Chinese WTMs to catch up:

"Take the field of wind energy. Denmark is in the front globally within the field of wind energy; a lot of accumulated experience, in many cases there will be a lot of creative ideas. A relative late starter, China is still in the learning phase. But sometimes we can do reverse innovation" (Int. 49, 2012).*

Overall, Chinese actors are increasingly contesting their role as pure 'imitators'. However, there are barriers to reverse engineering, or, for that matter, other ways of technological "leap-frogging.

The last (and most difficult) mile – on construing a competitive game

These barriers are e.g. a matter of how "aerodynamic design may not be so advanced here" in China (Int. 4*, 2011). A matter of complicated mathematics (Int. 2, 2012; Int. 39, 2011; Int. 36, 2013), it is necessary to develop capabilities of developing, defining, and optimising algorithms; yet,

"luckily, they [the Chinese customers] have huge problems learning that. Well, it would surprise me if they could. How long have we had a prime time for the wind power industry out here? Five years. That they should have been able to learn this [in such a short time], which the rest of us have spent forty years to learn [would be surprising]… What we are good at in the West, and what they find a little more difficult out here, that is 'thinking outside the box'…to see things from another perspective. Here they know how to calculate. If you have an equation, they can solve it and get the right result. But you must know how to define the equation" (Int. 2, 2012).

This leaves foreign control system suppliers assured that they are 'ahead' in the catch-up game, at least for the time being. However, the position of foreign actors as 'front-runners' is not stable, but constantly re-negotiated. For instance, expressed by a Chinese supplier, Chinese companies will eventually "seize the market", despite some minor setbacks along the way, as Chinese actors get

"better very slowly and step by step. That means, OK, you [the Western companies] started out 30 years earlier. To give an example, like China's high-speed rail, the Japanese did that already a few decades ago, so for China, you'll see in a few years, in less than 10 years, we will also have developed like that. Although you may suffer and experience some setbacks, like the EMU [Chinese high-speed rail] derailment, which happened last year or the year before, this does not at all affect the development of core technologies of local Chinese companies" (Int. 12, 2013).*

Gradually, a competitive 'catch-up' race seems to be construed. Overall, it is widely recognised that Chinese companies are moving fast(er), making foreign companies acknowledge that they must protect themselves and also move faster in terms of technological development:

”It is one hundred per cent certain [that the Chinese will catch up]. And how we will tackle that market situation, when we reach that – that’s one of the big headaches at home” (Int. 2, 2012).

”They [foreign WTMs] don’t have a chance. Everybody knows that the Chinese want to make it themselves” (Int. 9, 2012).

Acknowledging the rapid catch-up of Chinese companies, Western companies tend to focus on having to ”be a little bit better. We always have to be. You can say that they are faster than us, so they’re catching up, but we also know that the last mile is the most difficult one” (Int. 15, 2012). A way to stay ahead is still considered to be through IPRs such as patents (Int. 12*, 2013), or through other legal and non-legal protective means. In this way, foreign companies are trying to stay ahead, e.g. through IPRs and by licensing out only older technology platforms (Int. 36, 2013), as well as through investments in R&D in continuously more ‘intelligent’ solutions (Int. 35, 2013):

”Yes, we do that for certain [develop continuously]. We move forward rapidly and do everything we can to put aside resources for that [R&D]. But of course, they will find out something at some point, which can substitute for our system, but when we get to that, then [we will have developed something new, hopefully]” (Int. 2, 2012).

Ascribing value to software

This competitive race is being construed as if the value of software had risen over time. While software codes were not treated as strategically important in the initial phase by Chinese actors, instead being treated as ”freeware all of it” (Int. 41, 2013), associations qualifying software have changed over time, raising the value of software. Traditionally, Chinese “people don't want to pay that much for software” (Int. 34, 2012):

“Chinese customers think the software is relatively unimportant, worthless. We don’t focus on software, don’t emphasise software. So we have to understand the idea of the Chinese customers, Chinese customers value the hard things, not soft things” (Int. 40, 2012).*

The lack of appreciation of the value of software is, in addition, being linked to the level of experience and the length of the company’s R&D-background:

”If you meet a newly established customer in China, then they don’t understand that it [software] costs a lot of money, but the large ones, they understand. So even though they try to push you, they know…there’s a reason why they are sitting there, I don’t know how many hundreds of people, looking at some nitty-gritty stuff…so they know” (Int. 41, 2013).

In the gradual process of upgrading, Chinese actors seem to have started out by building indigenous capabilities within the least complex components, as well as within the components, which are taking up the largest share of the turbine’s cost structure. Consequently, Chinese actors have only relatively late started to focus on the main control software, as this is one of the most advanced components, and a component which does not take up the largest share of the cost structure.

"Like the components with most intelligence built-in, this is what can be protected more easily, right. I guess this is how companies have looked at it. They have seen that and concluded, well, we'll start out with the tower. Produce it from the knowledge that we have. Blades…now coming into focus. That you are producing something also means that you are building up some knowledge. Somebody must understand why it must be done like this, and then…you are building up knowledge" (Int. 35, 2013).

Over time, as a quality crisis has been produced over time, and as Chinese actors have built own capabilities, the focus of Chinese customers has increasingly turned towards control systems and software (Int. 15, 2012).

Producing matters of concern in the potential software-TEN

In the above, some of the socio-technical barriers to reverse engineering have been indicated. Further, it has been indicated that a struggle for access to source codes is critical for the attempt to upgrade by Chinese WTMs. Stumbling upon barriers to source codes, i.a. due to the boundaries and framings set up by IPRs, relations have become unstable. In the following, the chapter dives further into some of the matters of concern that the software-TEN is producing, as a controversy is configured over the 'pacifying' framing tool of IPRs. This controversy can even be mapped in light of international debates on IPR and China's innovation strategy and legacy of technology transfer. First, matters of concern of Chinese actors are outlined, which leads to an outline of matters of concern of foreign actors in the emerging controversy over IPR.

Matters of concern for Chinese actors and the stem issue of China's sustainable development

As indicated earlier, there seems to be socio-material resistance to the development of indigenous innovation capabilities of Chinese actors, e.g. as there are barriers to reverse engineering of software. Hereby, the framing of the potential wind power- and software-TEN, as means of Scientific Development towards China's Sustainable Development and a Harmonious Socialist Society, risks to be destabilised. In the following, the chapter looks into some of the issues and concerns by Chinese actors within wind power, as they face potential limits to upgrading from technology sourcing.

Limits to conventional acquisition of technology and capabilities

Facing barriers to reverse engineering of software problematises China's legacy of a 'technology for market' strategy, as the issue of software makes the continuous dependence of many Chinese WTMs on foreign licenses and software technologies visible. This concern is e.g. expressed by the political pole in the 5YP S&T Wind Power (2012*). That is, while "[E]arly on, our wind turbines relied mainly on the introduction of foreign design techniques or on joint design with foreign agencies" (5YP S&T Wind Power (2012*), 2, 1(1)), China has upgraded in various fields. However, Chinese new wind turbines still suffer from insufficient capacity, e.g. as China lacks software tools for wind turbine design with independent intellectual property rights, and as China lags behind in terms of conducting independent design and R&D according to the environmental wind resource conditions (5YP S&T Wind Power (2012*), 2, 1(1)). Improving these areas is framed as critical to improve wind power equipment performance, "and to protect the Chinese wind power industry's sustained, rapid, and steady growth" (5YP S&T Wind Power (2012*), 2, 1(3)). Further, the 5YP S&T Wind Power (2012*) states that China is

"[f]ocused on solving the key scientific and technological issues associated with the ability of independent innovation. Based on the status quo and trends facing the development of wind power in China, key technologies of wind power with independent intellectual property research should be promoted" (5YP S&T Wind Power (2012), 3,2).*

Here, a narrative of China's victory and victimisation (by foreign patents) seems to be indicated. This narrative device of China's subjugation is also reflected in the earlier MLP S&T (2006-2020), which states that "experience shows that developed countries are unwilling to transfer core technologies in China" (MLP S&T 2006-2020). Hereby, "the importation of technologies without emphasizing the assimilation, absorption and re-innovation is bound to weaken the nation's indigenous research and development capacity" (MLP S&T, 2006-2020). Consequently, the MLP S&T "warns against blindly importing foreign technology without plans to transform it into Chinese technology" (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 4). Accordingly, stressing the importance of "[i]ndependent [indigenous] innovation" as the essence of China's innovation strategy (chinaipr.gov.cn, Jun. 10, 2014), the Chinese President, Xi Jinping, has recently stressed that China strives towards "important breakthroughs in key technologies, and [towards] master[ing] crucial technologies into our own hands" (chinaipr.gov.cn, Jun. 10, 2014). This concern for owning core technologies seems to have been translated to customer-supplier relations around controller software:

”We have this discussion on source code. But it’s the decision of the Government, that now they need to have their own IPR, that is to say…they have to own the source code (Int. 42, 2012).

As focus seems to have moved gradually from absorbing technology to owning and developing it indigenously, the present analysis, however, has illustrated that there may be socio-technical barriers to indigenous innovation. While ‘Scientific Development’ and indigenous innovation has been framed as an ‘elixir’ of the Chinese Government to realise ‘the great renaissance of the Chinese nation’ through ‘innovation with Chinese characteristics’ (in McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 3), the thesis may have displayed some of the overflows, or the ‘bitter taste’, of this ‘elixir’. That is,

“the ’Trade Market for Technology’-policy, didn’t work as expected. They have spent more than 20 years to attract foreign companies and learn, but there is still not one single completely indigenously designed Chinese wind turbine. When there’s some, the core technology, the software, is foreign. Or the capabilities have been bought, through mergers and acquisitions (M&A) and foreign employees” (Int. 36, 2013).

The concern for indigenous innovation as part of China’s sustainable development is producing a controversy over IPR in the software-TEN, which is entangled in concerns over China’s legacy of technology transfer and technology sourcing. In this controversy, relations between Chinese WTMs and foreign control system suppliers are being continuously de- and reconfigured around negotiated ‘algorithmic boundaries’.

New business models for technology transfer?

Whereas the depicted customer-supplier relations engaged in conventional technology sourcing/technology transfer licensing agreements seem increasingly unstable, it appears that Chinese companies are in the process of experimenting with new business models, including more transfers of IPRs. In regard to China’s wind turbine industry,

”[t]he other business model that appears to have proven successful is one in which both technology and IPR were transferred from a foreign company to a Chinese company and ownership was fully in the hands of the Chinese company” (Lewis, 2013: 111).

For instance, Chinese WTMs increasingly engage in mergers and acquisitions (M&As) to upgrade their capabilities and to acquire full ownership of IPR (Lewis, 2013: 111). This is e.g. seen in the case of Goldwind and its acquisition of a 70 per cent stake of Vensys in 2008. ”Becoming the controlling owner of the company, gave Goldwind more power over the direction of Vensys’s R&D activities, as well as fewer constraints on access to its intellectual property” (Lewis, 2013: 124). Goldwind now has R&D facilities in China and Germany and has built R&D capacity through collaborations with universities and research institutes in China and overseas, e.g. with DNV GL and Aerodyn (Lewis, 2013: 122-126). However, due to the high cost of M&As, smaller companies and component suppliers are still engaged in traditional technology transfer (Lewis, 2013: 113). As regards acquisition of software companies, this is at the present stage still largely considered too costly by Chinese WTMs:

"There was someone asking me yesterday: 'If we want access to all of it, what would the price be?' Then I said, 'I guess that it will cost you two billion, and then you acquire X [foreign control system supplier]'. 'Well, that might be a bit too much at the moment' [they replied]" (Int. 2, 2012).

Lacking long-term experience and basic research in aerodynamics and algorithmic mathematics, moving ahead in terms of control system software and indigenous wind turbine design "won't", according to some, "happen until the day when they buy some company" (Int. 42, 2012), however.

Wider matters of concern of foreign actors in China

While Chinese actors are concerned about limits to reconciling the two innovation strategies of technology sourcing and indigenous innovation, the potentially emerging software-TEN in Chinese wind power is also entangled in wider concerns of foreign companies in China. Foreign companies tend to be concerned about the lack of protection of IPRs and the protection of Chinese wholly or partly state-owned companies. Taking the case of the Sinovel-AMSC trial,

"the whole world is just looking at this case, because the evidence is so obvious. It's like, there are emails, there is money...it's like, I did this, it's so obvious that it happened, but it's still in trial. And I think the rest of the world is looking at this very seriously, as like...okay, this is as obvious as it can possibly get, it is completely obvious that it happened, everyone knows that it happened - does China actually penalise that? I think if they do, it will be a very good and important moment in China's history, but if they don't, it will be equally as damaging. It's like even with an email saying 'I'm doing this', you can showcase them the money, and they took the thing, they sold the codes...It's like, I can't even protect…something that obvious..and I think companies will actually become even more protective" (Int. 11, 2012).

The seeming weak enforcement is considered to make it difficult to 'find the smoking guns' (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009). These concerns link up to wider concerns that China's official strategy of "enhancing original innovation through co-innovation and re-innovation based on the assimilation of imported technologies" (MLP S&T, 2006-2020) is a way of "tweaking foreign technology" in order to "create its own intellectual property and proprietary product lines" (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 4). In this way, the controversy configuring over IPRs between customers and suppliers of control system software seems entangled in international concerns over China's so-called techno-nationalism, in which the strategy of indigenous innovation is sometimes framed as a Chinese "blueprint for technology theft on a scale the world has never seen before" (McGregor/APCO Worldwide, U. S. Chamber of Commerce, 2009: 4, 6).

Entangled controversies – and China's exclusion from the 'good international club'

Overall, the controversy over contested algorithms seems to be entangled in wider international controversies over IPRs as well as over China's upgrading and catch-up. Taking the case of the AMSC-Sinovel IPR infringement case, the 'international' nature of the dispute can e.g. be seen in how the American Federal Bureau of Intelligence (FBI) has been drawn into the investigation of the incident, and how Chinese spy agencies and buildings of People's Liberation Army (PLA) are suspected to be involved, due to China's "far-reaching industrial espionage campaign by Chinese spy agencies" (Riley and Vance, 2012, Bloomberg/Bizweek). As stated in an article by Bloomberg regarding the AMSC-Sinovel case:

"In terms of outright theft of intellectual property, there is growing evidence that China's intelligence agencies are involved, as attacks spread from hits on large technology companies to the hacking of startups and even law firms" (Riley and Vance, 2012, Bloomberg/Bizweek).

In turn, such foreign fears counter Chinese fears for barriers to upgrading and catch-up. In the construction of such competitive zero-sum game, the space for Sino-foreign collaboration becomes unstable. For instance, the lack of trust in IPR enforcement in China has produced processes of exclusion:

"China is not received, they are not being full participants...they are not even being allowed to be full participants in the innovation community, because people are proactively not including them, because, I'm nervous about sending them things, like sharing my innovation, because I don't have confidence that they are going to be protected" (Int. 11, 2012).

Not being 'received' into the 'good international club', Chinese WTMs are predicted to face difficulties when going abroad, as "the trust level is simply not there" (Int. 11, 2012). In this way, while China also frames the issue of IPRs as a matter of "establishing the nation's credibility and image in international cooperation" (MLP S&T, VIII, 4), and of ensuring the 'sustainable development' of wind power (5YP S&T Wind Power), IPRs, as 'pacifying' framing tools, not only include, but often also exclude in the case of marketisation in Chinese wind power.

Conclusion and theoretical considerations – controversy over IPRs

Due to the critical role of China’s legacy on foreign licenses, *Chapter 9* has traced one part of the emerging software-TEN, namely customer-supplier relations around main control software. In the analysis, a controversy over IPRs, which configures around core algorithms of the wind turbine’s main control within the potential software-TEN, has been mapped. In the marketisation processes, IPRs are seen as important framing devices, as they confer ownership on specific entities to the exclusion of others (Callon and Çalişkan, 2010a: 7), and thereby help ‘stabilise’ and ‘pacify’ the boundaries of ownership.

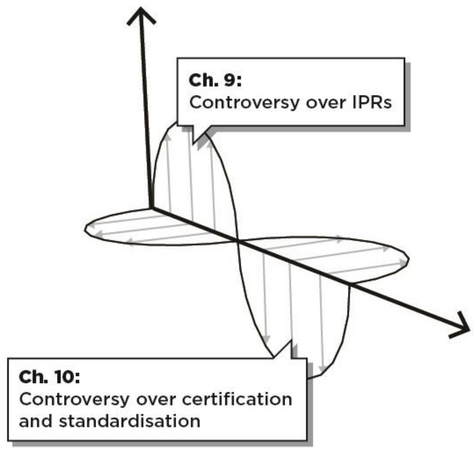
However, the analysis illustrates how the *pacification of goods* through IPRs can engender controversy. That is, rather than pacify, the framing tool of IPRs seems instead to have destabilised relations in the potentially emerging software-TEN, as IPRs (as well as i.a. algorithms and capabilities) create a seeming socio-material resistance to upgrading within software. In turn, such destabilised relations may threaten to destabilise the framing of wind power as technologically, scientifically, and even developmentally sustainable. Hereby, IPRs seem to produce a controversy as Chinese actors refuse the proposed framing of ownership to algorithms. That is, with new emergent ‘identities’ of Chinese WTMs and other actors, the framings of IPRs and technical locks, deployed by foreign software developers for control systems, are increasingly rejected. With shifting ambitions and agendas, this has made collaborative customer-supplier relations around control systems highly fluid and contested, rendering the boundaries of ownership (e.g. through IPRs) highly negotiable.

In the potential transition and move from quantity to quality in China’s emerging wind power-TEN, software algorithms seem to be transformed from an intermediary into a mediator/actor (Callon, 1991; Latour, 2005a), as they come to have an effect on the networks that they co-configure by de- and reconfiguring relations. In addition, IPRs have emerged as actors, as they produce controversies. In turn, the depicted emerging software-TEN around control systems is entangled in an ‘international’ controversy over IPRs and China’s indigenous innovation policy. Overall, the potential software-TEN configures a ‘global’ zero-sum game. This ‘competitive space’ increasingly constitutes a ‘hybrid forum’ (Callon, 1998: 260), as myriads of unforeseen actors, such as core algorithms, aeroelastic codes, agents, buildings of the People’s Liberation Army, cyber wars, and encryption devices are being enrolled. In this way, the analysis indicates how there is no straightforward opposition between the realm of technology and the realm of politics - or between technology and human and social capacities (Barry, 2001: 7-8). Having illustrated the dynamics of one central component in China's innovation policy, namely IPRs and patents in relation to main control software, *Chapter 10* looks into a controversy over another framing device, namely standardisation and certification, which forms a central component of China's innovation policy as well as of the emerging wind power-TEN's qualification struggle.

Chapter 10. Controversy over Standardisation and Certification in the Potential Software-TEN

On my way to the next interview, I wonder how the potential qualification struggle may play out in terms of testing, certification, and standardisation. My respondent – a foreign wind turbine manufacturer – gives me part of the answer. Indeed, the qualification struggle also takes place through standards.

Figure 16: Controversy over certification and standardisation



> *"And they [the Central Government] take control, because of the quality issues that we have seen. Simply – the market wasn't well run. And you can see the outage in the grid system – for China it was a wake-up call. We suddenly see the entire grid falling out, because of the poorly connected wind turbines. Then Beijing needs to take control – and rightly so. And they should have done so a long time ago, because now they are finally putting in standards and requirements for a higher quality. Standards and requirements for other [things] than just [installing] Megawatts into the ground, and that means that I am a bit hopeful again".*

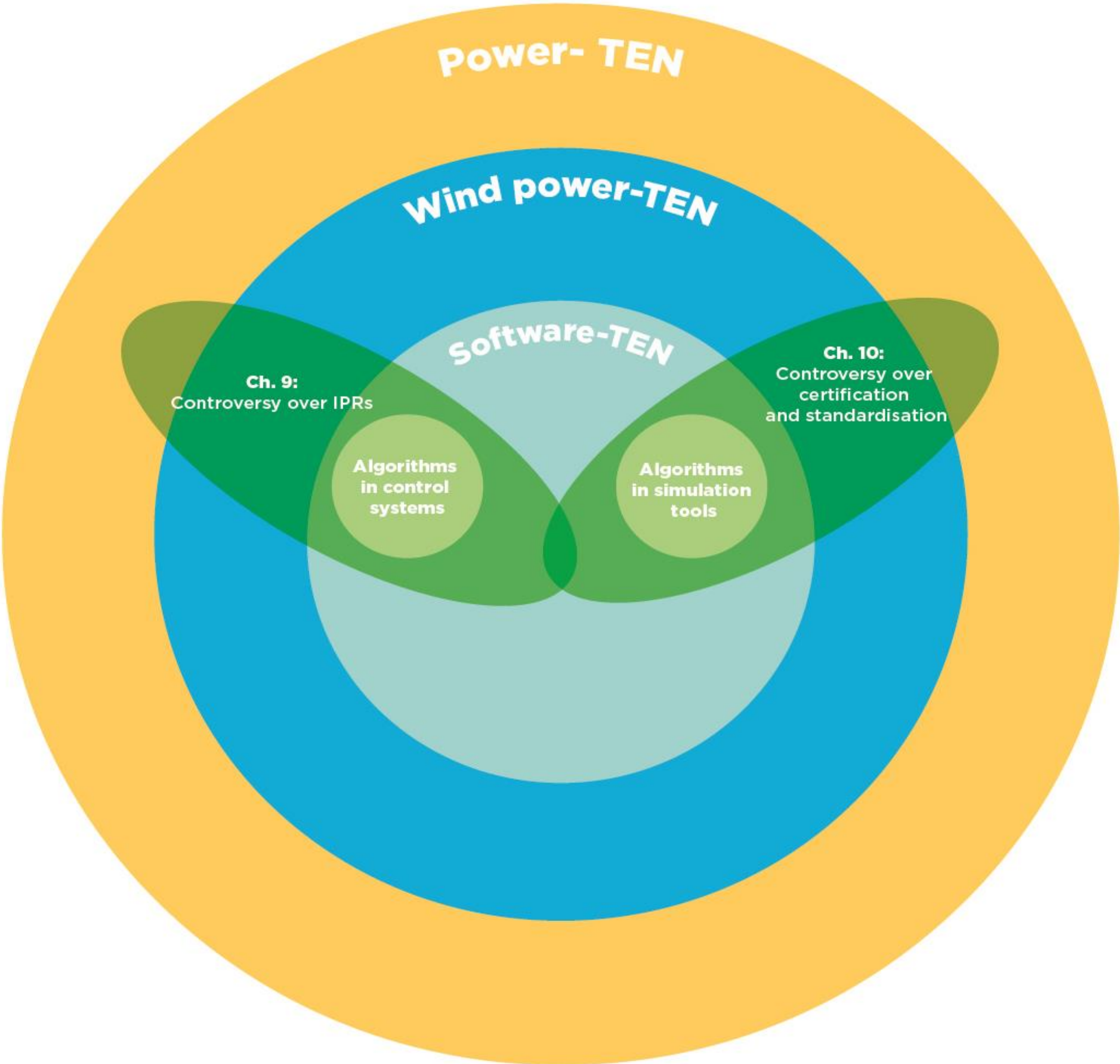
Conversely, other foreign actors in China question this qualitative shift. That is, "quality products are not the scope for the market right now. So there's no scope for foreign quality products. Maybe this will change, but I'm not sure it will – or at least it will take a long time". Indeed, something new might be happening in China's emerging wind power-TEN and the potential software-TEN, but what and how remains somewhat of a riddle to me.

Standardisation and certification and the case of aeroelastic codes in simulation tools

The previous four *Chapters 6-9* have displayed how a 'turn to quality' seems to be taking place in the emerging wind power-TEN in China. In *Chapter 9*, an 'algorithmic' controversy-mapping was undertaken. This was done by inquiring into a controversy produced by the framing tool of IPRs, which configured around software algorithms. Hereby, the analysis looked into the controversies that the *pacification of goods* can engender in the struggle to qualify wind power as sustainable. The overflowing from the pacifying framing tool of IPR has destabilised collaborative customer-supplier relations around control systems, simultaneously producing a competitive space, which renders the emerging software-TEN unstable. Diving further into dynamics of the *pacification of goods*, *Chapter 10* in the following conducts another 'algorithmic' controversy-mapping. This is done by diving into another part of the potential software-TEN, namely mapping a potential controversy over certification and standardisation, which configures around algorithms in simulation tools used for simulating and certifying turbine designs. This is indicated in *figure 17* below.

Improvements of China' certification and standardisation system constitute, along with the IPR system, critical parts of China's innovation strategy of indigenous innovation, in particular since WTO accession.

Figure 17: Zooming in on controversy certification and standardisation



Source: Own design

Firstly, the chapter provides a general overview of the performative role of standards for international trade and upgrading, as standards function by (temporarily) stabilising qualities associated to wind turbines. Abiding by the definition, one amongst many, of a standard "as a rule for common and voluntary use, decided by one or several people or organisations" (Brunsson et al., 2012: 9), the thesis focuses primarily on China's attempts at compliance with open,[72] international, *de facto* (as well as *de jure*)[73], technical standards[74] (Ernst, 2013: 4-5) for wind turbines, in which testing and certification according to a specific standard is needed. Secondly, the chapter looks into the case of China's emerging wind power-TEN and the emergence of actors of a potential software-TEN, configuring around the issue of standardisation and certification in China. Thirdly, the emergence of such a network around certification and standardisation is linked to the potential turn to quality taking place in the potential wind power-TEN. Fourthly, to look at how attempts at upgrading through international certification are unfolding in practice, the chapter dives into an algorithmic controversy-mapping, which focuses on collaborative relations around critical simulation tools. This renders an account of how relations between Chinese and foreign actors are being de- and reconfigured, as roles and positions are being contested. Lastly, this provides a basis for an illustration of how an emerging controversy over standardisation and certification is entangled in a struggle for defining 'quality' as well as in a global trade conflict on protectionism in which issues of both IPR and standardisation are entangled.

The role of standards for international trade and innovation

Apart from regulatory standards, such as IPRs in the form of the TRIPS Agreement (Maskus, 2002: 139) having an impact on international trade within the framework of WTO, international and domestic industrial and technical standards also play an important role in WTO in terms of their impact on international trade (Maskus 2002: 144) as well as on innovation (Ernst, 2013). To set the context for understanding the 'qualifying' and 'pacifying' role of standards in marketisation of wind power, the chapter first looks into the conventional lens on the role of standards for international trade and, subsequently, for innovation.

[72] Standards can be distinguished i.a. in terms of whether they are *proprietary*, implying that they are owned by a company that may license them to others, or *open*, which means that they are available to all potential users, usually without a fee (Ernst, 2013: 4-5).
[73] Another distinction is the difference between *de facto standards*, which are being adopted through a standards competition amongst rival standards consortia and *de jure*, which are being adopted through consensus, sometimes expressed through industry committees of formal standards organisations (Ernst, 2013: 4-5).
[74] In addition, standards can e.g. be distinguished by being either international or national in nature, or by constituting industrial or technical standards.

The qualifying role of standards – identify your ruler!

Since standards basically work to "ensure the quality and safety of products, services and production processes" (Ernst, 2013b: 1), standards are seen as important tools for furthering international trade, FDI, and technology licensing (Maskus 2002, 144). That is, standards and standardisation help establish trust in products and trade, as standards are basically providing shared, consensus-based codification and certification schemes for how to measure and evaluate the quality of a product (Espeland and Stevens 1998 in Brunsson et al., 2012: 19; Star and Griesemer, 1989 in Stark, 2009: 194; Bowker and Star, 1999: 33: 32). Thus, certification works to confirm compliance of a product or service with defined standards/requirements (Germanischer Lloyd (GL) (2010b): 2). As they contribute to making things comparable, standards enable value calculations of the product. That is, "standard setting produces shared rules that guarantee that products will be compatible. This process facilitates exchange by making it more certain that products will work the way they are intended" (Fligstein, 2001: 35). In order to make things comparable, a host of measurements and tools must be used to reduce the potentially multiple and conflicting 'qualities' (and values) of a product. That is, standardised testing and certification procedures help to quantify, classify, codify, and categorise (Brunsson et al., 2012: 5; Ponte and Cheyns, 2013: 461; Bowker and Star, 1999; Thévenot 2009: 808; Gibbon and Ponte, 2005: 15) in a comparable manner. As expressed through the analogy of a Chinese expert in the wind power-TEN, standards provide consensus on a common 'ruler', just as when (centi)metres are measured:

"A standard is used to detect a 'ruler'. It is to guide the foundation of your work, your basis for certified testing […] Do you have a ruler…this job [of certification] could not be done without a ruler" (Int. 21, 2013).*

By providing a common 'ruler', trust in the qualities of a product can more easily be established, which in turn facilitates market transactions (Fligstein, 2001; Gibbon and Ponte, 2005: 15, 8; Thévenot, 2009: 802; Brunsson et al., 2012: 4, 17-18; Ponte 2009; Ponte and Cheyns, 2013: 461). Hereby, standards are critical framing tools, which function to *pacify* the quality of the emerging good in processes of marketisation (Callon and Çalişkan, 2010b).

International standards within wind power

In terms of wind power, an international standard series for wind turbine design (type/model) certification (the IEC-61400-22 standards series) by the *International Electro-*

Technical Commission (IEC) – an international standard-setting organisation for all electrical, electronic, and related technologies[75] - has been developed over the last decade(s) to unify national certification programmes and demands and promote free trade (CRESP, 2005: 61). In addition to standards for turbine design (Type Certification), standards also involve i.a. wind turbine and project certification for complete wind farms as well as components to enable subsuppliers to enter the market (Germanischer Lloyd (GL) (2010b: 2). These standards have been gradually

"accepted, so it's actually de facto. It's very good to have just one, instead of having all these national standards to consider…so these are the standards that everybody is navigating by" (Int. 14, 2013).

Construed as 'de facto' standards, many countries have gradually aligned their national standards with international IEC standards; that is, "a lot of them have been turned into national standards, and also in China. As well as in Germany, and in Denmark" (Int. 14, 2013). That is, over time, a "complex" of harmonised standards

"has been developed gradually through the last ten years. It was [beginning] around the year 2000, I think. But it's only within the last five or six years that it has really played out. Before that, it was national standards. In the '80s and '90s, right, then there was a standard in Denmark, one in Germany, and one in the Netherlands" (Int. 14, 2013).

Also certification procedures are being gradually aligned across national boundaries, "so now you fulfill [the standards]…or you certify in accordance with these international standards, and then there might be something additional…And then it will be approved in Denmark also, and in Germany as well" (Int. 14, 2013). Hereby, ensuring that the product can be approved across borders, standards and certifications co-perform international trade:

"Certification of wind farms, turbines or components is state-of-the-art and a must in most places around the world. Furthermore assessment to harmonised regulations is an active support of export and eases market entries" (Germanischer Lloyd (GL), 2010b): 1).

Overall, international standardisation of wind turbines is "a guarantee of confidence in the international market" (Int. 14, 2013).

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[75] Certification of important components and complete machine is included in type certification (CRESP, 2005: 62). Type/model certification implies coherent evaluation of new types of wind turbines via design evaluation, tests, and field inspections (CRESP, 2005: 60), e.g. including design assessment, foundation design assessment, performance test, type test, production quality control (CRESP, 2005: 59).

Establishing trust in wind turbine quality through standards

In this way, international standards act as an obligatory passage point in terms of building relations to customers, national authorities, and financial institutions, since “if the Chinese companies do not have an international certification, nobody will finance it, and no local authorities will approve it” (Int. 32, 2012). Providing a guarantee that the turbine has been designed and manufactured according to design conditions and appointed standards, and that wind turbines are installed, running, and maintained according to the demands of the design documents (CRESP, 2005: 60), the design standard IEC 61400-1 works as a framing device, ascribing associations of i.a. performance (e.g. power curves and power output), safety, reliability (related to the downtimes/faults of wind turbines), and availability to wind turbines. That is, standards serve as a calculative framing tool, which can establish calculative agencies, which make it possible to calculate e.g. maintenance costs, lifetime cost of energy, suitability for on-site wind conditions, adaptability to special environmental conditions, and to grid compatibility (Vestas-CWEA, 2011).

First and foremost, a certified wind turbine implies a guarantee of a turbine-specific power curve. This creates certainty of output (and economic performance) from the wind turbine, which in turn is dependent on the optimisation of the relation between *loads, aerodynamics*, and the *control system/controller* (LAC) during simulation and testing. By producing a power curve, the certification acts as a warranty for the owner, as it offers “a guarantee for the owner of the power curve, which again has a financial impact for the owner” (Int. 11, 2012):

”If you can guarantee 99 per cent [of the power curve], that has a bigger impact on the operator’s budget, than taking a little off the price [in the price negotiation]” (Int. 11, 2012).

Apart from power curves as a guarantee of ‘performance’, metrics for availability and reliability refer to whether or not a turbine is “ready to run” and, thus, capable of producing electricity and revenues (when the turbine is not curtailed, that is) (Int. 22, 2012). Further, safety is considered ”the key point” of the standardisation process in China, that is: ”[t]hey all have to be constructed in a way that ensures that they don’t fall down” (Int. 14, 2013). Lastly, standards for power output can produce associations of ‘smoothness’ to the quality of wind power output, minimising the risk of grid disturbance (Int. 36, 2012; Int. 52, 2013). When turbines conform to consensus-based standardised measures, they help stabilise a framing of wind power as technically and economically sustainable, potentially reducing resistance against wind power.

The tested and documented certification triangle in accordance with standards

The basic function of a standard is that the standard guarantees that the design is documented, and "that you have used a renowned standard to control it" (Int. 14, 2013). In turn, certification of a wind turbine design consists of recursive processes of (1) computer calculations with a software simulation tool, (2) testing, and (3) documentation in what may be termed a 'certification triangle' (Int. 14, 2013):

"You can say it's like a triangle. You simulate the turbine, and then you find out, aha, I want a turbine which regulates [controls] like this" (Int. 14, 2013).

Put simply, certification is a process of proving/demonstrating to accreditation bodies that what you calculated/simulated was right (Int. 14, 2013).

"Actually, it's not so complicated. First, you must make a code [for simulation]. And then you have to make it [build a prototype and test it]. And then you must find out whether it works [...] And, if it doesn't work [as calculated/simulated], then you must re-enter the code and find out how things [work]" (Int. 14, 2013).

As the simulated/calculated turbine design must include the principle of the turbine regulation (controller/main control), certification involves an intricate interplay between a simulation tool and the controller. When having gone through all three steps of the 'triangle', the turbine should be "pretty optimised*"* in terms of the proper relation between load, aerodynamics, and control (LAC) (Int. 14, 2013). Finally, after having conducted iterative calculations, tests in a myriad of wind scenarios, and calibrations, the turbine's performance must be documented and inscribed into a host of certification documents, documenting how

"the turbine will not fall down, right. You can do that on the basis of load calculations, showing that when the wind blows this much, then the load on the turbine will be like this, and then the tower will bend, and then…and then what they do is asking, 'well, what about if something else happened? What if the one blade fell off, what then!? What if one blade cannot pitch, what then?! What about the other two blades then? How can you prove this?' And then you have to document how…all these cases" (Int. 9, 2012).

Through standardised certification processes, written into thousands of documentation pages, (temporarily stable) associations of technical and economical 'quality' and sustainability can be ascribed to the wind turbine. Hereby,

"[c]ertificates and signs of certifications awarded by the certification organizations are authority guarantee of products' quality, which are independent of the both sides of supply and demand. Consumers can diff[erentiate] good products from bad ones according to certificates and signs of certifications, thus improve[ing] purchase confidence" (CRESP, 2005: 57).

The role of standards for innovation

Apart from its impact on international trade, another widely held viewpoint is that ”standards are the lifeblood of innovation in the global knowledge economy” (Ernst, 2013b: 5). As international standards are spreading, this is argued to lead to the proliferation of specific knowledge, ideas, and inventions, e.g. as nations, which aspire to conform to the standard, must seek to develop technologies to support the standard (Ernst, 2013b: 7). Thus, ”technical standards contribute at least as much as patents to economic growth. As a key mechanism for the diffusion of technological knowledge, technical standards contribute to productivity growth” (Ernst, 2013b: 1). Conventionally, a well-functioning standardisation system and strategy is thus framed as a critical catalyst for industrial development and independent innovation (Wang et al., 2010: 12; Ernst, 2013b).

Certification spurring research and development of Chinese wind turbine designs

The role of standards for industrial innovation is also recognised within wind power in China (CRESP, 2005: 54-55). For instance, the process of adapting the largely European-based standards to Chinese conditions is seen as a matter of technological development:

*“In fact, the development of technology also includes standardisation, so, that is to say, if future standardisation is made well, then it will also promote the development [of the wind turbine industry]” (Int. 21**, 2013).*

Certification in accordance with international standards has e.g. spurred modified designs, which fit China’s particular climatic conditions where typhoons and low-temperature conditions are common. Pushing to comply with international standards, while modifying standards and writing their own standards, Chinese actors (research institutes, certification bodies, test laboratories, WTMs etc.) are thus claiming to upgrade (indigenous) capabilities and support the progress of the wind turbine industry. For instance,

*“in case of low temperature problems, we may want to write our own standards, but we must certainly first comply with the international [standards] for the large core [components]…unless you have some special circumstances, such as typhoons, which are not prevalent in Europe […] I use this example to say that standards, testing, and certification also support technical progress of the industry, leading the development of the industry” (Int. 37**, 2013).*

Further, since certification according to standards requires a lot of documented data, it is also recognised that after collecting the necessary data, the data will

“guide your revision of the standards, guide your research, guide your technological progress, so this [data and certification] work we are doing…we have established a large data collection center, and then run all the data collected, pooled it. I think after doing this, it will not only raise the quality of

China's wind power equipment development, but also have a great role in promoting global development" (Int. 37, 2013).*

Overall, certification is linked to China's upgrading of indigenous innovation capabilities as well as to the promotion of Chinese and global wind power. Due to its role in raising quality of wind turbine equipment and indigenous capabilities, certification and standardisation can thus serve to stabilise (and pacify) associations to wind power of technical and even scientific sustainability, and thus align with the overall means of Scientific Development towards China's Sustainable Development.

Upgrading of wind power technology through standards – and lagging behind latest editions

Overall, as wind turbines have become more advanced and 'intelligent' over time, as well as scientifically complex, and as wind power takes up larger shares of electrical grid systems, certification and standardisation (and its gradual alignment across borders) has become increasingly important to the continuous, sustainable development of global wind power. Levels of certification tend to reflect the technological and scientific level of national wind turbine industries. With a longer history of their wind turbine industries in Europe and the US than in China, it is widely recognised that the certification and testing systems in Europe (and the US) are at a more advanced level than in China (CRESP, 2005: 55). Facing quality issues and lagging behind the most advanced turbine designs (and their certifications), the current potential shift towards a larger focus on quality in China's potentially emerging wind power-TEN has led to an increased focus on the importance of certification and standardisation. Having displayed some of the processes of standardisation of wind turbines, the following sections provide an insight into standardisation by specific organisations.

Involved actors in standardisation and certification

In the above, the analysis has inquired into the role of standards for international trade and innovation. To certify according to standards, a variety of different actors are involved. In the following, the chapter therefore briefly looks into the international actors involved in IEC standard-setting and certification. Overall, the IEC complex is:

"a series of standards, which describes both…both how to certify it – that is, what is the certifying institution supposed to do, when they certify. And then there is a series of standards, which specify how you are supposed to document it technically, how you should calculate it and things like that…and how you should test this and this and that... So it's like an integrated system" (Int. 14, 2013).

First of all, in accordance with international practice, national accreditation institutes are granted the right to accredit certifications, certifying institutions, and test laboratories, “looking after that they [certifying institutions, test laboratories] are doing it right. And that they are accrediting according to a standard” (Int. 14, 2013). Further, because “you cannot approve of what you have done yourself” (Int. 14, 2013), accreditation, testing, and certification processes cannot be undertaken by the same institution. Only a few internationally recognised certification bodies have been accredited to certify according to the IEC standards, among those Germanischer-Lloyd (GL) and Det Norske Veritas (DNV). These two have recently merged, also including a merger with the consultancy company Garrad Hassan (GH), as mentioned in earlier chapters. Together, the three organisations constitute DNV GL. In addition, GL (now DNV GL) has developed “the most authoritative and widely used criterion” for wind turbine system certification (CRESP, 2005: 61). In addition to certification bodies, test laboratories must be accredited to conduct accredited tests in accordance with IEC-standards. For instance, among internationally accredited test laboratories are the Technical University of Denmark (DTU/Risø) and COWI in Denmark (Interviews).

Gradual development of international wind turbine standards

The complex of the international wind turbine design standard series is continuously evolving. For instance, IEC working groups, constituted by i.a. test laboratories, certification bodies, research institutions, nations, WTMs, design houses, and component suppliers, are negotiating and developing new and adapted standard editions. The standard of the overall turbine design employed in wind power is the International Standard IEC 61400-1, which encompasses around 22 international general wind turbine-specific standards. This design standard has been published in three editions (Int. 14, 2013; IEC, 2005). Despite attempts at harmonisation across countries, the requirements by certain editions of standards still differ, even between European countries (Risø DTU, 2008; DNV, 2011; Germanischer Lloyd, 2010b; Germanischer Lloyd, 2010a; IEC, 2005). Whereas the first edition of the IEC 61400-1 standard is considered outdated, the second edition from 1999 (‘IEC 61400-1:1999’) is still serving as national standard in some countries, including China. Some countries (i.a. Denmark) require the third edition from 2005 (‘IEC 61400-1:2005’) (Germanischer-Lloyd, 2010a; IEC, 2005; Interviews). Focused on safety issues, the latest standard pays more attention to large turbines and includes more critical load cases, i.a. emphasising the inclusion of turbulence simulations in the load calculations and extreme load extrapolation, which have not been foreseen in the second edition (Int. 14, 2013; IEC, 2005: 5; DTU Risø, 2008). Still using the second edition, China is “still one step behind the IEC standard” (Int. 53, 2013), which is “bad news for the Chinese wind energy industry and WTMs”, as WTMs and wind turbine developers abroad are in general very active in this regards (Int. 53, 2013). As IEC standards are gradually updated, certification schemes for design assessment (GL) have been updated and harmonised accordingly. Today, GL's Guideline for the Certification of Wind Turbines (GL 2010) has become a widely used international certification standard, and test laboratories such as DEWI and DTU Risø follow these (Interviews). Hereby, certification ensures compliance with IEC standards in terms of various security and quality criteria for specific type certifications (Germanischer Lloyd, 2010b).

Lagging behind international standards - and Chinese concerns about upgrading

In the following, it is illustrated how the lack of a long track record, a poor reputation in terms of turbine quality, along with a short tradition of certification and standardisation as domestic wind turbines and components have not been subject to obligatory certification (García, 2013: 138-139) in China, have had implications for China's export ambitions. This leads to an inquiry into the potential turn to quality in China's emerging wind power-TEN and an outline of an emerging network for certification and standardisation in China.

Standards as trade barrier to Chinese wind turbines – and the increasingly critical issue of exporting

Only following the second edition of the IEC 61400-1, Chinese turbines are excluded from the most mature and developed wind power countries (Interviews), and most Chinese wind turbine exports have so far been to less advanced wind power regions (Interviews). Overall, exports of Chinese wind turbines is still remarkably low (Int. 1, 2013; Wang et al., 2010: 6). Even though China has succeeded in building a certification and standardisation system within only a few years, in compliance with IEC-standards, Chinese WTMs still have problems selling their turbines on the international market (Interviews). This is linked to the way in which "certification in China is *de facto* not a requirement" since "it is only required that they simulate the design, not the prototype" (Int. 54, 2012). The lack of obligatory certification (García, 2013: 138-139) and the short background within certification and standardisation within wind power is argued to have resulted in a large amount of turbines with an unsustainable design (Int. 54, 2012). However, to be exported,

"they must be certified. How to do that, they have to find out themselves. And then [when they have succeeded] they can become suppliers to some of the international projects. But if they cannot get them certified, then they cannot become suppliers" (Int. 20, 2013).

Often lacking certification, and often producing a lower output than foreign wind turbines, foreign investors, customers, financial institutions, and insurers are claimed to lack confidence in Chinese wind turbines (Interviews),

"because this is a risk-infused business. With enormous up-front capital expenditures. Will they take that bet? […] You need a fully GL certified, proven, and tested Chinese turbine before any serious utility will put their money out there. I guarantee you that. I am not saying it isn't coming. It just isn't there now" (Int. 1, 2013).

Hereby, "certification is a matter of attempting to gain confidence from customers" (Int. 32, 2012). Chinese WTMs acknowledge that they, when compared with more mature, foreign wind power markets, lack a long track record and history of standardisation, certification, and testing in wind power. As Chinese WTMs "just started" (Int. 21*, 2013), Chinese wind turbines "are perceived as less reliable and lower quality" (Int. 11, 2012). Further, they are not considered competitive, that is, "they're not good [economic] performance, basically" (Int. 11, 2012). Acknowledging this, Chinese WTMs state that "we don't know the international market […] For the European market, we need local research to develop the right standards for Europe in order to meet the requirements" (Int. 7, 2011). Standards, in this way, constitute a trade barrier to Chinese wind turbines: "You need some certification and also you need some track record…that is a problem for us" (Int. 7, 2011).

While the limits to exports were not considered a critical issue during the initial growth phase within Chinese wind power, the current oversaturated Chinese market for wind turbines has made it necessary for Chinese WTMs to shift their focus increasingly to foreign countries (Int. 7, 2011; Int. 29, 2011; Int. 30, 2012). That is, "now the industry is squeezed, yeah. Eh, suffering" (Int. 5, 2011); "there are no profits, no money, so now we focus on foreign markets" (Int. 17*, 2012). In this way, it has become increasingly critical that "the overseas market is out of reach for most Chinese wind turbines manufacturers, who are largely unfamiliar with international market rules and legal environments" (Windpowermonthly.com, May 10, 2011). Hereby,

"the market barriers they are facing in terms of standards, in terms of all requirements, is actually quite extensive when you are entering from a Chinese setting into a developed market. You know, the standards in Denmark…for 30 years…are quite high, and you need to be able to prove that you can live up to those standards" (Int. 1, 2013).

From domestic to international market, and from quantity to quality – towards greater appreciation of certification?

As China's potential wind power-TEN is facing a 'quality crisis', and as Chinese WTMs "are increasingly looking outside of China […] they are recognising that they have to make different products for the international market" (Int. 11, 2011). Hereby, Chinese WTMs are claimed to begin

"to learn from the international market, 'oh – now I've got it, it's a completely different playing field out here! Now we need to have standards here. And we need to compete on something completely else'" (Int. 1, 2013).

In this way, a gradual process of learning and upgrading is indicated. A number of the most capable Chinese WTMs have, accordingly, gradually built up capabilities of certification:

"Yes, of course they want to, and they are in the process. There are also some GL-2010-certified turbines in China. And that's…well, yes, some have been sold to Europe" (Int. 2, 2012).

Sometimes, these attempts at international certification take place through demonstration projects abroad (Int. 43, 2013), setting up Chinese wind turbines for testing in Europe or US. Increasingly, Chinese wind turbines are thus complying, i.e. being "in line with international [standards…while] some are unique to China" (Int. 21*, 2013). Thus, according to a Chinese expert in wind power, "as far as I understand it, some models of domestic manufacturers also get a certificate from foreign certification bodies, including DNV GL, but there are also other certification bodies [than GL DNV]" (Int. 37*, 2013). Further, China's certification body for renewable energy, China General Certification (CGC), which was established in 2003, is committed to the implementation of the IEC standards. That is, working on aligning 'imported standards' with Chinese standards, CGC firstly "imported the [foreign] standards" (Int. 21*, 2013), and over time more "foreign advanced standards, such as [open] IEC standards" were used. Over time, China has now developed own national basic standards for the wind turbine industry, which "are at par with the international standards, with the IEC standards" (Int. 21*, 2013).

Driving the industry through certification and standardisation – a gradual qualitative shift and the choice to certify or not

While certification did not constitute a critical matter of concern in the expansive years of increasing wind power installations (GW), China has, over time, "found out that if the Chinese ever wanted to get a chance to sell a turbine outside of China, then there was no other way than going through this [international certification]" (Int. 14, 2013). Yet, certification is costly and time-consuming (Int. 14, 2013; Int. 20, 2013). In particular, the needed investment in basic research required for certification still creates reluctance in the emerging Chinese wind power-TEN. That is, this

"is an investment, which they are not really taking on themselves, to get it done. And maybe they don't trust themselves to be capable. So there are like all these opportunities…but it's a choice that they have to make… […] This is a huge investment, it takes a lot of work. In particular, if they are not sure that they have what is needed to get it certified (Int. 20, 2013).

Overall, certification, testing, and standardisation require investments in basic research, in particular in aerodynamics. As the current 'quality crisis' facing the emerging wind power-TEN has gradually resulted in shifting priorities and means of the political pole – e.g. reflected in the introduction of "standards and requirements for higher quality" (Int. 1, 2013) – there is also increasing focus on the need to invest in building capabilities for certification and standardisation. This is e.g. reflected in the 5YP S&T Wind Power (2012*) and China's Energy Policy (2012). Accordingly, the 5YP S&T Wind Power (2012*) raises the issue of certification and standardisation as a critical means of ensuring the "sustainable development of China's wind power industry research system "(5YP S&T Wind Power (2012*), 5, 7 (4 (6)). Recognising China's position as a relative latecomer, the plan thus argues that China's public testing system, wind power standards, testing, and certification system for wind power must be improved further (5YP S&T Wind Power (2012*) 2(1c)). The role of certification and standardisation for the development of wind power in China was not a priority area in the early growth phase, but has only emerged as an emergent matter of concern of the political pole, as the Chinese industry has grown, and as quality issues have emerged over time:

"When we set out to build a wind power industry, having in mind to develop this industry, that this was the future direction, China did not talk about it [i.e. certification and testing]… that in order to move forward China's wind power industry…But we also believed that standards, testing and certification were very important work, but at that time, we did not have our own industry, in 2003, right… back then the industrial technology was still weak (Int. 21, 2013).*

A turn to quality along with improving capabilities is here indicated, in which the assembling of a network around certification, testing, and standardisation has become increasingly important. As expressed by a Chinese expert:

"I think, if we can continue to implement this work, the quality of China's wind power equipment will be improved, it will play a big role. I think it is truly now a critical point […] I think that in the future of China's industrial rise, we must do this part of the job [certification] well […] And now I think that the standards, testing, and certification should precede the industry, because then you can drive the development of the industry" (Int. 21, 2013).*

As certification and standardisation are framed as important tools to drive the development of the wind power-TEN, certificates and standards emerge as critical pacifying framing tools, in the struggle to qualify wind power as technically and scientifically sustainable. In the following, the chapter looks briefly into traits of an emerging Chinese network for standardisation and certification in the Chinese wind power–TEN.

An emerging network for certification and standardisation within wind power in China?

In the above, it has been indicated how processes of certification and standardisation over time have been constituted as a critical means of qualifying wind power as sustainable, as well as for industrial upgrading. In the following, the chapter looks into the seeming emergence of a network around certification and standardisation in the potential wind power-TEN, which also produces a potential software-TEN.

Alignment with WTO – and with the strategy of indigenous innovation

Acceding the WTO in 2001, today China has achieved "the skeleton for standardization strategy thinking" (Wang et al., 2010). That is, in accordance with the WTO Technical Barriers to Trade agreement (TBT), member states must accept the Code of Good Practice for Standardisation, and China has consequently been working hard to make its standards meet the TBT (Wang et al., 2010: 3). The Standard Administration of China (SAC) is in charge of ensuring compatibility with i.a. ISO- and IEC-standards (Ernst, 2011a: 29). Further, to ensure WTO compliance, China's Ministry of Science and Technology (MOST) has in particular since 2002 been involved in the promotion of a Chinese certification and standardisation system. For instance, MOST wrote a couple of reports, which took outset in China's then relatively new doctrine of a 'Scientific Outlook on Development' (Wang et al., 2010), arguing that standards "are conducive to building a harmonious society" (Wang et al., 2010: 5). These reports by the MOST formed the basis for the Outline of China's 11th 5YP Development Plan for Standardisation in 2006 (SAC) (Wang et al., 2010: 7; Ernst, 2011a: 20) as well as for a proposal for China's National 11th 5YP Scientific and Technical Development Program in 2007 (MOST), which included an IPR and technical standardisation strategy (Wang et al., 2010: 7). Hereby, "a standardization strategy with Chinese characteristics began to take shape" (Wang et al., 2010: 1). Intent on developing a standardisation strategy 'with Chinese characteristics', China's standardisation strategy is equally intended to align with international standards as well as to spur indigenous innovation. The latter is to be achieved e.g. through promoting 'homegrown' standards as well as turning Chinese domestic standards into international standards (Ernst, 2011a; 2011b; 2013; Wang et al. 2010). That is, while it is

“important to adopt international standards, it is more important to turn independently developed technologies into international standards” (Wang et al., 2010: 5).

This strategy is also reflected in the 5YP S&T Wind Power (2012*), which argues for the need to adapt international standards to China’s unique environmental conditions and its industrial base (5YP S&T Wind Power, 2012*). However, much work on certification and standardisation still remains to be done within wind power. Although China already became a member of the IEC in 1957 (Wang et al., 2010: 2), and China has adopted the IEC wind turbine system certification system (CRESP, 2005: 59), there was still no integrated turbine equipment certification system in China by 2005 (CRESP, 2005: 58). That is, while growth rates in Chinese wind power exploded around 2005 when the Renewable Energy Law (REL) was issued, most wind turbines were still imported models (CRESP, 2005: 58), and most of these

“have GL or DNV certification. One of the important reasons for which there are still no native established quality supervision or certification for several years is that most wind turbines generator systems are not made in China. On the other hand, because there is still no complete certification system, native wind turbines generator systems development has been affected” (CRESP, 2005: 58).

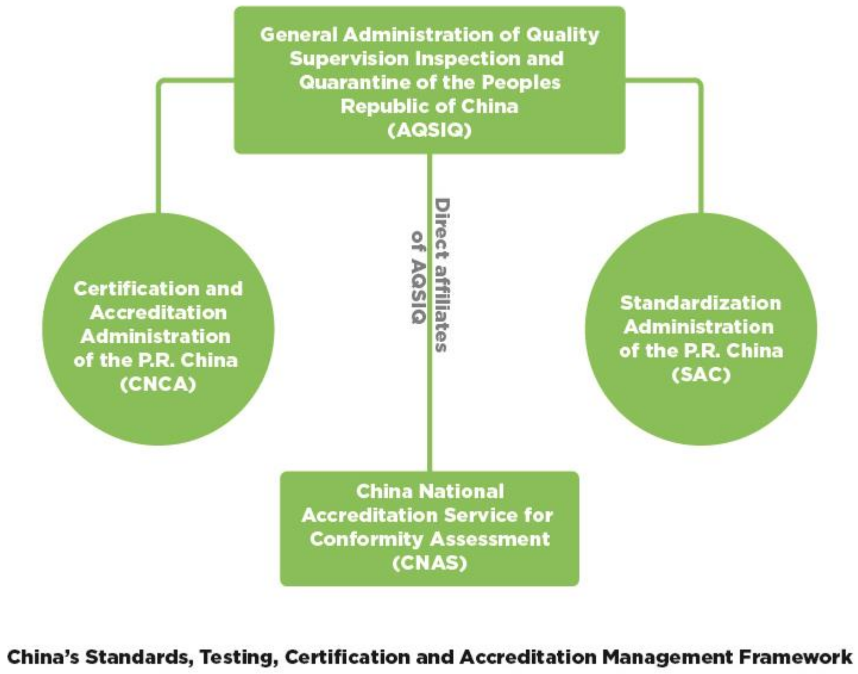
China’s relatively short background within wind power in general and within certification and standardisation (i.a. in regard to wind power) has produced concerns over the potentially detrimental impact of China’s legacy of technology transfer and imports of foreign technologies on China’s indigenous innovation and certification and standardisation capabilities. Accordingly, the 5YP S&T Wind Power (2012*) raises concern that China is largely reliant on foreign testing and design techniques. For instance, China’s test systems (e.g. for blades) and simulation tools are to a large extent dependent on foreign technologies (5YP S&T Wind Power, 2012*: 2(3); 2(1c)). Hereby, the plan argues that China must improve its capabilities for independent innovation, e.g. in terms of wind power equipment design and innovative capabilities (5YP S&T Wind Power, 2012*: 2(1a)); 2(1), 1). Despite rapid improvements and upgrading within certification and standardisation since the growth phase around 2005, certification and standardisation in the emerging wind power-TEN is still in a relatively nascent stage, and in particular the political pole has increasingly problematised China’s relative backwardness. In the following, the chapter inquires into how different actors have responded to this problematisation of needed upgrading within certification and standardisation.

Responding to problematisation

Whereas a market pole quickly emerged in the potential wind power-TEN during the initial growth phase, scientific and technical poles have tended to emerge at a slower pace. Yet, as the political pole of the Chinese leadership has increasingly voiced concerns over the sustainable and scientific development of wind power, facing a quality crisis, the technical and scientific poles, increasingly, seem to be surfacing, e.g. configuring around the issue of certification and standardisation. In the following, the chapter inquires into the seeming emergence of different poles engaging in the translation of a wind power-TEN, namely actors engaged in standardisation, accreditation, certification, and testing. As regards standardisation within wind power, the China National Certification and Accreditation Administration/Certification and Accreditation Administration of China (CNCA) (CRESP, 2005), which was founded in 2004 by the State Council and placed under the General Administration of Quality Supervision, Inspection and Quarantine of China (AQSIQ), is responsible for the accreditation of certification organisations, test organisations, and laboratories, and for certifying the eligible certification organisations (CRESP, 2005: 56-57; Ernst, 2011a). Below, *figure 18* shows some of the major actors in China's standards, testing, certification, and accreditation management framework for wind power.

Other direct affiliates of AQSIQ are China National Accreditation Service for Conformity Assessment (CNAS) with authority to accredit certification agencies and test laboratories for wind power, and the Standardisation Administration of China (SAC). In addition, the standard committee for wind power is the National Wind Mechanic Standardization Technology Council under the supervision of the National Standardisation Administration Committee (CRESP, 2005: 46; Interviews).

Figure 18: Structure of China's standardisation, certification, and accreditation system



Source: Directly adapted from CGC, 2013: 3.

As regards certification, the China General Certification Center (CGC) was established in 2003, with the aim of "build[ing] up capacity to test the turbines and to certify them like Germanischer-Lloyd and DNV and Garrad [now DNV GL], like a national competence. And there were no requirements [back then] in China that they had to be tested or certified or anything" (Int. 14, 2013). Testing products of manufacturers, certifying the eligible WTMs, and allowing WTMs to put certification marks on their products (CRESP, 2005: 57; cresp.org.cn), CGC is the only certification centre in China, approved by CNCA to certify equipment for renewable energy sources (CRESP, 2005: 57). In terms of test laboratories, for instance the Chinese Academy of Sciences (CAS) has a wind tunnel and a blade test centre (Interviews). Whereas CGC is concerned with wind turbines and components certification and testing, the China Electrical Power Research Institute (CEPRI) under the

State Grid works with standards in terms of grid connection, and has different test laboratories connected to it. CEPRI is, amongst other things, undertaking research on grid connection standards as well as on power quality. Further, CEPRI's new test site (in Zhangbei, Hebei Province) is a wind farm test facility serving to verify grid performance. This demonstration project was built in 2012, and while not mandatory for Chinese wind turbines to pass the testing, now ideally all wind turbines in China should pass through its grid performance test (Int. 19*; 2013; Int. 18, 2013; Int. 20; 2013; Int. 53, 2013).

Myriads of collaborations on certification

The gradual build-up of capabilities and the emergence of poles within testing, certification, and standardisation have taken place within a short time frame, often in collaboration with international partners. Capacity building through international assistance has a long background in China's wind turbine industry, where e.g. foreign research institutions such as Denmark's DTU Risø has assisted since the 1980s (Int. 20, 2013; Int. 8, 2013). For instance, CEPRI and CGC have been involved in Sino-Danish collaborations – often with Denmark's DTU Risø – under the Sino-Danish Wind Energy Development Programme (WED) (2009-2013). This has e.g. involved assistance to CEPRI in developing China's grid codes (Int. 20, 2013; Int. 19, 2013). Further, under the Sino-Danish Renewable Energy Development Programme (RED) (2009-2013), which is a programme jointly developed by the Chinese and Danish governments that include two components (namely the development of the China National Renewable Energy Centre in Beijing and joint Sino-Danish renewable energy projects), projects for e.g. testing and certification have taken place (Interviews; ens.dk). In addition, the China Renewable Energy Scale-up Programme (CRESP), which is a World Bank-sponsored programme for renewable energy development in developing countries, has conducted a project by the name of the Establishment of Wind Turbine Certification Capabilities from 2008 till 2011 (worldbank.org; cresp.org.cn; Interviews). Helping the "CGC to establish fully the certification technical capacity of wind turbine, through improving quality management system, compiling the certification guidance documents, purchasing the software and hardware equipments used for certification, and staff capacity building, etc." (cresp.org.cn), CRESP has helped building the institutional and technical capacity for testing and certification (Int. 21*, 2013). Today, CGC is engaged in a myriad of international collaborations to comply with IEC standards, e.g. receiving training in the usage of simulation software tools, jointly certifying new wind turbine designs, developing a database in accordance with IEC standards for wind condition surveys, and testing of blades (through a new blade test centre), among others with DTU Risø and DEWI

(German Wind Energy Institute) (Interviews). Lastly to be mentioned, China Electrical Power Research Institute (CEPRI) under the State Grid has extensive and fruitful collaborations with foreign research institutes and test laboratories, i.a. Denmark's DTU Risø on the wind farm test site in Zhangbei under CEPRI (Int. 19*, 2013; Int. 20, 2013). A variety of WTMs are also engaging in such collaborations. Amongst many others, the Danish WTM Vestas has produced a report with recommendations and evaluation criteria for investment decisions in public procurement, such as wind power projects based on the design standard IEC 61400-1 (e.g. 61400-12, parts 1, 2, and 3 for evaluating power curves) with the Chinese Wind Energy Association (CWEA) (Vestas-CWEA, 2011).

Algorithmic case study – a potential software-TEN in the qualification struggle of the emerging wind power-TEN

Having illustrated the role of certification, testing, and standardisation in the qualification of the potentially emerging wind power-TEN as sustainable, the chapter now dives into an 'algorithmic case study'. That is, first the chapter shows how a potential software-TEN is configuring around software tools for simulation in the work of certification, i.e., diving into the 'certification triangle'. Second, the case moves on to a case study of Chinese attempts at upgrading in certification and standardisation, in regard to simulation tools. Here, two accounts are offered on upgrading capabilities, configuring around software algorithms. Lastly, this results in an inquiry into how relations between Chinese and foreign actors have been de- and reconfigured over time.

The potential emergence of a software-TEN around simulation tools for certification

First, the case study inquires into the work of assembling a software-TEN around simulation tools for certification.

Step 1: Developing a simulation software tool – a matter of loads, aerodynamics, and control (LAC)

In the so-called 'certification triangle', a software simulation tool must first be developed to simulate the wind turbine design. Its role is to ensure that the structural dimensions of the tower can withstand the loads from the aerodynamic forces of the wind.

"The basic tool to design a turbine, that's the simulation. And that's where you calculate what loads that you want to design the turbine for, right. Well, it's like…when you are dimensioning a tower…and that goes all the way through…well, then you must know how strong it should be, and you need to know the loads that will be put against it. You calculate that through a [software] programme. Well, in the good old days, it was easier, then it was more like just sticking your finger into the air" (Int. 14, 2013).

Developing simulation programmes involves a complex interplay between the forces of loads, aerodynamics, and the main control/regulation (LAC) (Int. 14, 2013; Int. 57*, 2013).

In turn, this involves complex mathematics, where a number of power curves must be calculated:

”What is required in the certification is that you must do a load calculation. That is, first you have to calculate a power curve…that is, how much does it produce, and the other thing is to measure the different actual loads. And loads etc. also have very much to do with how you regulate it [the turbine] (Int. 14, 2013).

Overall, turbine developers are attempting to calculate how the turbine ”should look, how it should act, if designing it like this and this” (Int. 14, 2013). For instance, the Danish WTM Vestas engages in “LAC R&D”, which involves teams, which “use state-of-the-art simulation and design tools constantly optimising the operation of Vestas wind turbines in a trade-off between loads and production” (Vestas job-offer website). Likewise, Chinese certification bodies such as CGC engage in a host of experiments, e.g. load calculations using simulation tools to evaluate the turbine’s compliance with the standard requirements, i.a. looking at its power load, fatigue strength, performance, and strength (Int. 21*, 2013). In this way, software plays a central role already in the first step of the certification triangle.

Aeroelastic code for load calculation – describing the turbine mathematically

Since the simulation tool involves a complex interplay between the LAC forces, the simulation programme, firstly, requires simulation of the mechanical loads (Int. 32, 2012). Further, it must contain an aeroelastic code, which is the ‘core algorithm’ of the simulation tool. The aeroelastic code of the simulation tool contains the interplay of mechanical *Load calculations* (L) with the *Aerodynamic* forces of the wind on the blade structure (A), and with the specific turbine *Control regulation* (C):

”Well, this turbine can be described mathematically, something about structural rigidities, how heavy it will be per metre, or something like that. And then the blades are normally described in terms of how the forces - the aerodynamic forces - how they are being influenced by the movement [e.g. the pitching] of the blades, right. And the movement of the blade and the wind coming in are giving like…all this you put into a model, where you have some numbers for this, and then you can put it into some software, some aeroelastic software, and then you can simulate it…” (Int. 38, 2013).

Apart from research institutions (and companies) involved in ongoing basic research into the development of new optimised aeroelastic codes for new sizes and types of turbines, there exist myriads of aeroelastic codes, some of which are sold commercially. For instance, the simulation tool Bladed is a commercial load calculation tool (Int. 41, 2013) used in mechanical simulations, which is developed and sold by Garrad Hassan (now DNV GL) (Int. 43, 2013). Bladed is considered “the industry standard integrated software package for the design and certification of onshore and offshore turbines” (gl-garradhassan.com). Other simulation tools – or so-called optimisation tools – are e.g. Flex (models for wind turbine design) and HAWC2 (an aeroelastic code), which have been developed by the DTU Risø, which are considered as research tools rather than engineering tools (such as Bladed) (Int. 20, 2013; Int. 35, 2013; Int. 38, 2013; vindenergi.dtu.dk; Risø DTU, 2010).

Finding the optimal algorithm – on the interplay between simulation and control to optimise output

The simulation tool, basically consisting of software codes, i.e. ”computational calculations telling you how to simulate a turbine” (Int. 14, 2013), is crucial, as it models the turbine and how it should be regulated. In this way, simulation serves as a tool for turbine development and optimisation of turbine design, and forming the basis for a ‘competitive’ design, since “based on these things, you can design a better regulation [main control/controller], eh, than it was before […] Whose loads will be better, for instance” (Int. 35, 2013). The close interplay between simulation and regulation is related to the way in which the simulation tool must contain the so-called “regulation principle” of the wind turbine’s main control/controller, i.e., it contains the core algorithm of the turbine’s main control.

”Well, the controller, that’s also a regulation system. It’s of course something about monitoring the turbine, but also when it observes something, the controller, e.g. when the wind blows a lot, then it should do like this [e.g]. regulating, pitching the blades and things like that. So, first you simulate that when you construct a wind turbine. That means that you will find the algorithm, which you think is the optimal one. And then you have to put that one into the controller. And then you measure the turbine, install it and say, okay, how is it acting…does it act as we predicted [calculated/simulated]? And it’s not everything that is possible to predict. So then you have to trim and calibrate it” (Int. 14, 2013).

Due to this ”interplay between simulation and the regulation/control” (Int. 14, 2013), when mechanical design houses calculate the length of the blades and the size of the tower, they need to know how the main control and the pitch control are working in order to be able to simulate and optimise loads. Overall, optimisation of turbine design aims to raise power output (in a safe way), which can e.g. be achieved through flexible, modern blades in combination with optimised regulation strategies (main control system algorithms), as these together can reduce the performance-load ratio. When the performance-load ratio is reduced, the same turbine structure can have a bigger rotor and by that raise its output while lowering the cost of energy. Hereby, simulation tools for calculating i.a. mechanical loads such as Bladed help optimise output, and potentially also to construe associations of economic, as well as technical and scientific sustainability.

Step 2: Building a mechanical prototype – testing and trimming the turbine

When a simulation programme has been developed, which can simulate the turbine, the second step of the ‘triangle’ is to build and test a mechanical turbine prototype/model. That is, it is assessed whether the *in situ* measurements of the actual loads on the prototype perform as the calculated loads in the simulation programme. Sometimes, performance of the turbine can e.g. be improved through a new rotor and through regulation strategies of the control system, as well as the identification of new components, where needed. This involves continuous ’trimming’ of the turbine. To do this, a programme must be developed to measure whether the turbine actually functions optimally.

“You make some measurements [tests] and say, well, if the loads on the turbine fit your calculations, then it’s actually good enough, and then it actually doesn’t mean anything what the algorithms look like. You just try to compare those two situations” (Int. 14, 2013).

Following this process, the turbine and the programme for measurement must be trimmed. That is, a programme must be developed to measure, test, and trim the turbine, as well as develop and trim the measuring programme to check whether it acts as planned, or whether something should be adjusted (Int. 14, 2013). After this, three-dimensional drawings of the blade together with a report, e.g. containing the loads of the structural design and displaying the statistical calculations of the different components, can be made (Int. 14, 2013; Int. 32, 2013). This finally leads to an accredited measurement, which “is what you need to deliver for certification” (Int. 14, 2013).

Step 3: Theoretical documentation for certification as basis for an accredited measurement

Having demonstrated the design and how test measurements comply with the calculated simulations, the wind turbine design can be delivered to a certification agency, such as DNV GL, or CGC, for an accredited certification. The turbine design is thereby being documented through drawings, specifications, and calculations according to a standard. This last part of the certification ‘triangle’, the theoretical documentation, is made in order to adjust the deviations between the test results and the simulated calculations (Int. 14, 2013; Int. 21*, 2013; Int. 37*, 2013; Int. 32, 2012).

”In order that the certifying authorities can certify, they must see documents demonstrating how we have done the calculations in the different systems, the likely faults. And those fault cases you must document according to the certification. They cannot approve it, if the turbine cannot sustain dangerous situations […] And you must show simulations of how it will act in 100 years and all that – actually, it’s quite complicated” (Int. 32, 2012).

Aeroelastic codes producing a ’competitive edge’

Having described the three steps in the certification triangle, it has been illustrated how optimisation of wind turbine design is related to the reduction of loads while optimising power output, which requires the development of ‘elegant’ designs and more flexible blade structures.

”It’s not just a matter of production [power output], that is, the power curve…you can say that previously, you looked at how much you could optimise the power curve in relation to the rotor squaremetre. If you had a large rotor, how much power could you extract from that? And what you look at now, when you design, is how much energy that it can extract in relation to the loads on the turbine […] And that is more complex, than where you are just looking at how much kilowatt per square metre that you can extract, right” (Int. 14, 2013).

As wind turbines have become more advanced and ‘intelligent’, turbines are increasingly being distinguished in terms of their power-load performance, i.e. the reduction of cost of energy:

”You can say that…a wind turbine, even though they look alike, they can be more or less advanced. A lot of what we are working at, that is actually building knowledge into the blades. Or into the entire wind turbine. To ensure that it has the best aerodynamic solution of all. The best response possible” (Int. 35, 2013).

In the end, intelligent design “is being measured in terms of cost of energy. How much money does it cost? How much does a kilowatt hour produced by the wind turbine cost?” (Int. 38, 2013). In this way, aeroelastic knowledge and research is being framed as a ”parametre of competitiveness” (Int. 35, 2013), as it helps construe associations of ‘elegant’, ‘advanced’, and ‘intelligent’ design. That is, associations of ‘competitiveness’ is about

”all these things…which you cannot really see at first... Because…it’s possible to make some…how to say…some simple blades. Or something like that. And it may run okay” (Int. 35, 2013).

While running ‘okay’, optimisation of aeroelastic codes help produce associations of a ‘competitive edge’, bracketing and framing the more advanced from the less advanced research institutions and WTMs into their respective places.

Into the turbine’s stomach – and distinguishing the advanced from the less advanced

In regard to this framing, Western actors tend to be framed as ‘superior’, while Chinese actors are being framed as ‘inferior’. For instance, aeroelastic analysis requires complicated mathematics (Int. 14, 2013) of both dynamic and static values on the blade, and these calculations are not described in the standards. Instead, “it’s actually something, which is…it’s not really described in the standards, how you do it…it’s kind of a…it’s a pretty tricky issue" (Int. 14, 2013). With a relatively long background in basic research, Western research institutes have pushed Western companies to move forward, trying

"all the time to push the boundaries of the possible […] So we try to like put in an extra parametre all the time, putting as much knowledge into the system as possible. Because then you can produce larger turbines and stuff like that" (Int. 35, 2013).

For instance, the DTU Risø has long-term experience with developing advanced aeroelastic tools, thereby knowing 'the stomach' of the wind turbine. For instance, the simulation tool HAWC2

"corresponds to Bladed, apart from that it is more advanced, and that we have developed it ourselves. We have some people here…we are all the way down into the algorithm, we are all the way down into how everything is fitting together…so we kind of know the 'inner workings' of Bladed…it's not Bladed of course, but HAWC2, and we know how it functions inside the stomach. And we also know how to use and apply it. So therefore, we have much deeper knowledge than the users have" (Int. 20, 2013).

At the same time, HAWC2 is a better tool for research and optimisation, whereas Bladed is more of a mechanical engineering tool, which does not enable further research and development (Int. 20, 2013). Conversely, Bladed is more 'generic', and nobody (apart from GL Garrad Hassan) has access to its core algorithms. Instead, "Bladed has the advantage that it is very user-friendly" (Int. 14, 2013).

Construing 'algorithmic quality' and a competitive space around aeroelastic codes – with no guarantees given

Overall, the simulation tool's aeroelastic codes and the integrated source codes of the main control are being constituted as 'core' to the optimisation of wind turbine performance. Hereby, simulation tools and their algorithmic 'stomach' may be claimed to produce associations of *algorithmic quality*. Performing algorithmic quality, and delegating 'inferior' and 'superior' roles and positions to different actors, in terms of more less advanced simulation tools and their aeroelastic codes, a competitive space is being construed around critical core algorithms. That is, indigenous simulation tools help produce associations of i.a. low cost of energy, long-term performance, continuous development, and ongoing learning and upgrading:

"It might be that if you take a X-turbine [Western WTM] now and then a Chinese turbine at the side…it might be that the Chinese turbine is cheaper, but if they don't…if they don't generate any new knowledge by themselves, then the next generation of X turbines will have beaten this one in terms of cost of energy. And then they need to buy licenses from…so the only way they can make sure to have the lowest cost of energy, that's by staying some generations ahead" (Int. 35, 2013).

As Chinese actors struggle to upgrade in the area of simulation tools, the framing of inferior and superior actors is not given, however. This is recognised by Western actors, which state that they must continuously "develop and focus on development all the time…this is what is to keep us ahead" (Int. 35, 2013).

Two accounts of Chinese algorithmic upgrading – contested roles in the emerging software-TEN?

In the above, aeroelastic codes have emerged as 'core' components in simulation tools for certification. The analysis has indicated ongoing work of assembling a potential software-TEN configuring around simulation tools in the qualification struggle of China's potential wind power-TEN. In the following, the chapter dives into an account of how roles, positions, and relations are being configured around simulation tools in the potential software-TEN, looking at this from two competing perspectives, and with an emphasis on prospects of upgrading. This is used as an illustration of how roles, positions, and identities of actors are being negotiated and contested.

Algorithmic barriers to upgrading – an issue of black boxes within black boxes and IPRs within standards

While algorithms of simulation tools are critical in the process of optimising and certifying new turbine designs, the core algorithms (aeroelastic codes) are locked. That is, Garrad Hassan's (now part of GL DNV) simulation tool Bladed (gl-garradhassan.com) is more like a "black box, meaning that nobody actually knows how it calculates" (Int. 14, 2013; Int. 35, 2013). That is, customers cannot see what it contains, what it does, but they can use the tool" (Int. 14, 2013; Int. 35, 2013). Thus,

"when you use Bladed, then it has some built-in standard routines, which Garrad-Hassan [now DNV GL] has built in, you have a pitch regulation, and then you have different things. And then there is a control regulation algorithm in Bladed. It is black-boxed" (Int. 14, 2013).

Likewise, the algorithms of the HAWC2 and Flex are not open to others (Int. 35, 2013). Established largely on foreign design licenses, most Chinese WTMs, most Chinese research institutes, and certification bodies have acquired and adopted the commercial simulation tool Bladed from Garrad Hassan (now DNV GL) (Int. 7, 2011; Int. 29, 2011; Int. 30, 2012). Yet, since the simulation tool is closed, "they don't know how it calculates. They don't. And that's actually, I would say, a core issue" (Int. 14, 2013). Further, since the simulation tool contains the regulation principle of the main control, whose core algorithm is locked, as shown in the previous *Chapter 9,* relying on simulation tools without having developed a simulation tool indigenously “involves some black boxes” (Int. 14, 2013; Int. 58, 2012). That is, without access to the key algorithms of both the simulation tool (the aeroelastic code) and that of the main control’s regulation, which is built into the simulation tool, the simulation tool becomes a matter of “black boxes within black boxes” (Int. 14, 2013). That is, “you also have the regulation built into it, that is, what the main control looks like! So that’s the crux of the matter!” (Int. 14, 2013). In this way, the issue of certification, testing, and standardisation indirectly seems entangled in an issue of IPRs; that is, a simulation tool is needed to obtain an accredited certification, while that same simulation tool may contain black-boxed algorithms, not necessarily by patents, but rather through technical locks and cryptations.

Lacking capabilities of documenting black boxes

Without access to the simulation tool’s aeroelastic code and its built-in regulation concept/main control algorithm, it becomes difficult to document how the different systems and algorithms fit together in the final step of the triangle according to international standards:

”This [the aeroelastic code being black-boxed] is one part. Then there is the other thing. Then they go to buy a main control from X [foreign control system supplier], and it contains an algorithm. How that algorithm functions in relation to the one in the simulation tool…That’s actually…how can you actually document that?” (Int. 14, 2013).

In this way, the issue of black-boxes within black-boxes complicates the third step in the triangle of international certification, where ”those developing the turbine, they must document it. That is, they must calculate, and then they have to conduct a complete calculation and tests and everything…And then those certifying it have to say, well, the documentation is okay and also make a parallel calculation in order to verify that it’s okay” (Int. 14, 2013). In order to properly document that simulations/calculations (step 1) align with actual measurements during testing (step 2), parallel calculations must be performed by using two different codes, as a matter of control of the simulation tool: ”And that’s what constitutes the control. It’s obvious that if you come up with results which differ widely on critical points, then you must dive into the issue of how to explain this. But this is the control” (Int. 14, 2013). In addition, the standard states that those who certify must make their own control calculations:

”Well, it is stated in the [IEC] standard that, well…you must simulate how the turbine functions with this kind of code. It doesn’t say which one [code]…but…and then it states that the certifying authority must make their own parallel calculations. Which…and this constitutes the control of the calculations that are delivered [as documentation for certification]” (Int. 14, 2013).

Further, it is stated in the standard that the same code cannot be applied by those applying for certification and the certifying body. That is, two different codes should be employed since a potential mistake in the calculations otherwise can be repeated without being detected. However, in China there has been a lack of indigenous simulation tools, which implies a risk of dependence on the same tools (Interviews).

Lack of basic research in aerodynamics and quality control – barriers to reverse engineering

The issue of dependence on commercial simulation tools and locked core algorithms is in turn entangled in the legacy of foreign design licenses in Chinese wind power. In the initial years of building a Chinese wind turbine industry, focus was not on investments in long-term basic research into aerodynamics and advanced aeroelastic codes. Hereby, ”although some Chinese actors are working with aerodynamics, they still need to develop an aeroelastic code” in contrast to “other countries who have been occupied with wind power [and] have had research in this field, and have developed those codes themselves” over decades (Int. 14, 2013). Having followed a strategy of component technology sourcing, Chinese WTMs risk losing the overview of the wind turbine, and its ‘stomach’, which is critical to optimising aeroelastic codes. Thus, while Chinese actors are increasingly able to work with aerodynamic codes, another issue is to understand them and/or how to optimise then (Interviews).

”If we say…we start to develop a new turbine…then we simulate it in Bladed, but in reality they don’t know what’s inside of it…maybe they have an algorithm, which works, but they don’t know whether it’s the optimal one. And then they will get a main control from X [foreign control system suppplier], and there’s a standard…and then they have some third-party to test it, and then they find out, well, it is actually not functioning according to how we calculated it…and then they think about that – but they don’t know what’s optimal” (Int. 14, 2013).

Further, software tools always contain a number of mistakes, but when core algorithms are closed, it is not possible to detect these or to change them without assistance from the simulation tool provider. That is, ”they can’t change the code without asking [the foreign certification body], telling them that they would like to do this and that…and then they [the foreign certification body] has to change the code, so you [the Chinese] can calculate” (Int. 14, 2013). Overall, black-boxed algorithms seem to create barriers to optimisation and reverse engineering, which in turn may create associations of ‘less advanced’ and ‘less intelligent’ turbines. In turn, this may threaten the framing of wind power as technically and economically sustainable, but also as scientifically sustainable.

Dependence on suboptimal codes – on copycatting and lack of indigenous design

Dependent on closed simulation tools, adapting turbine designs to Chinese conditions becomes difficult (Int. 8, 2013), since without understanding the aeroelasticity of the wind turbine design, "they can't…they can't adapt it…if they encounter a problem" (Int. 38, 2013). In addition, Bladed is not considered the most advanced code, or the best tool for optimisation or research and development (Int. 20, 2013; Int. 14, 2013). "Bladed is an aeroelastic code. But not particularly advanced" (Int. 14, 2013). What Chinese actors get from Bladed is a "kind of a standard package" for common situations, "but if you get into the more refined issues, then you have some weaknesses [in the code]" (Int. 14, 2013). However, Chinese actors tend to trust Bladed, even though "it might not be the best [simulation tool], and they may not know how it calculates" (Int. 14, 2013). The same applies for the control system algorithm, which foreign control system suppliers have largely developed from other industries, in particular the marine industry, and only lately having applied to wind power. In this way, many control system suppliers are

"not experts on wind turbines. That means…what's the optimal algorithm? It's not X [foreign control system supplier] you should ask about this. They can develop an algorithm which works. And you can tell them that you want the turbine to work like this, and then they can make it work like that, in a good and reliable manner. Hardware and stuff like that. But X [foreign control system supplier] doesn't make wind turbines themselves. […] When I say that the aeroelastic code is where you calculate…when you simulate…what will I do, if I do like this and this…X [foreign control system supplier] does not have an aeroelastic code. They cannot make simulations of how the control actually functions" (Int. 14, 2013).

Apart from the risk of being dependent on suboptimal codes for Chinese environmental conditions, the locked algorithms create socio-technical barriers to optimise and adjust codes according to the specific environmental conditions. Further, Chinese actors risk becoming dependent on advice from actors, which are not offering independent advice, e.g. as Garrad Hassan (and their tool Bladed) has become part of the merged certification body GL DNV (due to the merger and acquisition). That is, "Garrad Hassan has been acquired, and then you have a certification body, which sells consultancy services within the same company. And that's not so wise" (Int. 42, 2012). These seeming socio-technical barriers to reverse engineering in the development and optimisation of new turbine designs have delayed the entrance of Chinese WTMs on the international market. That is, Chinese WTMs are working on

"getting GL certification, they need to do their 3,000 hours run…let's see, it will probably come, but I think it is a lot slower than what we have seen, and what we had anticipated a couple of years ago" (Int. 1, 2013).

Accordingly, in 2014, Vestas proclaimed that they did not fear the entrance of Chinese WTMs into the international market in the near future any longer, but rather saw a possible expansion of their own market share in China (metalsupply.dk, Jun. 13, 2014). Further, it is widely recognised that while some of the best Chinese WTMs have acquired foreign design houses and smaller WTMs, "it's still something they have bought. That is, we still lack seeing a proper Chinese design, which has been developed from the ground [and which] they have done properly, and where you can say that they have made it all from A to Z" (Int. 14, 2013). Hereby, while it is often claimed that there is still no purely indigenous Chinese wind turbine design (Int. 14, 2013; Int. 20, 2013; Int. 36, 2013), it is also claimed that most Chinese turbines "are just based on existing [foreign] designs, which could be optimised" (Int. 57*, 2013), as they have been acquired from design houses and consultancy firms who have largely licensed mature technologies "in order to keep ahead" themselves (Int. 36, 2013).

Risk of useless control system source codes – limits to leapfrogging

Lacking overview of the wind turbine's 'stomach', needed for developing indigenous designs, the much-desired source codes of the main control (as shown in *Chapter 9*), risk becoming useless, even when Chinese actors may gain access to them :

"Well, I'd say, if they don't master this [the aeroelasticity], then I'd think that they cannot use that source code for anything at all" (Int. 35, 2013).

Indeed, certification and wind turbine design – and control system algorithms – seem intricately entangled and require long-term investment in learning and basic research. Before that, it will not be possible to use more advanced design codes such as Flex or HAWC2, or even to develop indigenous codes, since other design codes such as Flex "require that you can understand all the things…what do they mean […] So you can say it is a long process" (Int. 35, 2013). Consequently, there seems to be no easy way of leapfrogging in terms of developing indigenous wind turbine designs. Indeed, particularly for modern intelligent turbines, building certification capabilities is "a huge task for the large turbines […] it's a huge task. Because the quality requirements are really…extremely hard…20 years ago, Boeing couldn't build a wind turbine at two Megawatt. And now they [WTMs] have to build one at six or ten [megawatt] to be competitive" (Int. 20, 2013).

Transformative upgrading – gradual learning of ’the new student’

While the above account depicts a somewhat bleak perspective of Chinese capabilities of certification and indigenous design due to the critical role of simulation tools, another competing account seems to be emerging, which offers a transformational perspective of upgrading. This account of gradual learning and upgrading reflects how Chinese certification bodies, universities, and research institutes have increasingly engaged in R&D, e.g. spurred by the Chinese Government to develop aeroelastic codes. Accordingly, CGC is claimed to work on “developing them [the codes], they are learning...only ten years old. They have to learn and learn” (Int. 8, 2013).

Building certification capabilities and learning from Bladed

Working on and improving knowledge on aeroelastic codes, CGC has now technical teams dedicated to understanding and translating international standards and standard specifications, to conducting simulations and testing, and to developing and adapting standards to local conditions. One of the most difficult things in this work is to interpret and understand ‘the meaning’ behind the standard specifications, which requires several years of studying for China as a ‘new student’:

”For us new students, so to say, it’s very important, because we have to check with a lot of literature […] Why is this, what is this principle, why should it be like this, right? And a lot of it may be completed after the data have been forgotten, it’s not [regarded as] important, but for us in this new school, it is very important, [otherwise we have to] check a lot of literature” (Int. 21, 2013).*

In regard to simulation tools, CGC, research institutes, and Chinese WTMs have largely been dependent on Bladed since “in the field of simulation everybody internationally uses their [Garrad Hassan’s] simulation tool for load calculations” (Int. 21*, 2013). The Bladed tool has served as a basis for ”accumulating technological capabilities” (Int. 21*, 2013), e.g. through training by e.g. Garrad Hassan/GL DNV, i.e. the developers of the Bladed tool (Int. 21*, 2013; Int. 37*, 2013). Even though Bladed is “not open”,

“it will have some interfaces, so we can make some development on the surface. We can use some programmes to help us to improve the software [and] if there is need to, they [Garrad Hassan] can provide some software support, but normally we will be able to do it ourselves now” (Int. 37, 2013).*

Yet, acknowledging its limits, increasingly Chinese actors are also experimenting with other simulation tools, e.g. Flex, as well as experimenting with developing indigenous codes.

Turbine design for typhoons – being forced to be creative

As eager ‘students’, Chinese actors in the emerging software-TEN configuring around certification and standardisation seem spurred on by a desire to conduct ‘indigenous innovation’ as well as to abide by international standards. To succeed in indigenous innovation of standards, pure copycatting of international standards is not enough, as international standards have largely been developed to European conditions. Instead, reengineering is needed. Chinese WTMs are therefore also increasingly attempting at conducting reverse engineering of software tools. Increasingly engaging in aerodynamic research with a dedicated control system department working on algorithms, CGC adopts different software tools for turbine design and claims to gradually have developed its indigenous ‘own software’ and its ‘own new tools’, e.g. for when a typhoon is coming (Int. 21*, 2013; Int. 37*, 2013; Int. 49, 2012).

“That means we are also studying how to generate this typhoon model…after hitting the blade, how much load it can bear from the wind?…then we hope to develop a model of a typhoon and a typhoon simulation tool […] Yes, an emulator [simulator], which can guide the design of the typhoon blade that you want in the future” (Int. 21, 2013).*

This is reflected in an official CGC presentation, where it is stated that CGC engages in a ”[s]erious certification process”, which involves

”[t]racing back to the source of turbine load diverge[nce]. We do not only concentrate on load assumptions and results; independent simulation of control algorithm capture[s] the impact of every detailed modification; strength analysis covers every bolt of the turbine; we check the design assumptions in the field” (CGC, 2013: 9).

Overall, Chinese actors are gradually building indigenous capabilities for design, as they engage in reverse engineering, e.g. adapting turbine designs to typhoon conditions (Int. 21*, 2013). In this way, adaptation of turbine design (and simulation tools) to local conditions “forces you to be creative, there are no innovative people to give it to you, as others do not have these problems, isn’t that right? (Int. 21*, 2013). In this way, China upgrades capabilities in certification, which “drives technological advancement of the entire industry” (Int. 21*, 2013).

De- and reconfiguration of collaborative relations

The two competing accounts of ‘algorithmic barriers’ to upgrading and transformative upgrading, respectively, in the ‘algorithmic case-study’ above provides a picture of some of the negotiations taking place in the potential software-TEN around simulation tool algorithms. That is, the case illustrates how capabilities, and thereby also roles and positions, of Chinese actors are being negotiated. In the following, the chapter inquires further into how the negotiation of roles and positions of Chinese actors are de- and reconfiguring relations and identities of actors. This leads to the last section, which maps a potentially emerging controversy around certification and standardisation in the software-TEN.

Collaborative relations in certification and standardisation

Due to the interdisciplinary nature of wind turbine development and certification, in particular of aerodynamic research, there exist a myriad of collaborative relations between different types of actors in the market, technical, and scientific poles working on issues related to certification. In particular, in mature wind power regions like Europe and the US, there exist multiple 'formalised' and 'less formalised' collaborative relations, e.g. between developers of aeroelastic codes and the users (Int. 14, 2013). In these (often 'informal') collaborations, different actors engage in the work of comparing simulation codes and test measurements, since "this is the only realistic way to verify the codes [of the simulation tool] and to improve them" (Int. 14, 2013). That is, it is only "by working with those codes… that's where you gain the understanding" (Int. 14, 2013). Likewise, as regards the main control for a specific turbine design, WTMs and control system suppliers in Europe and the US often engage in collaborations:

"Well, it is an interplay between the wind turbine manufacturer and the control system supplier […] Then the [wind turbine] manufacturer says they would like the turbine to regulate like this and this, and then they [control system supplier] programme it [the control system] accordingly and produce some software, which can do that and stuff like that" (Int. 14, 2013).

In addition, WTMs may ask test laboratories for assistance, when it comes to simulation tools and understanding why, for instance, the Flex or HAWC2 programmes are acting unexpectedly. However, it requires a considerable amount of knowledge and experience to be able to ask research institutions and test laboratories (what is framed as) 'informed questions' (Int. 14, 2013: Int. 20, 2013; Int. 35, 2013):

"Some of the clever companies, the people…they know…they have a pretty good idea of what's going on inside and can ask some pretty clever questions about…'why – when they are running this…why did it act like this? That seemed pretty'…And [then we (test laboratory/research institute] think, 'well, oups! We have to ask our developers', and then we have to say, 'well, that's a really good question, I'll go and check. I think you are right, it might be that in the future, in the next update…or that the manual should be written a little more clearly, so you don't misunderstand…why it acts like this, when you actually thought that that would be impossible'" (Int. 35, 2013).

These collaborative relations between i.a. WTMs, control system suppliers, certification bodies, design houses, and/or test laboratories are often based on personal connections, e.g. as wind turbine engineers often shift jobs within the wind power-TEN. As expressed below,

”if you know these people who work in Garrad Hassan on a friendly level, you can make some suggestions, and then it’s sometimes an advantage to speak Danish etc. If you have been playing together for a long time, you have some confidentiality. You can just call them, even in the evening, and get some support. And you can’t do that if you sit in China and get in contact with the service department of Garrad Hassan” (Int. 32, 2012).

Thereby, ‘knowing somebody’ can help actors optimise the codes e.g. in Bladed, because ”of course it has its limitations. But then you can make some customer-specific changes, if you know somebody who knows somebody in GL [DNV GL/Garrad Hassan] (Int. 32, 2012). In Denmark, for instance, collaborations are taking place in the so-called ‘Denmark Wind Valley’ or “Wind Power Hub [where] there’s a lot of learning across [company borders]” (Int. 32, 2012), as ‘everybody knows each other’ (Int. 32, 2012; Int. 9, 2012; Int. 2, 2012). In this “dynamic international community [of learning], research collaboration is very much like ’give-and-take’” (Int. 14, 2013). When personal relations associated with trust (based on ‘informed algorithmic knowledge’) have been established, parts of the source codes may be shared, enabling code adjustments (Int. 14, 2013).

Exclusion from collaborations in the ’good international club’

With a background in foreign design licenses and still suffering from a framing of Chinese wind turbines as ‘poor quality’, Chinese actors face barriers when attempting to join these ‘innermost research circles’, since it is “often like, ‘can’t you develop a blade for us?’” rather than an issue of ‘give-and-take’ (Int. 35, 2013). That is, “this dynamic community does not include China. There is no serious research in aeroelasticity [in China]” (Int. 14, 2013):

“The Chinese would very much like to join – how to put it…join the inner circle of the good international club. They would love that, but then they must be able to give something. This thing about saying that we want to participate…but if they only think about what they can gain themselves, but not about how they could give something in return…in that respect, they are pretty poor partners” (Int. 14, 2013).

Consequently, Chinese WTMs and others are often excluded from collaborations i.a. in regard to optimising the interplay between the simulation tool and the regulation/control algorithm. Instead, the control system supplier and foreign design turbine designer/license provider may collaborate directly, instead of involving the Chinese WTM:

”But when they get X [the foreign license provider], who is very active in China to deliver [the design]…then they deliver a turbine [design], and then they will also deliver an algorithm. And then it’s

probably XX [the foreign control system supplier], whom they are talking to regarding how to design the regulation algorithm. The [Chinese] wind turbine manufacturer does not need to know anything about this" (Int. 14, 2013).

Overall, it seems that algorithms as calculative tools produce inclusions and exclusions, and in this was may be transformed from 'innocent', mundane intermediaries into actors, as they come to have an effect on the relations they de- and reconfigure.

Issues of lacking recognition – lost in the limbo of (lacking) confidence

Although CGC has been accredited as certification body, and should also be recognised internationally, there still seems to be a lack of recognition of 'mutuality', as they are often not regarded as being 'at the level of DNV GL'. Instead, it is predicted that it will take years for them to gain sufficient confidence outside China (Interviews). Hereby, it is "widely acknowledged that the Chinese institutions, which are young in this field, might have problems in being accepted at the same level as the well-known European institutions, but it is their goal" (Int. 14, 2013). Consequently, even though the 'formal' part, in the form of certified and accredited calculations, may be delivered from China to obtain European accredited certification, these calculations will sometimes not be trusted (Interviews):

"Because when you do this kind of work, then there's always two parts…the one thing is the formal…bambambam, have they calculated this, this, and that?" […] "and then there's the second part: do you think that what you've got is okay?" (Int. 14, 2013).

Lost in a limbo of lacking confidence, the ideal of the certification system in which national accreditation institutions should recognise each other mutually, does not always function properly, as Chinese actors are 'not being recognised' (Interviews). To overcome this, basic research in algorithms (i.a. aeroelastic codes) is a "pre-requisite for the development of their own technologies, but also for being included in international networks in regard to these things [since] if they don't do research themselves and don't make anything, which is relevant for others, then they won't get anything the other way. That's how it works" (Int. 14, 2013). Again, algorithms are emerging as actors in the formation of relations in the emerging software-TEN within Chinese wind power.

Fighting resistance and contesting their own inferiority

As Chinese certification bodies and WTMs have increasingly built capabilities and experimented with development of simulation tools and aeroelastic codes, the role and position of Chinese actors as 'inferior partners' is increasingly being contested. That is, Chinese certification bodies want *"to reach an equal status, like DNV and Germanischer-Lloyd [DNV GL], right? [They] want to be internationally accredited. But I think that's the way towards the goal. The alternative is that the Chinese bring their turbines over here to DNV, make some agreements with DNV or Germanischer-Lloyd and have them certified" (Int. 20, 2013).*

As Chinese certification capabilities are now "fully in accordance with international standards, and we are participating in international exchanges of these international institutions" (Int. 21*, 2013), Chinese actors argue that their 'platform' has changed, and that they have now reached 'a platform to do something' (Int. 21*, 2013). This indicates that Chinese actors are contesting their framing of being 'inferior' to and excluded from others. At the same time, Chinese actors recognise that there has been, and sometimes still is, a lack of trust in Chinese wind turbines and certification capabilities. This was in particular the case in 2003, when China had just started out within wind power:

"A lot of people were questioning it…that is, a lot of people were not agreeing with…because you [China] do not have any industry, the manufacturing industry is also very weak. When writing standards, they also think you [China] are just translating foreign standards. You don't have any people to make wind turbines, so how should you write standards? So there is still some resistance" (Int. 21, 2013).*

Consequently, even though CGC may have certified a Chinese wind turbine, it might be necessary to certify the wind turbine several times, since "in Germany, no! We need GL [DNV GL]" (Int. 8, 2013). Hereby, the 'pacifying' tools of standards and certificates do not always work to pacify associations and qualities to the emerging good of wind power, but rather risk destabilising it.

Negotiating identities in collaborations – construing associations of mutuality

Increasingly, to overcome these barriers and to construe associations of 'trustworthiness', Chinese WTMs and certification bodies have worked on upgrading and on developing simulation tools through diverse collaboration, i.a. with design houses (Int. 43, 2013; Int. 37*, 2013; Interview 21*; 2013). As Chinese actors have upgraded capabilities, relations and positions between Chinese and foreign actors in the emerging software-TEN are becoming increasingly negotiated:

"Owners in other countries say, we want the certification from GL, not only from CGC. So they have to negotiate. Now things are getting better, because the basic is that CGC must conform to international standards, in order to certify...and your certification will be checked by all other certifications...it's no problem. This is basic. The quality is first, second is to try to get more recognition from other organisations, yeah" (Int. 8, 2013).*

In this way, as Chinese actors strive towards writing new indigenous standards, relations are being transformed, involving more "learning from each other, promoting each other" (Int. 21*, 2013). For instance, Chinese ideas for adapted standards seem to be increasingly internationally recognised (Int. 21*, 2013), and CGC is increasingly involved in different working groups within the IEC Wind Turbine Certification Advisory Committee (CGC, 2013: 17; Interviews).

An emerging controversy over certification and standardisation?

As China struggles for recognition and for qualifying Chinese wind power as sustainable, certification, testing, and standardisation have become a critical obligatory passage point. In the above, it has been illustrated how relations, positions, roles, and identities of Chinese and foreign actors seem to be reshuffled in the ongoing qualification struggle facing the wind power-TEN. In the last section of the chapter, before concluding, the analysis inquires further into a potentially emerging 'controversy' over certification and standardisation, or what may be termed a 'standardisation war', which is entangled in myriads of issues of e.g. catch-up, IPR, and protectionism. Indeed, standards increasingly include IPR and has become a hotly debated issue (Ernst, 2011a; 2011b; Ernst, 2013b: 1). Firstly, the matter of concern of international standards is shown, and secondly, the matter of concern over domestic standards, seen from a Chinese and Western perspective, respectively.

Matters of concern over international standards – struggles of defining quality

The negotiated nature of roles, positions, and identities in the potential software-TEN around simulation tools for certification and standardisation is entangled in matters of concern over upgrading and catch-up, and thus over China's Scientific Development. In this regard, obtaining international recognition in terms of indigenous standards has become increasingly critical, as the Chinese potential wind power-TEN is facing a quality crisis. In the following, the chapter first looks into the 'standardisation war' unfolding in regard to international standards, which in many ways is related to a fight for the right to define quality.

Harmonisation of standards as constituting free trade and healthy collaboration

Facing a quality crisis and the quest for Scientific Development, as well as the need to turn towards the international market in the oversaturated wind power-TEN, China has become more actively engaged in the work of harmonisation of international standards, working in different IEC committees (Int. 55, 2013). This serves to prevent "creating technical barriers to trade […] hoping to achieve a global access for certification, so that everybody is not doing it differently" (Int. 21*, 2013). Further, this work serves to give China a stronger voice in the international wind community (Int. 21*, 2013). That is, China "should be a very important core member of this work [of developing a] unified approach, with a correct understanding of IEC standards etc." (Int. 53, 2013). In this context, standards are construed as critical framing tools to build associations of 'free trade' and 'healthy collaboration' (Int. 21*, 2013):

"Actually, we follow principles in line with international standards in the whole testing process, believing that the wind power is a transnational and international industry. It must rely on free trade, we must rely on the cooperation between countries, so that global cooperation can develop soundly. That you cannot rest complacently on the laurels of certification, each country not being engaged with each other, that is not conducive to the development of global trade, so we should unify the world, which is a basic principle" (Int. 21, 2013).*

Negotiated quality and barriers to leapfrogging – no such thing as the best turbine, algorithm, or standard

In the struggle for harmonisation of standards, standards and turbine quality constitute contested issues. For instance, each adaptation of existing or formulation of new standards must be negotiated. This is e.g. seen in the adoption of the third edition of the IEC 61400 standard, which has been met with a great degree of resistance (Germanischer-Lloyd, 2010a: 6). Turbines acquire what may be termed associations of 'algorithmic quality' through certification, as alignment of simulations/calculations and tests are being documented. However, as indicated earlier, even the quality of algorithms, by itself, is also negotiable, since there is no such thing as 'the best algorithm', and as they are always 'filled with errors'. Rather, algorithmic quality is situational, as "there's no such thing as the best turbine. It really depends on what kind of project" (Int. 11, 2012). For instance, the calculation of cost of energy is project-specific, being related to the project "terrain, and also the wind conditions, and the turbulence" (Int. 23, 2012). Overall, standards, their metrics, and the calculative agencies they produce can become constituted as situational and debatable. Accordingly, new standard formulations and the process of harmonising standards often constitute a contested issue, as different actors will promote their own metrics and calculative devices. This makes it impossible to write into the standards *how* the simulations and testing should be conducted, as there is even disagreement within standard committees, which are constituted by market, scientific, and technical poles.

"In the standard…there are some points…I guess this is the critical point, that is, you have to do this and this. But not how one should do it. And this is also related to the fact that those people who make these [standards], they are researchers and some from industry etc., who sit in these committees. And to make a standard, they must agree that now you can do like this…otherwise it cannot be included in the standard, right. And they aren't [agreeing]. And that means that as long as they don't agree [these] explanations cannot be included in the standard" (Int. 14).

As standards do not explain '*the hows',* this also constitutes a barrier to rapid leapfrogging for Chinese actors, "because, first they [the standards] should be translated […] Second, you have to understand these standards, and then also understand why they have developed in that way, and why it is in this way…what principle is this based on" (Int. 21*, 2013). Yet, as outlined earlier, access to this kind of data is not open. In the above, it is indicated how a 'negotiated', or even an emerging 'competitive space', is being construed around standards, their calculative tools, and the calculative agencies they construe. As expressed by a foreign WTM, while willingly providing assistance and raising recommendations on Chinese standards, "when it comes to standards, that is where we start to become competitors again" (Int. 1, 2013).

China's two-track approach and entangled controversies over standardisation and IPRs

The quest for a stronger voice in IEC negotiations (and in the definition of quality) is in the meantime entangled in matters of concern of the Chinese political pole. That is, China is attempting to transform itself from being a mere standard-taker "to become a co-shaper, and in some areas a lead shaper, of international standards" (Ernst, 2013: 2). This is being referred to as a 'two-track approach' in China's standardisation strategy, which involves both adaptation to international standards and developing their own domestic standards (Ernst, 2011a: v). This has recently been expressed by the new political leadership in China, in a speech on innovation by President Xi Jinping. Thus, fighting China's 'victimised/inferior position',

"focus on China possessing its own core technologies did not exclude international cooperation. But, he said, China would demand a bigger say in the rules and standards that govern global science and technology innovation" (President Xi Jinping in Sinosphere, 10 June 2014).

With an aim to become a lead shaper of standards, China is claimed to shift from a catch-up approach to an upgrading-through-innovation strategy (Ernst, 2011a: v-vi). That is,

"domestic innovative capacity is considered to be the key to a sustainable transformation of its economy beyond the export-oriented "global factory" model. To achieve this goal, China's government is very serious in its aspiration to move from being a mere standard-taker to become a co-shaper, and in some areas a lead shaper, of international standards" (Ernst, 2011a: 2).

With its roots in the MLP S&T (MOST, 2006-2020) and the doctrine of Scientific Development, which positions standards as a tool for indigenous innovation (Ernst, 2011b: 6), standardisation is entangled in the stem issue of construing a Harmonious Socialist Society through Scientific Development. In this potentially transformative struggle, the upgrading of China's standardisation system is positioned as a critical means to lessen the “control of foreign advanced countries over the PRC”, especially “in the area of high and new technology” (Ernst, 2011b: 4). As expressed in President Xi Jinping’s speech,

“[o]n the traditional competition field of international development, the rules were set by other people [...] To seize the great opportunities in the new scientific-technological revolution and industrial transformation, we must enter early on while the new competition field is being built, and even dominate some of the competition field construction, so we become a major designer of the new rules of competition and a leader on the new field” (Sinosphere, 10 June 2014).

That is, standardisation also becomes a matter of reducing dependence on foreign technologies (and license fees), and of introducing own sometimes patent-worthy technologies into global standards (Ernst, 2011b; Wang et al., 2010). Hereby, the emerging controversy over standardisation becomes entangled in another controversy, over IPRs:

”China is working within the international system with the long-term goal of creating patent-worthy technology essential to global standards. By including Chinese technology into global standards, China seeks to strengthen its bargaining power and to reduce its exposure to high royalty fees. At the same time, however, China seeks to use its increasing geopolitical influence to promote new sets of rules for international standardization, and hence to transform the international standards system itself” (Ernst, 2011a: v).

At the same time as China is seeking to remain abreast with international standards, such work is a costly affair (Ernst, 2013b: 7). Thus, as a ’latecomer’ China must consider whether to adopt the international standard or whether it is better (and/or cheaper) to create a new domestic standard (Ernst, 2013b: 7). Apart from the already depicted attempts at doing reverse engineering of standards by i.a. the CGC, e.g. developing a wind turbine for typhoons, China has also introduced a China Compulsory Certification mark (CCC) for safety approval of technological and industrial products (US Chamber of Commerce, McGregor, 2011: 23), which requires testing and recertification of many foreign products in China (US Chamber of Commerce, McGregor, 2011: 23). In this way, China’s political leadership is claimed to encourage domestic standards by pursuing a government-led, yet ambiguous and fragmented, approach to standardisation (Ernst, 2011b: 5), which does not resemble what is conventionally framed as (the American-style) market-led, voluntary standards model (Ernst, 2011b: 2). That is, rather than letting standards develop by competition, the Chinese ”government will continue to play an important role as a promoter, enabler, and coordinator of an integrated standards and innovation policy” (Ernst, 2011a: 1). Overall, the dual-track approach is engendering what may be termed a ‘standardisation war’. In the last section of the chapter, before the conclusion, the analysis maps part of this emerging controversy.

The configuring of a ’standardisation war’

The dual-track approach seems to engender controversy on an ’international scale’, since it is entangled in concerns over i.a. upgrading, catch-up, subjugation, protectionism, and trade war. Hereby, the emergence of a potential software-TEN around simulation tools for standardisation configures a ’competitive space’, or what may be coined a ‘standardisation war’, in the process of qualifying wind power as sustainable. In the following, this standardisation war is first explored from a Chinese viewpoint, thereafter from the viewpoint of foreign actors, the different viewpoints underlining the importance of the controversy.

International standards as trade barriers – on Chinese subjugation to foreign technologies

Rather than automatically pacifying the qualities of wind power, standards for wind power seem to produce multiple and contested qualities, and to engender a competitive space between Chinese and foreign actors. This is entangled in wider concerns that China, as a late-comer in certification and wind power in general, is being excluded from collaborations and foreign markets. Thus, whereas ”China had considered technical standards a means to facilitate world trade” upon WTO-accession in general, “it turned out that the first barrier it encountered when its products entered the international market was technical regulations and standards” (Wang et al., 2010: 7). Hereby, standards are seen to function as conventional trade barriers. Indeed, it is generally held that “certification and testing regimes can be formidable tools of protectionism” (US Chamber of Commerce, McGregor, 2011: 23). In wind power, Chinese actors tend to find that they struggle with ’protectionism’ in foreign markets, due to a lack of trust in China’s certification:

”We have made a lot of preparations for exporting, but there are some issues with the trust by foreign markets in Chinese certificates, they want to test them themselves. They don’t trust [Bu xiangxin /不相信].This is a misunderstanding, we can do anything, so it is just an export barrier. It’s protectionism, a trade barrier [maoyi de tiaozhan/贸易的挑战]. There are also troubles with anti-dumping” (Int. 44(*), 2012).

Overall, the potentially emerging software- and wind power-TENs produce controversies over standardisation, entangled in the grand narrative of China’s catch-up through indigenous innovation and control of own intellectual property and definition of own as well as international standards, and thereby aligning with China’s Sustainable and Scientific Development. In this account, ”it is not okay that key technologies come from outside. We should control core technologies. China thinks in this way. But in the West, the MNCs control the key technologies, often through standards” (Int. 59, 2013).

Simultaneously, the Chinese ambition to meet and even set international standards could be an indication of the rising capabilities of Chinese WTMs and of the potential ‘turn to quality’ in China’s emerging wind power-TEN. That is, ”you have to reach a certain stage, before you can actually manage internationally and start beginning to see an advantage [of standardisation]” (Int. 18, 2013). Hereby, the gradually rising focus on standards in Chinese wind power – both domestic and international – can be seen as a matter of an upgrading strategy and process. Thus, in the initial growth phase, Chinese domestic standards were set intentionally low in order to make sure that domestic WTMs could meet the standards. Further, with an interest in satisfying the domestic market, emphasis was not on international standards. In this way, rather than being an issue of technical barriers, some claim that if Chinese WTMs had wanted to invest, they ”could be approved [internationally] without any problem. There’s nothing to it […] It’s just an approval process” (Int. 15, 2012). Summing up, today’s increased focus on international quality standards is a “very new trend” (Int. 18, 2013). That is, as capabilities have risen, and as overflows have become ubiquitous, emphasis on quality through standards and obtaining international standards has become increasingly critical, which is particularly visible in the current potential turn to quality.

Chinese standards as a protectionist tool against foreign technologies

Having displayed the account of China’s dual-track approach from a Chinese perspective, in the following, the analysis looks into how it is being framed from a Western perspective.

Construing a hot topic of standardisation and trade barriers

China’s introduction of domestic standards and the mandatory Chinese Compulsory Certification-mark (CCC) are often seen as a tool of Chinese protectionism by foreign actors (Ernst, 2011a: 37; Ernst, 2011b; U.S. Chamber of Commerce/McGregor, 2011: 23; Interviews). China largely sees protection through domestic standards as a necessary means since WTO accession, as WTO accession constructed ’a policy vacuum’ due to the reduction of other trade restrictions (licensing requirements, tariffs, and import quotas) (Ernst, 2011a: 4). Conversely, from the perspective of Western actors, the introduction of domestic standards within wind power is being seen as an obstacle, or trade barrier, to foreign companies (Interviews), and the CCC mark has produced fears of Chinese industrial espionage, in particular in terms of software and encryption testing, which requires the sharing of source code encryption keys (Ernst, 2011a: 37; U.S. Chamber of Commerce, McGregor, 2011: 30; Interviews). Further, the CCC mark postpones market entrance of foreign products as

"they haven't been geared towards working with this in any professional manner. And then a barrier is…there are only few centres capable of certifying. That's a huge problem. So it's also this thing about that you can't bring international certificates to China and have them directly approved […] And it's not so easy to have them tested these few places [in China]" (Int. 18, 2013).

The issue of the dual-track approach is hereby being constituted as a "hot topic in U.S.-China economic relations" (Ernst, 2011b: 1). The issue of standardisation adds to "contentious disputes about exchange rates, trade, and foreign direct investment. Standardization, as well as intellectual property rights and government procurement, are at the center of this conflict" (Ernst, 2011b: 2). Framed as "trade weapons used to discriminate against" foreign products (U.S. Chamber of Commerce, McGregor, 2011: 22), Chinese domestic standards are entangled in discussions of international trade within the WTO. For instance, concerns have been raised that China's standardisation strategy (and its innovation policy) does not comply with WTO rules, since China is promoting the "creation and application of a large number of national standards in China, as opposed to use of existing international standards" (U.S. Chamber of Commerce/McGregor in Ernst, 2011: 3-4). Overall, processes of standardisation seem to configure a 'standardisation war' or hot topic – or what may be termed a 'hot situation' where "everything becomes controversial" (Callon, 1998: 260) – as a myriad of heterogeneous actors, such as IPRs, government procurement regulations, encryption keys, exchange rates, FDI, and trade weapons, and algorithms, are assembled.

Exclusion processes from standards – a competitive space with no welcoming hands

As foreign companies mobilise concerns regarding their exclusion from the Chinese market, the World Trade Organisation (WTO) is also being mobilised as an actor into the emerging wind power-TEN. This is not only due to the introduction of Chinese domestic standards, but also due to a Chinese list of public government procurement for large infrastructural projects such as wind power ('the buy-China-plan'), which has produced concerns over protectionism (U.S. Chamber of Commerce, McGregor, 2011: 19; Int. 1, 2013; Int. 51, 2010).

"China has some unique regulations in place that I haven't seen anywhere else, that are really – in my view – deeply skewed towards promoting their own companies. ..In face of WTO regulations, which they are not compatible with" (Int. 1, 2013).

Domestic standards and procurement lists favouring China's large, state-owned so-called 'National Champions' are claimed to establish a 'discriminatory', "trade-distorting ploy to challenge American supremacy in the global knowledge economy" (Ernst, 2011a: 2-3). A shift in the treatment of foreign companies has thus been noted over time. While foreign companies were treated with 'welcoming hands' in the initial phase, enjoying preferential treatment, this has changed, as wind power was designated a strategic industry. Treated as such, the wind power-TEN is heavily protected by the Chinese state and largely remains state-owned. Thus,

"that [preferential treatment of foreign companies] all came to a halt quite suddenly, when the market changed. And that was actually when we were officially designated a strategic industry…then the market changed rapidly (Int. 1, 2013).

To overcome these exclusion mechanisms of standards as well as public procurement lists requiring indigenous innovation product accreditation, which is seen as an attempt at "discriminating against the source of IPRs" (Int. 51, 2010), foreign actors have engaged in work on assisting Chinese in terms of certification and standardisation. While seeming somewhat paradoxical at first sight, this can be seen as a matter of "risk mitigation" (Int. 1, 2013):

"We need to know what is coming, so that we can adapt our products accordingly. We have seen in other areas that [Chinese] standards can also be used as protectionist measures. So you [China] will put in place standards which fit local or national producers, but exclude foreigners" (Int. 1, 2013).

While foreign actors reject the exclusion mechanisms of Chinese standards, in the Chinese perspective, China as a 'latecomer' faces the 'dual challenge' of barriers to entry in foreign markets, while they have opened their markets to international trade following accession to WTO (Ernst, 2013: 8-9). Hereby, China's emerging wind power-TEN seems entangled in the confrontation between simultaneous forces of interdependent markets characterised by extending boundaries and organisations such as the WTO, and of forces of its own national 'community economy' (Callon and Çalişkan, 2010a: 42). As these forces merge and coexist, hybrid and evolving configurations take shape as they do so (Callon and Çalişkan, 2010a: 45), which produce 'power struggles' between Chinese and foreign actors in the emerging wind power-TEN. These power struggles take shape as framing devices such as standards tend to both include and exclude. Thus, for instance, Chinese "players who want to go abroad" "will not find a lot of welcoming hands around the globe, I guarantee you that" "if they cannot open up their own markets (Int. 1, 2013). Overall, the potential turn to quality in the ongoing qualification struggle in Chinese wind power, which involves *pacification of goods* is highly controversial.

Conclusion and theoretical considerations – controversy over standardisation

Chapter 10 has dived into the work of the *pacification of goods*, i.e. the work of pacifying the framing of wind power as a sustainable renewable energy source through the employment of standards. *Chapter 10* displays the potentially controversial dynamics of the pacification of goods, namely, as standards and their calculative devices, e.g. simulation tools and algorithms, become contested and overflow, due to the way in which they produce contested mechanisms of both inclusion and exclusion. While standards ideally serve as pacifying calculative framing devices, which can construe calculative agencies and calculative agents, e.g. by construing a boundary between superior and inferior turbines, such framing is often "brutally contradicted" (Callon, 1986b: 25). That is, as something will always reside outside the framing, the overflowing can make the wind power-TEN fall to pieces, if only for a brief moment, since the proposed framing is rejected by hostile entities, which dissociate themselves from the framing. In this way, "[t]ranslation becomes treason, *tradutore-traditore*" (Callon, 1986b: 25).

The analysis shows how standards threaten to destabilise the framing of Chinese wind power as scientifically and technically sustainable, as Chinese wind turbines tend to be framed as 'inferior'. As Chinese actors oppose their framing as 'inferior', a controversy unfolds over certification and standardisation, in which seemingly mundane artefacts, such as the calculative devices of software simulation tools, are transformed into actors. In this way, otherwise black-boxed simulation tools, constituted as black boxes within black boxes, seem to fall apart, revealing the multiple entities (and algorithms) that must be assembled to hold them together. Algorithms create power struggles, as they are framed as critical for upgrading and for requalifying wind power as sustainable, which in turn produces exclusion mechanisms. While standards constitute an obligatory passage point for exports, algorithms in simulation tools for testing and certification function as an obligatory passage point for certification. Further, algorithmic knowledge tends to constitute an important means of establishing collaborative relations on R&D and basic research.

Overall, the chapter displays an emerging competitive space, where positions, roles, and identities of actors are being negotiated. The emerging competitive space construed by standards and their simulation tools is, in turn, entangled in a wider controversy over trade barriers and protectionism within WTO. In this struggle, Chinese actors gradually attempt to define their own domestic standards, construing alternative metrics of what constitutes quality, e.g. by adapting to local conditions of typhoons, and thus attempting to ascribe own turbine designs with qualities of 'indigenous design'. Such domestic standards can help construe associations of technological and scientific sustainability to wind power. Overall, the chapter maps an emerging ‘standardisation war’, which is entangled in China’s goal of sustainable development and construction of a Harmonious Socialist Society through Scientific Development. The analysis has further shown how the emergence of so-called global interdependent markets and trans-organisational networks, characterised by vague and fluctuating borders, which are based on principles of free circulation of people and knowledge, e.g. in the form of software, standards, and algorithms, simultaneously produce multiple exclusions and relations of domination (Callon and Çalişkan, 2010a).

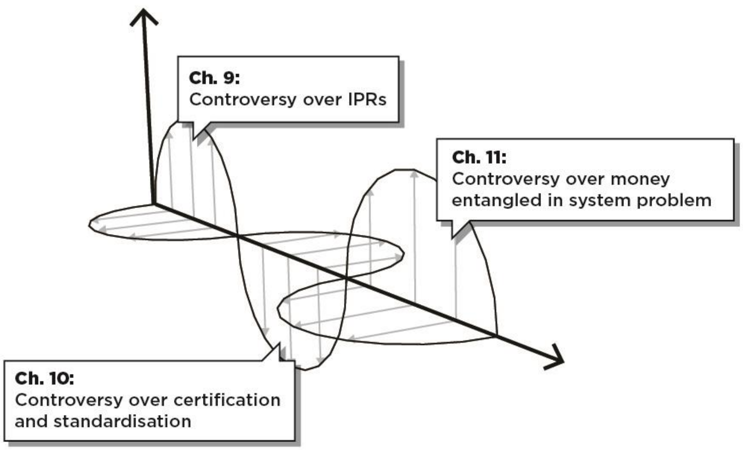
While the previous two controversy mappings have dived into the dynamics of the *pacification of goods* in Chinese wind power, the following two chapters will zoom in on the dynamics of *price-setting* in the marketisation of Chinese wind power. This is done, firstly, in *Chapter 11* by diving into a controversy over money (i.a. liquidity issues) as part of the qualification struggle in the emerging wind power-TEN, which is entangled in a so-called Chinese ‘system problem’ characterised by a large degree of state-control and -ownership.

Chapter 11. Controversy over Money and China's 'System Problem'

Finally! I have managed to set up a meeting with one of the 'grand old men' in Chinese wind power, whom I've heard so much about. Sitting in the office, I am beginning to suspect a point is missing in the rhizomatic account materialising in my fieldwork in China, namely the issue of China's 'system problem'. According to my Chinese respondent, this system problem

"is the core issue of China's total industrial system…so why did it cause these problems? So I think it is not a pure market economy…and therefore you see overcapacity in many Chinese industries [...] In China everybody is competing for life on lower prices, and finally this led to damage…so nobody is doing well. I think the market mechanism is not established yet".

Figure 19: Controversy over money and system problem



Stumbling upon the issue of China's 'system problem', my account begins to change shape, as I try to depict the thick mesh of the Chinese 'spiderweb' that it constitutes. Later, in a noisy Chinese hotel lobby, another 'grand old man' within Chinese wind power outlines some of the workings of this 'system problem', and how this has had implications for the development of China's wind power market:

"This is the problem...it's also the 'system problem' for China – you know, the state-owned enterprises. If you are a decision-maker, you are making the selection of the wind turbines dependent on the bidding...when you select the lowest price of the turbine, and when you have the largest installed capacity… that's your achievement. You are not responsible for the future, or for the turbine not working. You are only...maybe three or four years in your possession. Later, it's not you...so [you're] not so worried about that...but this is not only for wind, it's for everything".

It is particularly his last comment that stays with me, as I leave the hotel lobby: "But I'm worried about the basic system, it's not the driving force to improve".

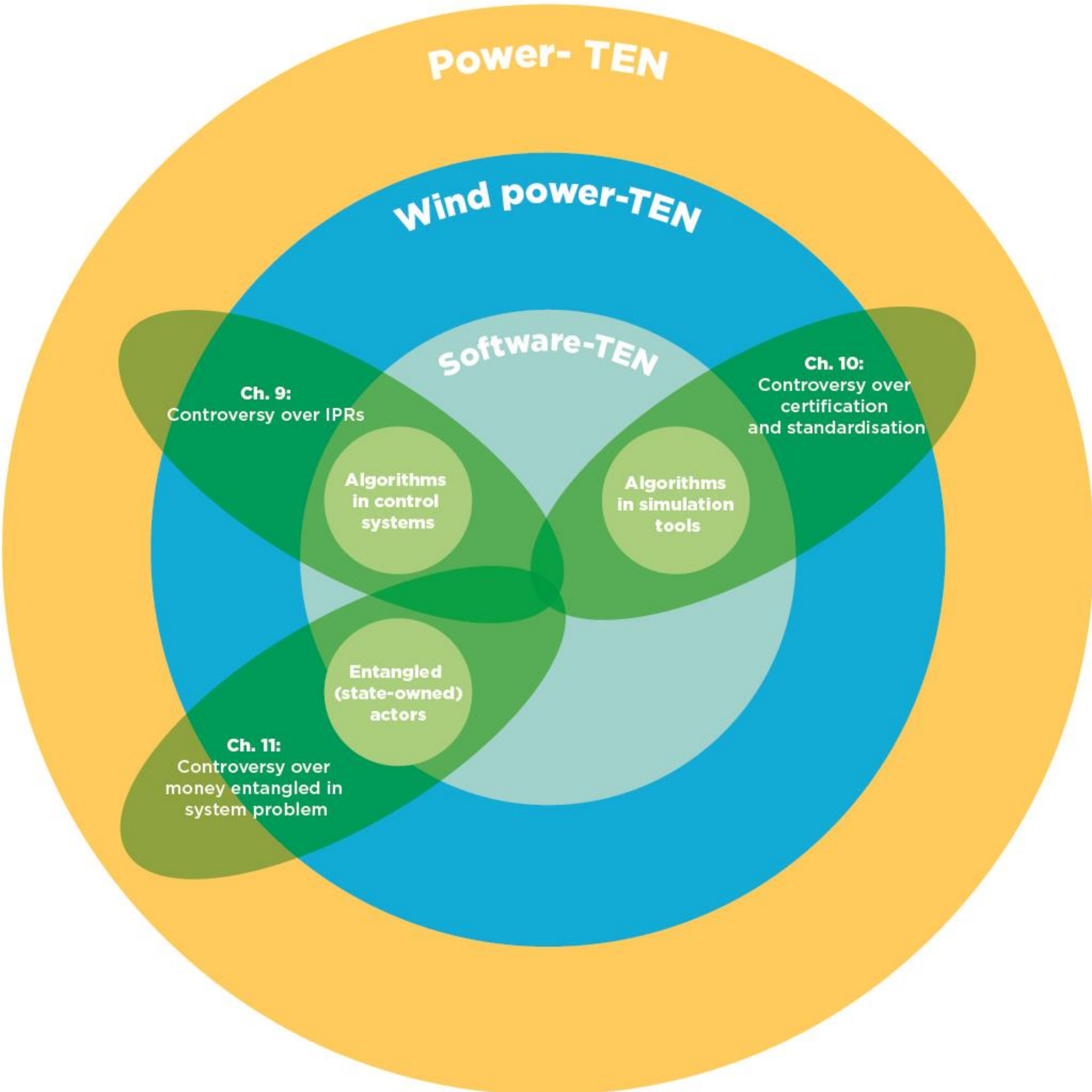
Follow the money! Tracing *’Chinese characteristics’* of marketisation in wind power

The historical background for understanding the ongoing qualification struggle in China’s wind power-TEN was laid out in *Chapters 6-8*. After this, two ‘algorithmic’ case studies were conducted in *Chapters 9* and *10* on dynamics of the *pacification of goods* involved in marketisation processes within Chinese wind power. This was done by following and mapping controversies unfolding around the framing tools of IPRs and standards. The analysis has hereby displayed some of the dynamics of the controversial qualification of Chinese wind power as sustainable. To shed further light on the ambiguous turn to quality in the ongoing qualification struggle, the two final controversy mappings in *Chapters 11* and *12* look into processes of *price-setting,* which is another critical component in marketisation.

In *Chapter 11*, this is done by ‘following the money’, namely rendering an account of how money (liquidity issues) are configuring a controversy in the wind power-TEN and software-TEN, which is entangled in China’s so-called ‘system problem’ of a largely state-controlled power-TEN. In this way, displaying how the software-TEN and wind power-TEN are entangled in a Chinese state-controlled power-TEN, and *vice versa,* the analysis dives further into some of the ’Chinese characteristics’ of green marketisation. This may help shed light on some of the paradoxical dynamics of simultaneous collaborative and competitive relations between Chinese and foreign actors hinted at in earlier chapters.

To inquire into the controversy over money, the chapter first inquires into the so-called ‘system problem’, which is largely a matter of ongoing restructuring attempts in China’s power-TEN, in particular since China’s WTO accession. This is indicated in *figure 20* below. Second, a case study on how money configure a controversy between Chinese (often state-owned) customers and foreign control system suppliers is outlined. Third, this leads to an account of the de- and reconfiguring of relations, as roles, positions, identities, and also qualities are negotiated. Lastly, this concludes with a mapping of the construction of a potential ‘nationalistic game’, entangled in multiple agendas of i.a. ‘opening up’, upgrading, catch-up, and how these sometimes conflicting agendas may affect the potential turn to quality in the emerging wind power-TEN.

Figure 20: Zooming in on controversy over money and system problem



Source: Own design

Challenges of 'opening up' – and the role of the political pole as regulator, operator, and manufacturer in Chinese wind power

China's process of 'opening up' since the influential 'Open Door Policies' introduced by Deng Xiaoping in 1978 has gradually opened China to foreign companies and foreign direct investments (FDI), and in many ways can be said to have culminated formally with China's accession to the WTO in 2001. Apart from requiring reforms within IPR and standardisation, corporate governance reforms have formed part of WTO requirements for China's accession (Wei, 2003; Oi, 2005)[76]. Accordingly, China has worked consistently on establishing a so-called 'relatively perfect modern corporate system' and has introduced regulations regarding corporate governance and the rule-of-law as well as numerous corporate restructuring reforms in order to improve the profitability of China's often ailing SOEs (Oi, 2005: 135; Wei, 2003: 101). In the following, the chapter first briefly lays out processes of corporate restructuring in China and attempts at reforming corporate governance, which takes place along with China's overall so-called 'capitalist transition' from a 'planned economy' to a 'socialist market economy with Chinese characteristics' (McNally, 2006: 20; Wong, 1999: 105; Meidan et al., 2009: 592). This is done with a focus on China's power sector, or what the thesis treats as a potential power-TEN, in which the Chinese State (the 'political pole') tends to operate as regulator, operator, and equipment manufacturer (Liu and Kokko, 2010: 5528). That is, through SOEs,

"the Chinese state participates directly in the wind power sector in several ways by commissioning wind power projects, operating wind farms, and producing equipment for the wind power industry" (Liu and Kokko, 2010: 5523).

With an aim to dive into the way in which the Chinese political pole acts as regulator, operator, and equipment manufacturer in the marketisation of wind power, potentially constituting a so-called Chinese system problem, the chapter first inquires into China's iterative corporate restructuring processes in tandem with China's overall 'capitalist transition', or what is also described as China's 'emergent capitalism' (McNally, 2006). This provides a backdrop for understanding the ongoing restructuring in China's power-TEN, which co-constitutes and is co-constituted by the emerging wind power-TEN.

China's cautious 'transition' – and restructuring in the power sector

China's development has since China's Open Door Policy (1978) been marked by what is conventionally termed a cautious 'transition' from a planned to a market-based economy in iterative waves of liberalisation, with pauses in-between and extensive administrative

[76] Corporate governance is broadly defined as "the system or process by which companies are directed and controlled" (Cadbury Definition 1993, Tam, 1999: 7), or as the set of processes, customs, policies, laws and institutions affecting the way a corporation is directed, administered or controlled. Corporate governance also includes the relationships among the many 'stakeholders' involved (shareholders, management, board of directors; in addition, other stakeholders are employees, suppliers, customers, banks, lenders, regulators, the environment and community at large), and the goals for which the corporation is governed.

reorganisation (Meidan et al., 2009: 593). In particular, since the early 1990s, state-led corporate restructuring/corporatisation and privatisation has taken place along with China's attempts at market reforms, involving the transformation of enterprises (also state-owned) into shareholding companies (Oi, 2005: 120; Brødsgaard, 2012a). In the first Company Law (1993/1994), three categories of company ownership structures were laid out, namely wholly state-owned enterprises (SOEs) (non-marketised firms), joint-stock companies (marketised SOEs and community-owned enterprises), and limited liability companies (private firms) (Chang, 2005; Oi, 2005; McNally et al., 2007). Non-marketised SOEs tended to be protected within the state redistribution system, in close cooperation with the Central Government. In turn, marketised SOEs and community-owned enterprises tended to enjoy the support of local governments, due to their impact on local government income (Boisot and Child 1996; Nee 1992 in Chang, 2011: 325). Finally, private firms tended to suffer from lack of support from government and from government-controlled banks (Chang, 2011: 325). Although already experimenting with the development of a private sector since late 1970s, in particular since the early 1990s, a range of private sector company-types has been introduced, over time resulting in private companies gaining more currency (McNally et al., 2007), hereunder involving the introduction of wholly foreign-owned enterprises, joint ventures with foreign firms, and even venture capital firms (Chang, 2005: 325). Nevertheless, the bias towards SOEs still seems to be prevalent (Chang, 2005: 327; Interviews).

In addition, in order to improve effectiveness and competitiveness of Chinese enterprises, so-called business groups (*qiye jituan*企业集团) have become a prominent corporate business structure in China (Keister 1998: 404, 434; Brødsgaard, 2012a). In a *qiye jituan*, the core company[77] is usually an SOE (Keister, 2000)[78], which has been turned into a limited liability company, and where the state continues to play a dominant role as majority shareholder. In this way, the Chinese State can assert partial control and/or influence over the other business group members, which are partly or fully owned by the core company

[77] Termed 'parent company', 'head company', or 'mother company', dependent on the ties and structure of the business group (Keister, 1998; 2000).

[78] There are two forms of business groups (Keister, 2000: 68-69). The most prevalent is known as *qiye jituan*s, which are vertically organised and centred around a core company (often a large SOE). Another type is business groups consisting of small privately owned firms, which are formed voluntarily, are horizontally organised, and are comparatively loosely integrated (Keister, 2000: 68-69). In large business groups, a number of specialised firms exist, such as a finance company, a marketing company, an R&D facility etc. In smaller business groups, all members use the core company's specialised divisions (Keister, 2000).

(Keister, 2000; Keister, 1998). Business group members are connected through interlocking directorates, cross-shareholding, debt and financing relations, as well as production and management relations (Keister, 2000; Lin and Milhaupt, 2013).

Building the National Team – and the 'SASAC list'

Chinese corporate restructuring reforms have been undertaken in order to promote the development of a private (or non-state) sector, price liberalisation in the domestic market, relaxation of government control and central planning, privatisation of SOEs, and the development of a legal framework for private enterprises (Fan Gang in McNally, 2006: 20). Yet, SOEs in many ways still enjoy protection and preferential treatment compared to private companies (Chang, 2005; Interviews). Under the slogan of 'grasping the large, let go of the small' of the early 1990s (Nolan, 2001: 18; McNally et al., 2007: 3), a central ambition of the Chinese political leadership is to build strong domestic ((partly) state-owned) companies, which can compete internationally. Today, China boasts the second-largest number of Fortune Global 500 companies in the world (Lin and Milhaupt, 2013: 697). Most of these[79] are SOE business groups, which are supervised by an organ of the Chinese Central Government, i.e. the government agency SASAC (State-Owned Assets Supervision and Administration Commission of the People's Republic of China), and which are controlled by different organs of the Central Government within critical industries (Lin and Milhaupt, 2013: 699). The SASAC is the ultimate controlling shareholder of these large corporations (Lin and Milhaupt, 2013: 697). This group of large, powerful SOEs has been formed around former state plants in China's pillar industries, or old ministries, e.g. electricity generation, machinery, and electronics (Nolan, 2001: 17-18), and is referred to as the 'National Team' of China's so-called National Champions (Nolan, 2001; Brødsgaard, 2012a; Lin and Milhaupth, 2013). With a total list of 117 National Champion corporations on the 'SASAC list' (sasac.gov.cn), these corporations have acquired enormous strategic influence, e.g. by holding "huge resources as they only hand over a small percentage of their profits to their nominal owner, the state" (Brødsgaard, 2012b: 4). In addition, these National Champions hold an

"administrative rank at vice-ministerial level, and some of them have CEOs at ministerial rank. This means that even government ministers have difficulties issuing orders to the large SOEs" (Brødsgaard, 2012b: 4).

[79] More than half of the Chinese companies in the 2012 Fortune Global 500 were SOE business groups supervised by SASAC and controlled by organs of the national government in critical industries (Lin and Milhaupt, 2013: 699).

According to the SASAC interim regulations, the regulations for the critical and central SOEs administered by the SASAC aim at

“establish[ing] a State-owned assets supervision and management system that suits the needs of socialist market economy, better run State-owned enterprises, push forward the strategic adjustment to the layout and structure of the State economy, develop and expand the State economy, and realize the preservation of and increase in the value of State-owned assets” (SASAC, 2003, Interim Regulations on Supervision and Management of State-owned Assets of Enterprises, article 1).

Forming part of the ambition of China’s political leadership to build ”a group of globally competitive large, multi-plant corporations” (Nolan, 2001: 16), at the same time as these SOEs receive considerable state support, they are contractually bound to promote the policies of the state. That is, ”[t]he core company coordinates the group’s activities and transmits business policy to group members, who are contractually bound to promote the policies of the state” (Lin and Milhaupt, 2013: 700). The National Champions are ”nested within vertically integrated [business] groups [where e]ach company’s majority shareholder is the core (parent) company of the group – which is itself 100% owned by SASAC, i.e. by the Chinese state” (Lin and Milhaupt, 2013: 700). Overall,

”[i]ndividual corporate groups are often linked through equity ownership and contractual alliances to groups in the same or complementary industries, to provincial-level business groups, and even to noneconomic state-controlled institutions, such as universities” (Lin and Milhaupt, 2013: 700).

Although many former SOEs have been formally privatised, i.e. turned into limited liability companies and often listed, the de facto privatisation process is often limited, as the Chinese State continues to hold the majority of shares. Hereby, while China’s Company Law (1993/94) ”promotes shareholder centralism and a two-tier board structure” (Wei, 2003: 112; Tam, 1999: 48), and the Property Law (2007) seeks to introduce a modern system of property rights (McNally et al., 2007: 4), property rights and ’boundaries of the firm’ are often considered extensively ’blurred’ in Chinese companies (Meyer and Lu, 2005: 63; McNally et al., 2007). For instance, while the Chinese State holds the shares in wholly state-owned enterprises (SOEs), it also holds the majority of shares in many joint stock-companies[80]. Sometimes, it even holds shares in limited liability companies (Oi, 2005: 121-127; Meyer and Lu, 2005: 63).

[80] As regards joint-stock companies, only a partial listing of assets takes place, meaning that it is seen neither as a traditional SOE, nor a private firm. The state still holds the majority of shares in these as well as in the wholly SOE – and has at times shares in limited liability companies as well. Such companies are often referred to as ‘partially listed companies’ (Oi, 2005: 121-127; Meyer and Lu, 2005: 63).

SOEs as black-boxes – and the entangled mesh of poles of emerging TENs in wind power

As outlined briefly above, the Chinese Government continues to constitute a majority shareholder not only in large SOEs, but also in many partially listed companies, and even at times in privatised companies, with de facto state-owned banks “often directed by various levels and sections of the government to provide loans to SOEs” (Tam, 1999: 143). Further, the Communist Party of China (CPC) often retains control over companies through appointments of CPC ‘cadres’ to key positions (Tang and Ward, 2003; Keister, 2000). This relates to China’s so-called *bianzhi* and *nomenklatura* systems. *Bianzhi* translates as “establishment of posts” (Brødsgaard, 2002), while the related nomenklatura system implies the “list of positions, arranged in order of seniority, including a description of the duties of each office” of political cadres. Together, the bianzhi and nomenklatura systems play a decisive role “in governing China at the central and the local level” (Brødsgaard, 2002), as they ensure the control of the positioning of provincial governors, local and central officials in the Party, and government cadres (Brødsgaard, 2012a).

Overall, China can be claimed to have adopted a prescriptive and legalistic approach to corporate governance (Tam, 1999: 91), e.g. as the so-called ‘three new committees’ (boards of directors, supervisors, and shareholders’ meetings) are functioning alongside the traditional so-called ‘three old committees’ of Chinese companies (i.e., the branch committee of the CPC, the Workers’ Representative Council, and the Labour Union), which have not yet been completely phased out in Chinese companies (Tam, 1999: 52; Tang and Ward, 2003: 68-104). So while China on paper seems to move towards what in conventional corporate governance parlance is termed ’shareholder capitalism’ (Gilpin, 2000) and an ‘outsider-based’ model of corporate governance (Mayer 1994, 1995 in Tam, 1999: 91), in which shareholders’ profits and management autonomy can be ensured through so-called ’external markets’ of ‘arms-length’ transactions and contracts (Tam, 1999: 27), Chinese corporate governance in many ways de facto resembles what is conventionally termed an ’insider-based model’ (Mayer 1994, 1995 in Tam, 1999: 91). This means that ‘insider stakeholders’ of the Chinese political leadership retain control (Wei, 2003: 19-20; Morrison, 2001: 93-96). Hereby, rather than reflecting conventional shareholder capitalism, this displays traits of what might more properly be termed ‘stakeholder capitalism’ (Gilpin, 2000: 150) or, perhaps more prevalent, ‘state capitalism’ (cf. e.g. Lin and Milhaupt, 2013).

One of the reasons why relieving state control of China’s SOEs remains challenging is linked to the extended ‘social responsibilities’ of Chinese SOEs. Rather than (just) focusing on improving profits for shareholders, a large number of China’s SOEs face ‘social’ obligations. These obligations have an historical background in the work unit *danwei* (单位) system, which formed an integral part of China's former 'command economy'. This was characterised by a 'dual economy', namely a non-state sector and a dominant state sector heavily burdened by social responsibilities (Lieberthal, 2004(1995): 184-186). In the danwei system, the SOE was in effect both a production unit and a social welfare unit, constituting the so-called 'iron rice bowl' (Oi, 2005: 115; Wong, 1999: 129-130). Constituting basically a self-governed mini welfare state, as it provided public social welfare for its employees, this danwei system has now been formally dismantled. Nevertheless, despite many years of restructuring and privatisation, the state still remains a main owner, and although the number of China's SOEs has fallen in the statistics (Oi, p. 115), China's often debt-ridden SOEs still face various informal social duties (Oi, 2005: 116). Hereby, China's SOE reforms can be characterised as "Draining the water before the tunnel is ready" (Cai, 2004: 329), implying that a social security network is still lacking to overtake the responsibilities of the '*iron rice bowl*' of the danwei system (Oi, 2005: 116).

The above has illustrated what seems a thick mesh of relations of the Chinese government, CPC, and (state-owned) companies, where "the organizational structure and governance characteristics of the SOE groups" largely seems a "black box" (Lin and Milhaupt, 2013: 697)[81]. With such tight 'spiderweb' of relations, it begins to seem impossible to completely disentangle poles of the emerging TEN within wind power, e.g. as the political pole and market are likely to be intricately interwoven.

Current attempts at 'comprehensively deepening reforms' – or disentangling poles

Recognising how China must reinvigorate its restructuring reforms, China's current and still relatively new political leadership (5th generation (Xi Jinping-Li Keqiang)) has currently embarked on a path towards 'comprehensively deepening reforms'. This is e.g. evidenced in the recent issuance of 'The Decision on Major Issues Concerning Comprehensively Deepening Reforms' (ultimo 2013)[82], which emphasises market-based policies and restructuring, governance and market mechanisms, and the fight against corruption (china.org.cn, Nov. 16, 2013). Overall,

[81] The seemingly "contradicting forces for further enterprise autonomy and continued central control that characterizes the evolving relationship between business groups and the Party-state" has by Brødsgaard (2012a) been framed as a matter of "integrated fragmentation" (Brødsgaard, 2012a: 624).

[82] Adopted at the close of the Third Plenary Session of the 18th CPC Central Committee (www.china.org.cn, 16 Nov. 2013)

”[t]he general purpose of deepening its all-round reform is to develop socialism with Chinese characteristics, to advance modernization in the State governance system and governance capability” (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013: I-Significance and Principles, 2).

As part of these reforms, it is stated that the Chinese Government should ”effectively shift its role by building itself into a service-type government that bases its functions on the law”, and reduce the Central Government’s role over market operations to a minimum level (Plenary Session of the 18th CPC Central Committee, Nov. 2013, IV-government role, 15). In addition, to ensure market operations, China is to ”[p]erfect a mechanism where prices are determined by the market”, and to ensure that ”[a]ny price that can be affected by the market must be left to the market” (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013, III-Modern market system, 10). Amongst other things, this implies that within ’natural monopoly industries’ such as power utilities, the functions of different SOEs should be better defined, e.g. through continuous improvement of corporate governance and investment accountability, and by separating government and enterprises:

”In the natural monopoly industries held by State capital, the separation of government and enterprises, of government and funds, and of franchise operation and government supervision are the main thrust of the reform. Further break all forms of administrative monopoly. Improve coordinated and effective corporate governance structures. Establish a professional management system. Establish long-term incentive and restraint mechanisms, strengthen SOE’s investment accountability and explore ways to publicize important information, including SOEs’ financial budgets. State-owned enterprises should reasonably increase the proportion of market-oriented recruitment, reasonably determine and strictly regulate SOE executives’ wage levels, and position benefits, consumption and business spending” (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013, II-Basic economic system, 7).

The recent attempts at ‘comprehensively deepening reforms’ reflect how the Chinese political leadership i.a. seeks to reinvigorate China’s corporate restructuring and corporate governance reforms, emphasising the need to disentangle the market from the government. Or, in the terminology of the present inquiry, it seems that the Chinese political leadership continuously attempts at disentangling the political pole from the market pole.

Zero tolerance towards corruption and the role of guanxi

Another central part of the current attempts at ‘comprehensively deepening reforms’ is the heavy emphasis on fighting corruption (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013, X Supervision of power, 36), displaying ’zero tolerance’ towards corruption (Xinhuanet, Mar. 13, 2014). In China, the scale of corruption is considered to constitute an increasing problem (Brødsgaard, 2012b). Further, it involves greater amounts of corrupt money and higher level officials than in the past and is worst in sectors with heavy state-involvement (Chang, 2011), but is also prevalent in private companies, since engagement in ‘political’, ‘informal guanxi networks’ is considered critical for firm survival (McNally et al., 2007: 1). The issue of corruption is often coupled to a Confucian tradition in China for nurturing inter-personal relations, so-called *guanxi* (关系), which has become increasingly critical in relations between companies and government officials along with Chinese economic reforms (Chang, 2011). These reforms have made the so-called ‘accessing form of *guanxi*’, that is, the forms of *guanxi* which are nurtured in order to access critical resources from government officials, more central (Chang, 2011).

Restructuring in China’s power sector

Having outlined China’s process of corporate restructuring, in the following the chapter looks into how restructuring has taken (and is taking) place within China’s power sector. This provides the context for the following case study on the de- and reconfiguration of relations in a liquidity-constrained wind power sector.

Unbundling powerful companies within power generation and transmission

China’s restructuring process has also had an impact on China’s power sector, which constitutes one of China’s traditional ‘pillar industries’. Although starting out with comprehensive power sector reforms already in 1993, it was only by 2002 that the power sector underwent a radical restructuring (Meidan et al., 2009). This restructuring involved the unbundling/disentanglement of electricity/power transmission from the generation of power. Such unbundling is conventionally considered important for ensuring regulated, fair competition, and an orderly and open electricity market (Shi, 2012; Meidan et al., 2009: 592). However, while it is often also considered recommendable to unbundle power transmission from distribution to ensure competition, China’s power grid system is responsible both for transmission and distribution. As briefly outlined in *Chapter 6*, the unbundling of generation from transmission was ensured by splitting up the pre-existing China State Power Corporation into the ‘Big Five’ separate power generators (Yu et al., 2009: 5223) as well as into two grid companies (the State Grid Corporation of China and China Southern Power Grid Corporation). In addition, an extensive administrative restructuring was undertaken in regard to the power sector, e.g. rendering the Energy Bureau under the National Development and Reform Commission (NDRC) i.a. with responsibility for wind power (Liu and Kokko, 2010; Lema and Ruby, 2007).

While the five large power generation enterprises (the ‘Big Five’), carved out of the State Power Corporation, are predominantly owned by the Chinese Government through main shareholder ownership, these five companies also have majority shareholdings in consortia with other private and state-owned power investors in generation assets, which extend their reach well beyond the assets/capacity that they were given during the 2002 reform (OECD/IEA, 2006: 36). Further, although the Big Five only account for 40 per cent of the installed total power capacity in China, "ownership of the remaining generating capacity (outside of the big five) is widely spread among industrial and financial enterprises, but remains largely with the state in various forms" (OECD/IEA, 2006: 36). As regards the two grid companies, these are owned entirely by the Central Government. Reflecting their status as strategic assets for the Chinese political leadership, both grid companies as well as the Big Five generating companies are listed on the SASAC list. This marks how these state-controlled corporations are all powerful actors in China's power sector and in general; for instance, the State Grid Corporation's director "is a minister, so in this way they [State Grid] are higher in the hierarchy than the National Energy Administration (NEA) under the NDRC" (Int. 8, 2013).

"And there are also the generators, the Big Five, right, which also have an enormous power. And the coal lobby [of which they are part] is really powerful" (Int. 18, 2013).

The power sector's irrational industrial structure – and limits to price liberalisation

Another central part of the process of restructuring China's power sector is the pricing mechanism. While electricity prices are set by the State, the Chinese State aims to "[p]ush ahead with price reforms of water, oil and natural gas, electricity, transportation and telecommunication" (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013, III-Modern market system, 10). In this way, the Chinese State aims to take 'proactive efforts' in regard to "the pricing mechanism of electricity to gradually let the market decide the prices of electricity generated and marketed, while the prices of transmission and distribution are to be decided by the government. The state will regulate the prices of coal for electricity generation and prices for electricity marketed, and explore ways to set up a renewable energy trading mechanism" (Energy Policy 2012, VIII. Deepening Institutional Reform in the Energy Sector).

In this way, when it comes to 'naturally monopolised' public utilities for electricity generation and transmission, the government still sets prices (3rd Plenary Session of the 18th CCP Central Committee, Nov. 2013, III-Modern market system, 10). Thus, the Chinese Government still plays a decisive role in setting electricity prices and in electricity resource allocation. According to China's Energy Policy 2012, which adheres to the principle of 'comprehensively deepening reform',

”[t]he energy pricing mechanism is yet to be perfected, and industrial management is still weak. The overall service level needs to be enhanced. Overall, restraints of the current systems and mechanisms have seriously hindered the national development of the country’s energy industry” (Energy Policy 2012, I. Current Energy Development).

Nevertheless, despite multiple and ongoing attempts at reform, China’s power sector is still claimed to suffer from an ‘irrational industrial structure’ and energy mix (Energy Policy 2012, I. Current Energy Development). This can be claimed to reflect how China’s power sector as a pillar industry is highly politicised, involving many different actors and divergent interests and objectives, and thus also how the CPC is still the ‘glue’ that changes and dictates the direction of development (Andrews-Speed 2011 in Korsnes, 2014: 180) Hereby, while China’s power sector has been restructured and forced to take a more commercial approach to their operations several times, it remains under tight state control and ownership (Meidan et al., 2009: 602). While the iterative and somewhat schizophrenic moves of both liberalisation and reaffirmation of state control (Meidan et al, 2009; Korsnes, 2014; Yeh and Lewis, 2004; García, 2013; Shi, 2012) have resulted in reforms sometimes being stalled midways, they also reflect how ”[g]overnance of the energy sector is high-level politics in China” (Korsnes, 2014: 180).

Text-box 1: Managing – or caught by - the spiderweb?

Interviewer: Yeah, it’s maybe like navigating a spiderweb.

Interviewee: Yes, exactly. And sometimes you feel like…as we talked about earlier…in a way you feel like caught in it in a way! It’s crazy!

The role of ‘National Champions’ in China’s wind power-TEN – benefiting from entangled relations with parent company

In the above, the ongoing de- and reconfiguration of a Chinese power-TEN - along with ongoing power sector reforms - has been outlined, illustrating how the political and market poles are tightly entangled. This sets the background for an inquiry into how the wind power-TEN in turn is co-constituted by and constitutes the power-TEN. Listed as a ‘new energy’, wind power has been nominated a ‘national strategic emerging industry’ in the State Council’s 12th 5YP for National Strategic Emerging Industries and gradually receives more attention within the power sector (china-briefing.com; Jun. 1, 2012). The wind power-TEN is part and parcel of the overall power-TEN, e.g. as wind farms are owned and/or run by the five state-owned generators (the ‘Big Five’). Further, it was the ‘Big Five’, which obtained the vast majority of concession project tenders during the concession project (described in *Chapter 6*). In addition, while there exist both private and state-owned Chinese WTMs, all WTMs must have close relations with state-controlled generating companies (the ‘Big Five’) in order to be able to sell their turbines in China (Interviews). Although not listed (directly) on the SASAC list, some state-owned WTMs are part of large business group corporations listed on the SASAC list. For instance, Guodian United Power Corporation, which since its establishment in 2007 has become the fourth largest Chinese WTM (in 2011) and is now one of the fastest growing companies in wind power (Li et al., 2012 in Korsnes, 2014: 190-191), has benefited from its unique position of its parent company, namely the power generating company China Guodian Corporation. China Guodian Corporation is one of the 'Big Five' listed on the SASAC list (Korsnes, 2014: 190-191). In addition, one of Guodian Corporation's subsidiaries is the wind farm developer Longyuan Power, which is responsible for Guodian's renewable energy assets (Interviews). Hereby, the WTM Guodian United Power, is at the same time being 'wholly-owned by China Guodian Corporation, a generating company, and linked to the wind farm developer, Longyuan Power' (Korsnes, 2014: 190-191). Thus, the supplier of wind turbines, the WTM Guodian United Power, in a way sells turbines to 'itself', i.e., to its own mother company and one of its subsidiaries. Another example is the state-owned WTM Dongfang, which forms part of the large SASAC-listed business group, Dongfang Electric Corporation (DEC), which is engaged in multiple businesses and industries[83] (dongfang.com.cn). In this way, large state-owned WTMs are often very influential companies, which can benefit from a unique position as subsidiary of a parent company from related industries such as machinery and equipment manufacturing, and which often have direct links with electric power utilities (Korsnes, 2014: 190-191). In other words, the wind power-TEN is tightly entangled in the overall power-TEN.

Managing the Chinese 'spiderweb' – a case study on trust in a liquidity-constrained wind power-TEN

Having provided the context for understanding how the wind power-TEN and the power-TEN form part of China's overall corporate restructuring, a case study on the de- and reconfiguring of relations in China's wind power-TEN is rendered in the following. This is done by diving into the potential software-TEN, which co-constitutes and is co-constituted by the wind power-TEN, as well as by zooming in on the current quality crisis and consolidation phase within Chinese wind power. As the consolidation starting around year 2011 produced a liquidity crisis in the wind power-TEN, due to a downturn in new wind farm projects, the case provides insight into how the quality of relations between Chinese

[83] i.a. power generation, substation and transmission, railways and transportation, environmental protection, financing, investment, and general electric and machinery (within e.g. fossil fuels, nuclear, and renewable energies).

WTM customers and foreign suppliers of control systems has shifted over time, from the time of rapid growth around year 2005 and till around year 2012/2013. With entangled relations between the power-TEN, wind power-TEN, and software-TEN, and between their constituting poles, foreign control system suppliers find their work of nurturing customer-supplier relations – and of handling postponed payments during the liquidity crisis – in China's emerging software-TEN overly

"complex. There's a lot of common pockets and blurred boundaries. How to find out, who it is that doesn't pay [us] the money?…For instance, when X [Chinese wind turbine manufacturer] doesn't pay, then it's likely because Y [wind farm owner] doesn't pay, and then in the end it's because the State Grid and the state don't pay!" (Int. 48, 2012).

This time not focusing on the role and agency of algorithms or controversies over IPRs or standards, the analysis now *follows the money,* i.e., mapping a controversy over money (liquidity), which is entangled in China's so-called 'system problem' – and a 'spider-web' (see *Text-box 1*) – and which has produced concerns over trust.

Liquidity issues in China's wind power-TEN

To conduct such controversy-mapping on the issue of money, the chapter first outlines the liquidity issues facing China's wind power-TEN.

Chain debts trickling down in Chinese wind power

In the current consolidation phase, Chinese WTMs lack liquidity and have suffered from falling profits. In 2013, Sinovel and Goldwind reported an unprecedented fall in profits in the beginning of 2013, by as much as 163 percent in Sinovel's case (www.windpowermonthly.com, Apr. 16, 2013). The financial troubles for Chinese WTMs is entangled in so-called "chain debts in the Chinese wind power industry", which have severely restricted the Chinese wind industry during consolidation (Windpowermonthly.com, Apr. 16, 2013):

"[T]he government owes subsidies to wind farm developers, the developers owe payment to turbine manufacturers, and turbine makers owe payment to component suppliers" (Windpowermonthly.com, Apr. 16, 2013).

One of the reasons for these entangled chain debts is an insufficient renumeration (feed-in-tariff (FIT)) for wind power projects, which is only equivalent to that of thermal power plants (Windpowermonthly.com, Apr. 16, 2013). The insufficient renumeration (García, 2013: 140) in turn finds part of its reason in China's Renewable Energy Fund introduced in the Renewable Energy Law (REL), which is supposed to cover the additional costs of wind power through a FIT subsidy (Windpowermonthly.com, Apr. 16, 2013; Interviews):

"So this [Renewable Energy Fund] system they have - with payment of this feed-in tariff, that's too poor and too slow. And then…it's a problem…I don't think it's like a conscious stalling of payments, it's just that this system, which they are running, is too bureaucratic and ineffective…the reporting must, well, yeah, run on a yearly basis, and then a year after you sent in [your report], then you can maybe get your money back. There's a very long delay in this process, in the approval procedures, which basically is based in the defects of classic Chinese administration" (Int. 18, 2013).

As the Renewable Energy Fund does not function efficiently, and requires a technically advanced cross-provincial management system, "there have been years, where they [wind farm developers] couldn't get the money out, and then they haven't been able to pay for the turbines. And then the banks have financed it, because they knew that the province was obliged to pay for it…but that payment has just been pushed and pushed and pushed" (Int. 20, 2013). Yet, over time, as control of wind farm installments has been centralised, also the state-owned banks have started to limit their credits (Int. 9, 2012, Int., 20, 2013), as a matter of stalling growth in wind power. Overall, all SOEs involved in wind power are being "squeezed in terms of liquidity" (Int. 15, 2012). As banks

"won't lend them money, that's how it [the rapid growth] has been halted. And then there's only one [way] to do it. And that's to stop your own payments down the chain" (Int. 15, 2012).

In addition, power generating companies and wind farm developers have been squeezed from lost profit margins and potential revenue, due to rising unit costs of wind power generation from high curtailment rates (Windpowermonthly.com, Apr. 16, 2013; Bloomberg, 2012: 5). Lastly, while electricity prices have been stable, rising coal prices have implied that generating companies "are actually losing money – at least they claim so – from producing electricity from coal. And then they have no money to pay for the wind turbines, they've got. And then they [the wind turbine component suppliers] don't get paid by [X or Y or Z] [Chinese WTMs]. You know them all. I'm just saying, they are all lacking money" (Int. 9, 2012).

Secured by common pockets – and foreign suppliers as the last to get paid

These entangled debt chains of tightly connected SOEs in Chinese wind power have had an "effect all the way down" to foreign sub-suppliers (Int. 47, 2013):

"Chinese companies are linked closely together like in a chain. If the state-owned banks lack money, then the State Grid, the power generating companies, the wind farm owners, and the WTMs lack liquidity. And then, in the end, there is no money for the European suppliers. They need some money in order to be able to pay" (Int. 45, 2012).

The entangled nature of Chinese SOEs has resulted in lacking and/or postponed payments from Chinese customers to i.a. foreign control system companies as the Chinese WTMs "simply don't have the money. It's as simple as that. Their customer hasn't paid [them]. And that's true" (Int. 47, 2013). Yet, the entangled nature of both smaller and larger SOEs in the power-TEN, who all have "the same owners" (Int. 2, 2012) makes it difficult for foreign suppliers to detect the one holding back payments in the chain in the first place. Another issue is that while foreign companies are preoccupied with lacking profits and liquidity, their Chinese state-owned customers do not seem as urgently concerned with solving the liquidity issues. Instead, Chinese customers (WTMs) of foreign suppliers tend to feel more or less 'secured' by their mother company, their 'brothers' and 'sisters' (Interviews) and the so-called "common pockets" between the many state-owned actors in the entangled business group structures, and thus "see no big deal whether the money are in one box or the other" (Int. 15, 2012). Rather than fighting for larger market shares or profits, SOEs are guaranteed a certain market share (Int. 15, 2012), and when facing financial troubles in wind power, the business group may temporarily reduce engagement in wind power, instead turning towards other business group activities (Interviews). In contrast, foreign companies ”are not at all thinking in the same terms. It's a totally different way of thinking" (Int. 15, 2012). Overall, finding themselves at the bottom of the debt chain, foreign suppliers have had troubles surviving in the Chinese market during consolidation (Interviews). As expressed by a foreign component supplier, where Western companies would

”say, 'we need to stop, we don't have more money', they are not closing down, as the rest of us would maybe do…Because they say, 'the one who owes me, is my brother. I'll get them'. And they don't have a board of directors asking you, 'are you sure of that?!'" (Int. 9, 2012).

While private companies have difficulties surviving during consolidation, SOEs are currently "driving the market. All the private ones, most of them still exist, only few have gone bankrupt, but it will come. Because they cannot continue like that. […] A lot of the private ones are disappearing, but the large state-owned ones, they will be driving the market. Of course that's a focused strategy from the government, I'm sure" (Int. 2, 2012). Already, the consolidation phase has resulted in a reduction in the number of WTMs, from around 80 to "now less than 30" (Int. 45*, 2013), and is seen by Chinese and foreign actors in the emerging wind power-TEN as a strategy of the Chinese Government to reduce the total number of WTMs to only a handful (Interviews).

Soft budget constraints and irresponsible SOEs in Chinese wind power

While primarily the smaller private WTMs are going bankrupt, the SOEs “still do not want to give up” even though they are losing money (Int. 62, 2012). The way in which SOEs seem capable of continuing business even in times of consolidation, reduced profits, and liquidity constraints, is being linked to the ’soft budget constraints’ rather than hard budget constraints facing SOEs in terms of financial performance (Liu and Kokko, 2010: 5527; Konai 1980 in Chang, 2011: 322)[84]. For instance, state-owned generating companies are claimed to focus more on market share and reputation than on profits:

”But they [SOEs/generating companies] want to have...wind power, we have the new energy. Haha. They want the reputation. Reputation's better than the profit, and at that time, coal power was still profitable. So the wind projects lose a little bit of money, [but] the coal power still has profit. So no problem” (Int. 8, 2013).

Hereby, ‘soft budget constraints’ – largely founded in a legacy of the ‘iron rice bowl’ – tend to prevail in the power-TEN and wind power-TEN, where strong dominance of the State in both electricity generation and equipment manufacturing has resulted in a focus on local objectives such as employment, development of local industry, public control (or even ownership) over the power sector, tax revenue, and local growth rates, rather than just profit maximisation (Zhao et al., 2012a: 224; García, 2013).

In turn, this is argued to be one amongst other reasons for the overcapacity problems and the financial insolvency of many wind farms (Zhao et al., 2012a: 224). Hereby, SOEs tend to be framed as “irresponsible”, as they “have a sort of attitude that Megawatts are more important than the dollars or Euros, [or] whether it's connected to the grid or not” (Int. 11, 2012). As “everybody is state-owned, -financed, or –controlled, they have no financial interest in delivering electricity. They are cross-financed, with common pockets” (Int. 22, 2012). In this way, a sharp distinction is being established between Chinese private and state-owned companies. While private companies are framed as ”fast” (Int. 33, 2012), SOEs are conversely framed as slow and inefficient, and marked by bureaucratic structures as well as more or less opaque guanxi with the CPC and the government (Int. 33, 2012; Int. 5, 2012).

”When you are a director of e.g. a large [state-owned] company…they are being appointed in the Party, and it’s kind of an apprenticeship – to be director for a company is like an apprenticeship – and then

[84] This in spite of the fact that China’s market reforms have aimed at restructuring the central redistribution system and the governance of SOEs, which is supposedly causing both local governments and SOEs to gradually switch from ‘soft budget constraints’ to ‘hard budgets’ (Lin 2006 in Chang, 2011: 322).

they will become politicians. And that means, they are crappy leaders – it's [wind power] not their baby, right?" (Int. 15, 2012).

Accordingly, as directors of large SOEs often aim for a political career within the nomenklatura system, SOEs are claimed to be characterised by a "big boss philosophy that government is very important, so we need to flatter the officials, and then we will get orders. That's good enough" (Int. 5, 2012). Apart from being framed as inefficient, SOEs are sometimes also associated with 'corrupt governance structures' (Int. 33, 2012). It is widely acknowledged that the Chinese wind turbine industry is marked not only by uncertainty regarding laws and regulations, protectionist industrial policies, limited human capital, but also by insufficient financing, bureaucracy, and corruption (Klagge et al., 2012: 376). These issues are in turn often linked to the corporate restructuring process, during which some of the WTMs for instance have been listed. According to several respondents, some of the many new companies have been 'fake shell companies', in which a number of well-connected 'happy go lucky' managers were 'installed' through their *guanxi* (Int. 42, 2012):

"You had this euphoria, which has been there in all these Chinese companies – with shares to buy… Now it has cooled down a bit. Because they are all fake companies – it's business people, who turn up and behave like they are masters…then they buy some shell companies, put them on the stock exchange…and then they get a lot money back, right into their own pockets" (Int. 42, 2012).

Potentially an example of such 'hot air balloon' companies, Sinovel (also see *Chapter 9*) was established in 2006 and has focused on "rapid and relentless growth" (Bloomberg/Bizweek, Mar. 15, 2012). In this way, Sinovel became the second-largest turbine maker in the world, after the Danish manufacturer Vestas within less than four years (windpowermontly.com), and the world's largest WTM by 2011. However, in order to establish Sinovel, the founder Han Junliang[85]

"didn't do it alone. Sinovel is one of the best-connected clean energy companies in China. Among its major investors is the private equity group New Horizon Capital, co-founded by Wen Yunsong, also known as Winston Wen, son of China's [former] premier, Wen Jiabao. Han [Junliang] was also close to Zhang Guobao, until recently head of China's powerful National Energy Administration [NEA]" (Bloomberg/Bizweek, Mar. 15, 2012).

Allegedly, Sinovel's relation to the former head of the National Energy Administration (NEA) "may have given him [the founder] an early look at yet-to-be-published government

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[85] With a background in the ranks of a SOE, Dalian Heavy Industry Group, which builds steel-rolling equipment and other massive machinery, and within its electrical equipment division, the founder and president of Sinovel, Han Junliang left Dalian Heavy in 2006 to start Sinovel. Meanwhile, Dalian Heavy is among Sinovel's major shareholders and its biggest benefactor (Bloomberg/Bizweek, Mar. 15, 2012). In addition, Han Junliang left himself with "a 13.3 per cent stake in Sinovel" (Bloomberg/Bizweek, Mar. 15, 2012).

regulations and given Sinovel preference in the kinds of turbines chosen to power the state-planned wind farms. When China finalized bids for a mega-wind project in 2008, Sinovel won 47 per cent of the deal, by far the biggest share of any manufacturer" (Bloomberg/Bizweek, Mar. 15, 2012). In this way, Sinovel's founder "seems to have ridden the wave just perfectly" (Bloomberg/Bizweek, Mar. 15, 2012).

Overall, the explosion in the number of WTMs is claimed to have "looked way too nice and impressive, and it happened in no time. When something goes this fast and looks so nice, then it's often because somebody was going to earn some quick money on an IPO [international public offering]. And now political focus has been turned towards this issue [of corruption]. It looks like a lot of pure hot air – a lot of fake contracts on fake projects in order to sell some stock options. That's illegal and should be punished" (Int. 24, 2013). In turn, the current attempts at 'comprehensively deepening reforms' of the Chinese political leadership imply that "a lot is happening behind the scenes right now in connection with the clean-up during consolidation" (Int. 24, 2013) in the emerging wind power-TEN.

Liquidity issues entangled in a Chinese 'system problem' – no good for the country

The dominance of SOEs in Chinese wind power is in turn by Chinese actors framed as a comprehensive Chinese 'system problem' of China's overall 'industrial system', and is used as an explanation for the current quality crisis: "This is the problem...it's also the system problem for China...you know, the state-owned enterprises" (Int. 8, 2013). In the following, the chapter looks into how this 'system problem' co-performs the ongoing qualification struggle in Chinese wind power, producing concerns over i.a. money (e.g. prices, generating costs, liquidity) and quality.

Measured almost exclusively on low prices, successful bidders in concessions and wind farm projects have predominantly been Chinese SOEs, which with soft budget constraints have been prepared to sacrifice short-term profitability in order to win the projects (Yu et al., 2009: 5223). That is, "most of the state-owned enterprises not so care of the cost, haha. They only want to win the bid - win the bid is their achievement, their reputation, haha...that is...so the problem is they offer the price...is extremely low, the price...making the project not profitable" (Int. 8(*), 2013). Although the preference and support of large SOEs by banks and government has been successful in reducing turbine prices, creating scale advantages, and rapid growth, the preference of SOEs by banks "could lead to a lack of project evaluation behind credit decisions" (Korsnes, 2014: 193). In turn, the price-bidding and 'target-madness' (i.e. focusing on GW) has resulted in quality compromises, as bidders have had to keep wind turbine costs as low as possible. That is, “in the current stage, it’s not so much about the quality, it’s the price” (Int. 62, 2012). This compromise of quality is possible for state-owned bidding companies as they are only measured on

“the largest installed capacity, that's your achievement. You are not responsible for the future…[for] the turbine not working, haha. You [generating company] are only...maybe three or four years in your possession. Later, it's not you...so [you will] not [be] so worried about that [quality]...but this is not only for wind, it's for everything [in China]” (Int. 8(*), 2013).

In this way, targets and incentives such as bidding criteria have overflowed into quality problems in the long term, which is e.g. reflected in higher generating costs (Int. 8, 2013; Int. 20, 2013; Int. 21*, 2013): ”Because high quality must be high price, high cost. But for the generating cost, depending on the high quality. For twenty years. I call it the wind turbine fatigue...that's the machine, you've got loads, very high...but nobody takes care about them” (Int. 8, 2013). As “quality is long term” and is not visible right after the installation, but only “after three years, five years” (Int. 62, 2012), “nobody cares about quality, and no authority is saying ‘this is good, this is bad [quality]’” (Int. 21*, 2013). In turn, this comprehensive system problem of SOEs squeezing prices beyond the limit is being constituted as ”a political problem” (Int. 8, 2013) and an issue of China’s ’overall industrial system’ (Int. 21*, 2013):

“So this is the core issue of China's total industrial system. What caused this problem? I think, it is caused by the lack of a pure market economy, and therefore you see China’s overcapacity in many industries. You know, overproduction. But I think, production overcapacity is a good thing for the industry, you can choose the best one. That is, overcapacity is a good thing…If there is only one person selling, then prices will be high, and the quality may not be good. So if there are two, competition will be better. But in China, it is often not a healthy competition making price competition better…Instead the price is getting more and more whatever [lower]… In China we are all low price fighters, and this finally led to abuse […] and everybody is doing bad. I think, it is because the market mechanism has not been established” (Int. 21, 2013).*

Above, it is indicated how notions of China’s overall ‘industrial system’ and the lack of proper ‘market mechanisms’ of a ’pure market’ are being employed as discursive devices to explain why “everybody is competing for life on lower prices” regardless of quality and profits as well as how this has “led to damage, so nobody is doing well. I think the market mechanism is not established yet” (Int. 21*, 2013):

“[It is] not the Chinese government's strategy, it’s the result of China's entire economic system. That means that excess capacity is like the development of the survival of the fittest, which could contribute to good actors emerging to do the job. In China, however, people buy things in a market, which is not pure, so he will not buy the best, he will buy the cheapest, and therefore we don’t have people to make any good products” (Int. 21, 2013).*

To reiterate, the thick mesh of entangled relations of state-owned actors in Chinese wind power are being constituted as a comprehensive ‘political problem’, which reflects China’s lack of ‘pure market mechanisms’ in its entire ‘industrial system’. These issues have been framed as a Chinese ‘system problem’. The system problem produces concerns over i.a. the financial sustainability of Chinese wind power and over myriads of quality issues. That is, “the preference for low-quality, state-owned projects induced by government investment, is potentially destructive” (Korsnes, 2014: 193) for the framing of Chinese wind power as ‘sustainable’. According to industry experts, the system problem constitutes ”a big trouble for the future. No good for the people, no good for the country. With a system like this […] I'm so worried about it, because in this way…no driving force for manufacturers to improve their quality” (Int. 8, 2013). In this way, the system problem creates potential socio-technical barriers to a potential turn to quality, since the “market can still not finance good quality” (Int. 24, 2013), but has “still got to change” (Int. 8, 2013). With its equivocal nature, the ‘system problem’ potentially constitutes an overflowing ‘stem issue’, which forms part and parcel of the ongoing qualification struggle in China’s potentially emerging wind power-TEN. Against this backdrop, the chapter dives into how the concerns over money (liquidity), entangled in China’s corporate restructuring and system problem, have de- and reconfigured the quality of relations over time between Chinese WTMs and suppliers of control systems.

Changing quality of customer-supplier relations and issues of money and trust

Having set the backdrop for understanding the money (e.g. liquidity) issues in the entangled wind power-TEN and power-TEN, the chapter dives into an account of how a controversy over these issues have de- and reconfigured relations in the emerging software-TEN. This is done by focusing on customer-supplier relations around control systems. First, the analysis looks into how foreign suppliers of control systems have dealt with lacking payments from Chinese customers. This leads to an inquiry into the emergence of new actors, so-called ‘agents’, which act as ‘lubricators’, when relations have ‘gone sour’. Finally, an account of the transformation of customer-supplier relations over time, as well as between subsidiaries in China and Danish headquarters, is rendered.

Riding off the storm together – and never (ever!) break your relations

During the consolidation within Chinese wind power, foreign suppliers of control systems have increasingly faced the dilemma of how to tackle postponed payments from their state-owned customers, while keeping on good terms. Due to the entangled nature and ‘common pockets’ of Chinese SOEs in Chinese wind power, foreign suppliers fear that they will lose their customer if they stop their deliveries of control systems and/or services when payments are lacking:

”We can’t just close down, because then X [a Chinese wind farm developer] won’t understand why the turbines are not running as they are supposed to, and then Y [a Chinese state-owned WTM] says, that’s those stupid people from Z [a foreign component supplier], and then we’ll have a bad relationship with X [the Chinese wind farm developer], and then we will be put down at the bottom of the list. Out here you need to ride off the storm together” (Int. 9, 2012).

Consequently, aiming at ”keep[ing] on good terms with the [wind farm] owners”, some foreign suppliers have chosen to continue delivering service because “we have this rule that everything which is related to the end-user, we will do that, as we have done all the time” (Int. 9, 2012). Otherwise, if not continuing service, ”I’ve spoiled the relation, that I wanted to keep, because then I have created a bad reputation in regard to service. So we decided instead to stop delivering [control systems] to new wind turbines” (Int. 9, 2012). In this way, suppliers “say, ‘well, hrmf, then we’ll have to ride the storm off together’, haha, even though…that’s difficult to get through…through eight months…to say, we need to stick together in this…but you have to” (Int. 9, 2012). This practice is framed as a matter of being patient and displaying trust in the Chinese customer, because “then a year passes by, and then it [payments] slowly starts to roll again” (Int. 9, 2012). Hereby, instead of starting to ’make trouble’, it is important to ’stay the same’, patiently waiting for the market to turn around, even though

”it’s beyond criticism, and they also say…when I ask them, what the heck, when will things change?…’Just relax, it will come. Just keep staying the same, then everything will be fine’. And then they keep an eye on you. They really keep an eye on you, how you behave…and they reward you for it…Because if you start to make trouble, then they will put you right back to the bottom of the list. Then you will never get your money back, that’s for sure” (Int. 9, 2012).

Conversely, other foreign suppliers have adopted a no-tolerance practice towards delays in payments, and e.g. require pre-payment from the customer before shipping deliveries, which, however, counters ’normal business practice’ in China (Interviews).

Treating the culprit nicely – the entangled nature of actors

The need to keep the ‘end-customer’ satisfied is, as indicated, intricately associated with the ‘common pocket issue’ of the wind power-TEN. That is, “it’s the government generating the problem” with liquidity, as the stallment in payments “has been a way [of the Chinese Government] to stop the train. It was like saying, ’now we stop the money flows and regulate the banks, so they [WTMs and others] cannot borrow money’” (Int. 9, 2012). Hereby, foreign suppliers find themselves in a dilemma, acknowledging that ”it’s not their [the customer's/WTM's] fault" that payments are delayed (Int. 9, 2012), but rather the Chinese government (and next in line, the Chinese wind farm owners). Yet, as 'nobody can take the Chinese State to court' (Int. 9, 2012), foreign suppliers must keep on good terms with the wind farm owner in order to keep their Chinese customer:

"That's actually wrong. Because they are the ones who are guilty, because they are the ones, who have not paid X [a Chinese state-owned WTM]. Well, it's…actually, you support the one, who is the reason for the problem, right. Actually, we do that. And that's…in terms of how we tackle this normally, then it's totally wrong" (Int. 9, 2012).

On the other hand, by displaying tolerance towards delayed payments, and "treating the culprit nicely" (Int. 9, 2012) - 'acting somewhat as a bank, which offers credit to their Chinese customers' (Interviews) – foreign suppliers show that they have comprehended the entangled nature of the Chinese wind power-TEN.

Emergence of agents and 'go-betweens'

As profits have been dwindling, chain debts have become ubiquitous, and as payments have been delayed in the emerging wind power-TEN, a new kind of Chinese actor has emerged to 'smooth' out relations between Chinese customers and foreign suppliers. That is, it has become increasingly impossible to conduct business in Chinese wind power without having an 'agent'/service company in-between customer and supplier. Such agents are "often the cousin of some government official" (Int. 9, 2012) and function through their guanxi with government officials whom they can 'butter up' (Interviews)[86]. That is, "now the market has dropped, and then it turns more corrupt" (Int. 15, 2013). In the following, the case study inquires further into the multiple 'qualities' of the agent. This analysis forms the basis for looking at the development of 'trust-based' relations between customers and suppliers over time, in what increasingly seems to constitute a rhizomatic 'spiderweb'.

The agent as buffer and 'lubricator'

First of all, agents help with prepayments to the supplier, thus acting as a 'buffer' guarantee of future payment, as well as of continued orders:

"Actually, he is useful, because – I ask the other way around. I need to be able to explain this the other way around [to the headquarters]. So, I need a 30 per cent prepayment. An agent in China doesn't just need good relations, he also needs to have lots of money. He needs to be a buffer for the payment. Instead of waiting for the money for nine months, we'll get them in three months. So we reduced the risk" (Int. 9, 2013).

[86] It is often unclear how agents emerge, and how they obtained the guanxi and money in the first place; however, this is largely being explained as a matter of having been born into (extended) families with political *guanxi*.

In addition to acting as a buffer for payments, the agent eases communication, as they often have previous professional experience with international collaborations. According to one agent, for instance, they are ”very strong at negotiating. I know foreigners very well. I can translate Chinese needs and foreign needs, make them meet – not word by word. But making things work” (Int. 45, 2013). In this way acting as a ”lubricant” (Int. 45, 2013), the agent assists the foreign companies who “are just like a baby, and I'm like a mother for them, so I deliver the results for them” (Int. 45, 2013). Helping communication between the Chinese customer and foreign supplier, the agent may be said to engage in *guanxi* in an ”embedding” form, which is prevalent in China primarily in business relations, as it implies a ”cultivation of trust and understanding in mutually beneficial connection, with an instrumental aim to promote cooperation and increase future benefits” (Chang, 2011: 319).

Knowing the 'right people' to get orders – the need to cultivate the soil and the lack of the philosopher's stone

Second, it is necessary to get assistance from an agent and his guanxi in order to find customers and supportive officials ”at the highest political local level, nurturing the soil both politically and commercially…talking to the right people, finding out who are the real decision-makers…securing that they at least know a little about us. In order to open up for a meeting with the right people” (Int. 13, 2013). This is important for foreign companies, since ”it's only the Chinese who actually know who's in charge” in China (Int. 13, 2013). The construction of such guanxi and the use of agents are consequently framed as critical to the survival of foreign companies in the Chinese wind power -TEN:

“And I should say, I don't have the philosopher's stone, nobody has the philosopher's stone, but in my personal opinion, I think that the closer ties you can create, in relation to the customers that you work with, and the closer you can get to the top of the company…now I'm talking about personal relations…the closer you can get to the political top and developing this network…then you can…I don't dare to say to a Party member…but that you come so close to the decision-makers, so they can see that a collaboration can give them something. In that case, I think that the risk of getting sidetracked both financially and technically becomes smaller for a Western partner” (Int. 13, 2013).

Establishing such relations with government officials and Party-members requires that the agent is 'paid a few more percentages', in order that he can 'butter up' the relevant people, acting as a hybrid middleman. While some foreign suppliers pay some 'extra dividends' for the services provided, others 'pay' through investment in time and money to build personal relations (Interviews). Possessing valuable connections to the political system, agents have a reputation for 'knowing a couple of tricks' in terms of buttering people up upwards in the system, both at the local and the central level (Interviews). This makes it

”quite funny to know these people, because they know, they really can do things…it’s not just empty talk, they can…they can…a lot of them really know some tricks, that’s… […] they know some people and can tell them to buy this” (Int. 2, 2012).

In this way, with the entangled nature of SOEs in Chinese wind power, ”the better the network, the closer you’ll be to the right decision-makers…And having the right relations, I think that’s the best form of security” (Int. 13, 2013). By ”knowing the right people”, the agent plays a critical ‘bridging’ role (Burt, 1992 in Chang, 2011: 318), i.e. using guanxi to link groups that are otherwise not connected, “usually to benefit his or her own interests” (Burt, 1992 in Chang, 2011: 318).

Receiving market intelligence

Third, agents assist in lifting some of the tasks that foreigners do not have the resources to do, because ”we don’t have the connections for that. We have the connections to those who have the connections. And that’s what we have to exploit” (Int. 13, 2013). For instance, State Grid and wind park owners do not offer market intelligence on “where the market is moving”, “what kind of regulations have been introduced, and what impact they have” to their foreign suppliers (Int. 2, 2012):

”They would never tell us anything in the first place, I can guarantee you that. That kind of information – you won’t get…what’s…what market they are working in, and their…that part out here, that’s one hundred per cent closed to us. That means that the requirements that park owners get from some grid company, a grid code, whatever…what they are basing that on, they won’t tell us. We just get the specifications and then we must fulfill it” (Int. 2, 2012).

Lacking unofficial market intelligence – and with official data often not considered trust-worthy in China – foreign companies must thus cultivate relations with agents in order to get access to market intelligence, which is critical “to make sure that you understand what’s going on. Many things take place behind the curtains here, and nobody can really see what’s happening” (Int. 15, 2012). In this way, by cultivating guanxi, or ’employing guanxi as strategy’, foreign suppliers can reduce uncertainties of e.g. resource allocation, information transmission, and market competition (Chang, 2011: 320). That is, foreign suppliers try to minimise associations of uncertainty and complexity of Chinese wind power market, “by establishing relationships with local partners who can offer relevant information, advice, and support” (Boisot and Child, 1999 in Chang, 2011: 328). In this way, guanxi seem to emerge as a critical intermediary, relating

Text-box 2: Grasping the simplicity and complexity of relations

Interviewee:”There’s something about this, which makes it incredibly easy. Because in a way it’s so simple. In its own overall complexity, it’s pretty simple to grasp that this is all about…”

Interviewer: “Relations?”

Interviewee: “Yes! If you’ve got them, everything is possible!”

actors together.

Outsourcing part of the spiderweb – and relations as a source of agency

Lastly, as an intermediary, the agent links actors through material means such as cigarettes, money, beer, wine etc. That is, the agent handles the relation to the Chinese customer himself and ”smokes the necessary cigarettes and drinks the proper amount of beer and wine” (Int. 2, 2012) with central or local government officials and/or state-owned developers and grid companies. In this way, ”it’s also a matter of outsourcing relations and the related drinking and smoking” (Int. 24, 2013), i.e. the time and money invested in networking and lobbying.

”It’s crazy, crazy [the need for connections]. And the best…the easiest way to do it is to outsource a bit of it, I think. And then use these ’go-betweens’, who are around” (Int. 2, 2012).

Hereby, the ability to construct relations with agents of foreign actors as well as agents’ ability to relate to officials have emerged as a certain form of ’capital’ and source of agency, since it makes it ’possible to do anything’ (see *Text-box 2*), which to foreign actors remains somewhat ‘opaque’. According to an agent, ”the best relation with Chinese people is not just about business. In China, the law is one thing, but the law can be changed by a person, if you have the right relationship” (Int. 45, 2013). In this way, relations are framed as a critical capital, in order to make things happen, and they are built through socio-technical means, e.g. social capital (guanxi), money, cigarettes, and *baijiu* (Chinese liquor (白酒)). In the following, the case looks into how relations have changed over time, as liquidity issues and agents have gradually entered the stage.

Transformation of relations over time

In the above, a controversy over money seems to be emerging between Chinese and foreign actors, which has drawn a variety of heterogeneous actors into the network. In this controversy over money, guanxi are being employed strategically as an ‘obligatory passage point’ for entering the supply chain of the largely state-owned Chinese customers. Further, guanxi are employed strategically by WTMs – both SOEs and private companies (and everything in between) – to gain orders from generating companies and/or wind park owners. In the following, the case looks into how the quality of relations has changed over time in the liquidity-constrained wind power-TEN. This also implies a further look into the nature of so-called ‘embedding’ guanxi, which is employed as a means of establishing trust (Chang, 2011). Such embedding guanxi is claimed to be employed by many foreign firms in China, as they attempt to develop “enduring, trusting, mutually supportive relationships through joint ventures or partnerships with Chinese counterparts who can help them cope with the unfamiliar and complex Chinese environment" (Boisot and Child, 1999; Luo 2001 in Chang, 2011: 328).

From cowboy hats and boots to building (trust-based) relations

In the initial growth phase of the Chinese turbine industry, around "2007, the wind market was a seller's market" (Int. 46*, 2012), "it was way too easy, on our premises" (Int. 2, 2012). In this context, foreign suppliers had no troubles finding customers, as Chinese SOEs

"just needed to install, install, and they were buying stuff like crazy…the money, it was an awful lot of money, which were put into this wind turbine thing…and there were no problems in terms of payments, well, the liquidity was incredibly high" (Int. 2, 2012).

In this kind of (Western) seller's market, there was neither time nor need for construing associations of trust. Instead, "it was just that the market was so big and demanding that they [the Chinese WTMs] were hungry for all this [foreign technology]" (Int. 2, 2012), and with high numbers of new installations, "the Chinese customers required high-speed response":

"Because major wind turbine [manufacturers], they all...some have the government relations...so the Government wants efficiency…they don't know the details...'I think in half a year or one year, you have to get this size'. Then all the guys below him just want to move fast, implement. The time schedule is important" (Int. 10, 2012).

As wind power installments consequently grew almost exponentially at the time, Chinese customers almost did not know what they were buying, "they just knew that it was a control system" (Int. 2, 2012). Despite this, lots of contracts were signed "without knowing what it was all about. It was so easy. You didn't have to sit down and try to understand" (Int. 2, 2012). Instead, "you just had to bring a piece of paper, and then they would sign. And we got the money" (Int. 2, 2012). This is being likened to working "with cowboy hats and boots on, and then moving ahead" (Int. 2, 2012).

Today, however, "that's not how it's functioning anymore, you can't do that anymore" (Int. 2, 2012). That is, undergoing a phase of consolidation as well as a liquidity and quality crisis, the situation has changed. Consequently, today "it's very much a buyer's market. Yeah, in particular since January this year [2012], when it really hit" (Int. 2, 2012):

"It changed overnight, in January [2012]. I think so. There were some new initiatives from the government, some economic restrictions have been introduced for the wind power sector, which have meant that it's changing now. And then, I can sense that it's not so much about selling a product anymore, it's about selling a relation" (Int. 2, 2012).

This new situation has required foreign suppliers “to sit down and think a bit. And you must talk with the Chinese, and need to teach them how to trust you” (Int. 2, 2012). In this way, now ”we are back to the things, which really trigger them [the Chinese]” (Int. 2, 2012), that is, building *guanxi* through associations of trust. Previously,

”you didn’t have to sit down and try to build trust. Well, that’s for sure what you need now. If the Chinese don’t trust you, you can leave. I normally say it this way: you may have the best product, at the best price, but you cannot sell it, if you don’t know the right people” (Int. 2, 2012).

In the following, the analysis dives into different strategies for adapting to these new circumstances and demands from the Chinese customers and partners, including the need for an ‘agent’.

Contracts (or working around them) – and moving towards guanxi

A conventional means of stabilising collaborative relations – to build trust – is contracts. Yet, contracts in China are often being worked around after signing them (Int. 2, 2012; Int. 13, 2013; Int. 42, 2012), as part of the process of trust-building. Thus, “when you sign a contract [in the West], it’s certain, because according to Western culture, or let’s say Danish culture, when he’s signing a contract, he’s very careful, each sentence, every word, so after signing the contract, he has great respect for this contract” (Int. 12*, 2013). Yet, in China a ”contract is not a contract in the classic understanding. Under the best of circumstances, it’s a letter of intention, and that’s it” (Int. 2, 2012). In particular, such pragmatic approach towards entering into contracts is needed when it concerns business relations with SOEs, who operate under ’special conditions’. That is,

“because everybody may be state-owned units, so having this background… after signing the contract as a state-owned enterprise, my contract has no certain place, I have no clear contract, where I can refer back to the contract, even after the contract was signed. We all know that there was too much in the contract, so it’s nothing more than an establishment of a relationship between the supply and demand sides” (Int. 12, 2013).*

As a framing device, contracts are meant to delegate responsibilities and rights of the different actors in the network. Yet, in China, a contract is framed as ”only a piece of paper. Even though I have a signature here, but after I change it...that's the difference” (Int. 10, 2013). As Chinese employ contracts instead as a pragmatic means for establishing relationships in order to work around the contract’s paragraphs, the contract ’overflows’ in the eyes of foreign suppliers. Thus, according to many Western actors, ”a Chinese contract is not worth the paper it has been written on” (Int. 42, 2013). Also Chinese actors themselves reckon that Chinese will “never follow it [the contract]” (Int. 10, 2013), which is particularly the case of SOEs:

”So that means that he’s [Chinese SOE] not 100 per cent complying with the execution of the contract, and this is a big difference. Frankly, it’s not just our clients, but in China all state-owned units, or all private Chinese companies are like this. There may be ten points in the contract, but there will not be full implementation of all of them. It’s just about laying down the supply and demand relations of the two sides, nothing more” (Int. 12, 2013).*

In the perspective of Chinese actors, this flexibility in reading the contract is necessary for stabilising relations. Accordingly, Chinese customers have become dissatisfied over time with what they frame as a lack of flexibility from Western partners in regards to contracts (Int. 12*, 2013), which has become an increasingly critical issue, as liquidity issues have become more pervasive in the wind power-TEN.

”It’s very strange, in China there is no clear boundary between business and personal relationships. The Danes find these mixed lines very strange, cannot figure it out” (Int. 45, 2013).

In this kind of situation, display of recognition, respect, and understanding of the special conditions of SOEs, and some kind of acceptance of delayed payments and introduction of agents, from Western suppliers have become increasingly critical to building trust and receiving orders. That is, in liquidity-constrained times, Chinese customers require a less legalistic and formalistic approach to partnerships, which necessitates other means than contracts, namely building guanxi, to construe associations of trust (Int. 45, 2013).

Changing strategy in order to construe associations of trust

Over time, as foreign suppliers have had to ’take off their cowboy boots and hats’ and, instead of hasty contracts and a legalistic approach, invest time in construing associations of trust, it has become increasingly important to show signs of pragmatic flexibility in regard to contracts. Recognising how ”we are making a serious mistake if we think that it [the contract] has got the same meaning [in China] as in the West” (Int. 13, 2013), foreign suppliers have gradually learned that

”it’s not so much about looking at the contract. It helps that you sit down together at the table. But it’s more about building up trust, so they trust you and trust what you tell them. It takes time. Costs some money. Haha. But when that has been settled, and you have invested the time, then you can do anything” (Int. 2, 2012).

This change in strategy of foreign suppliers in China has over time implied a higher acceptance i.a. of delayed payments and agents, and a higher flexibility in terms of working around the contract’s paragraphs, since otherwise ”it would be a very a dangerously conservative or ‘to the letter’-approach, right?” (Int. 15, 2012). This implies that many foreign suppliers are now “trying another approach”, to rebuild relations which have gone ’sour’. Rather than just being focused on signatures, it has become necessary ”to have a talk and to hear what actually went wrong” (Int. 2, 2012). That is, many foreign suppliers have lost orders over time, due to the way that

”the Chinese want to involve personal relations. There are so many competitors in China, so there are many factors, which affect X’s (a Chinese SOE’s/WTM’s) decision [on suppliers]” (Int. 45, 2013).

Lacking a “culture of the contract, a credit system” (Int. 46, 2012), the Chinese “credit [reputation] system is based on the person, I only work with the people, I believe in” (Int. 46, 2012). In this way, there are both personal guanxi, and supply chain guanxi (Int. 12*, 2013). In particular this is the case within wind turbine control systems, “because this is not like selling a bottle of mineral water…It [guanxi] is very critical, especially as a foreign brand, if you really want to grow in China, if you don’t have any relations (Int. 12*, 2013).

Customer-supplier relations as a marriage built on trust and respect – ‘when in China, do as the Romans’

To build such associations of trust, agents have – as depicted - come to constitute a critical means. However, in the beginning, foreign companies reacted with reluctance, due to a lack of understanding of the role and function of the agent, thinking: ”Who the hell is he!? It’s not because I don’t like him, but what does he do?” (Int. 9, 2012):

”I found it very difficult in the beginning, when there was suddenly someone…someone in-between…then I say…what are you doing? You know, that was really how it was. What is he doing?! You’re just disturbing […] It’s not how we do things normally, it isn’t! We don’t want any go-between…no…why is he there? What is he doing? It’s difficult to understand. And does he keep the money to himself, or what does he do? It’s…we just don’t understand” (Int. 9, 2012).

Acting with such initial resistance to agents, relations were destabilised over time. That is, as the consolidation phase resulted in liquidity constraints and delayed payments from SOEs, which necessitated the employment of an agent to act as a buffer, some Chinese customers have stopped their orders to foreign suppliers “because we didn’t want to pay the right people for their services, I’m totally sure that’s why [we lost our customers]. And nothing else” (Int. 2, 2012). That is, ”they just stop paying…yeah, but they think that they have been treated badly. And we think we have been treated badly. And then people stop talking. And that’s the worst thing you can do. Especially out here” (Int. 2, 2012). According to an agent, ”in the beginning they [foreign suppliers] didn’t want to have such a relation, to use these relations. But I think they cannot make business without it, as they will make so many mistakes” (Int. 45, 2013). Gradually recognising the function of the agent and the need for construing trust through guanxi, foreign suppliers have changed strategy, “reestablishing a dialogue”, e.g. by accepting the introduction of an agent by the customer (Int. 9, 2012). This has made relations more stable, and foreign suppliers have ”also got more orders” (Int. 45, 2013). Lastly, the gradual recognition of the need to employ framing devices other than contracts in China is by the Chinese being constituted as a matter of ‘respecting Chinese culture’. In the beginning, with high growth rates, the “very approach to doing business has been done in the wrong way…the respect has disappeared” (Int. 2, 2012). According to an agent,

“in China it’s easier to do as the Chinese, adapt and be flexible. But especially Danes find this very difficult. They should learn to act as the Romans. A lot of foreigners are very bad at this, Danes and also others. Danes want to understand why and how things happen. Instead, I just tell them, ’you just follow me’, but I don’t provide the reason, just the results. That’s very difficult for foreign people” (Int. 45, 2013)

Overall, it is increasingly recognised that ”it’s extremely important to go out there and show respect for the culture and the people…to nourish an amount of deference” (Int. 13, 2013):

”They [the Chinese] want that you as a Westerner understand Chinese business mentality. You need to understand China. You must act with respect, you must be honest. They may not be honest with you, but to a certain degree they are anyhow, because as soon as you get under their skin…under their skin, I think that the communication becomes much easier. I don’t use as much time for negotiation, when the trust has been established. But it takes such a long time!” (Int. 2, 2012).

Emphasising the need for mutual respect and trust, Sino-Danish customer-suppliers are likened to ”an entire marriage!” (Int. 47, 2013).

Implications for relations between headquarter and subsidiary

Apart from influencing relations between Chinese customers and foreign suppliers, the controversy over money has had implications for the de- and reconfiguration of relations between Chinese subsidiaries and Danish headquarters, not only between Chinese and Danish employees in Danish supplier firms, but also between Danish employees with connection to the Chinese subsidiary and the Danish leadership in the headquarter in Denmark. Through the following account, it is illustrated how relations tend to be negotiated.

Chinese concern for a lack of understanding of Chinese culture

First of all, related to the issue of ‘respecting local culture’, local Chinese employees in Danish subsidiaries are concerned that Danish headquarters do ‘not care how we were thinking’, displaying a lack of ’trust’ (*xinren bu gou 信任不够*), ’respect’, and ’confidence’, which is often being framed as ’arrogance’, constituting a ’common illness’ (*tongbing 通病*) of Danish companies in China (Int. 40*, 2013; Int. 10, 2012; Int. 46*, 2012):

“Yes, they [Danes] do not understand the Chinese market, but we [the local employees] have been ignored. So we feel very sorry, we lost to our competitors, especially in the Chinese market. […] This regional culture is too diverse, but you should listen to the local managers in what to say” (Int. 40, 2012).*

Not feeling ‘respected’ or ‘listened to’, Chinese employees in different subsidiaries tend to ‘feel lonely’, ‘feel very frustrated’, and ‘very angry’ (Int. 10, 2012; Int. 46*, 2012). This has created a demand for more Danish employees moving to China as long-term residents to understand the local culture and/or to establish joint ventures, in order to make it easier to ‘do as the Romans‘” (入乡随俗, *ruxiang suisu;* literally, “when entering the village, following local customs”) (Int. 46*, 2012).

“When you are not at work, you can consider yourself the king of your own world without a problem, but when you are working to get a market share in another market, I think you need to forget about your own identity” (Int. 46, 2012).*

Accordingly, some Danish managers have gradually learned that ”to make business in China – it’s a huge challenge. What I’ve learned from this is that we should never think that we can save the world with our own solutions” (Int. 13, 2013). Increasingly, Danish employees with relations to China, working either in China or Denmark, are working consistently with building trust between the headquarter and the subsidiary, giving subsidiaries more autonomy, and respecting that ”they are the ones who know the culture. Know the language. They are the ones who know all the nuances” (Int. 13, 2013). In this way, relations have been and are being negotiated over time. As Chinese companies have acquired new capabilities, it is increasingly important that ”you don’t do it as a student-teacher relation, but that you do it as an equal partner and with a common wish to do this. That’s the kind of respect that I think you must build up” (Int. 13, 2013).

Understanding the Chinese ball game and ongoing negotiations between subsidiary and headquarter

Second, some foreign suppliers have sought to reduce complexity, i.a. by bringing expatriates to China to control their affiliates and operations in China directly (Chang, 2011: 327):

”So now we need a new one out here, we need that. The headquarter doesn’t understand what’s going on out here […] You know, well, that the week after we’ve returned home, then it’s old knowledge we have got. It’s no use […] And that’s actually what I try to do. [Trying to find out] what the hell is going on (Int. 48, 2012).

In this way, some foreign salespeople and/or foreign managers in China look at this “a bit like undercover work, kind of adopting ‘several identities’, as they engage in relations with hybrid 'in-between' agents. Indeed, getting to understand the Chinese 'spiderweb' requires people to lobby, and

"to act in a certain way in the [Chinese wind power] industry, being secretive. That's what you become, everybody gets that way out here. I also keep the cards close to me. You've got your own…and you protect that" (Int. 2, 2012).

Some foreign suppliers have not localised as much as others. Whether or not they have been posted in China, or only have localised production in China (which also has implications for associations of trust), Danish employees working permanently or interchangeably between Denmark and China, face a dual challenge, as they must not only stabilise relations with Chinese colleagues and customers, but also with their Danish board of directors and management. This has become increasingly difficult in the stagnating and liquidity-constrained Chinese wind power market.

"Because the funny thing is…had it been a Western company, then you'd say, then the collaboration would have stopped there [due to lacking payments], right, and our customer would probably have stopped his development, because he couldn't get funded…But it seems like the Chinese [companies] somehow still have so much money that they can still pay their employees, so they are just continuing business […] And production, sales, and development and things like that, it's still running. And that's kind of a strange schism to face, because how is that possible!?" (Int. 47, 2013).

Facing the "schism" of comprehending the workings of 'soft budget constraints' of the state-owned customers, Danish suppliers "can never disappear [from the Chinese market]" despite lacking payments. That is, "the moment your presence is gone, then you are out of their [the Chinese customers'] conscience. And it happens very fast. So it [relations/guanxi] must be nurtured, nurtured, nurtured" (Int. 2, 2012). Consequently, the Danish headquarter must be convinced that the best strategy is to nurture guanxi, while "the Danish model, the German, the French, it's just stopping [deliveries of components] right away. And then they [the customer] have to pay right away, and before they do that, we won't do anything" (Int. 9, 2012). While Danish headquarters have sometimes demanded stopping deliveries, when payments are failing, some Danish subsidiaries have instead insisted on "sticking to the good relationship" in order not to lose all connections and orders:

"And then it gets even worse, as the Board [of Directors in Denmark], of course, tells me that then we need to stop activities – you do that in Europe. Then my next challenge is that this is not possible. I need to be on friendly terms with them [the Chinese customer]. Otherwise, they will put me at the bottom of the list, and then I will be the last one to be paid. That's also what the state-owned companies do out here. They keep making sure that things run properly. Because they know that some day it will get better, and then it's good to have good friends. […] That's almost the worst part – we cannot break them [the relations] – and that's why, I'm trying to kind of play by their rules" (Int. 9, 2012).

In this way, somewhat paradoxically, ”our biggest challenge is, when we have to report back to Denmark […] it's *so* difficult!" (Int. 13, 2013). That is, the headquarters does "not realise how difficult it is to do business in China" as headquarters and subsidiary "are so far from each other" (Int. 9, 2012). In this way, the headquarters "does not get, what's being said. They simply don't understand the little things being said, because it's so far away from you. It's just noise you're hearing" (Int. 15, 2013). Consequently,

”it's really difficult to go home and explain this to an owner or to a Board of Directors and the top management for that matter…Because 'how can that be true?! It just can't be true that we just have to go out there and talk with some people, and then believe that this is the best way?' You simply can't do that, right? But I must…I think personally that this is the kind of ball game we are in" (Int. 13, 2013).

In this way, as China is being constituted as ”another type of business world that we are entering, and we have to understand" (Int. 13, 2013), Danish employees in China and/or with relations to China compare doing business in Europe and China with "taking a stroll in the park and climbing a mountain" (Int. 42, 2012).

Dynamics of 'the relational' – and modes of valuating 'quality'

In the above it has been indicated how the consolidation phase of the emerging wind power- and software-TEN has produced a controversy over money. In turn, this controversy has transformed emergent actors from intermediaries into actors, as actors not just connect actors without transforming them, but have also engendered conflict. In this way, agents have had an impact on the de- and reconfiguration of relations in the networks that they constitute and which they are constituted by. Having traced some of the dynamics of 'the relational' in the marketisation of wind power in China, by following an unfolding controversy over money in the software-TEN, which is entangled in a state-controlled power-TEN, the chapter has indirectly shed further light not only on the negotiated nature of relations, positions, roles, and identities of Chinese and foreign actors in the emerging wind power-TEN.

That is, the chapter has also indicated how 'quality' (or 'qualities'), understood here as processes of valuation and price-setting in the current qualification struggle of wind power, also in this regard remains a negotiated and contested matter. Whereas Western companies thus have tended to frame the quality of wind turbines through quantitative measures in terms of e.g. certified reliability, performance, cost of energy, availability, stability, or 'algorithmic quality', which can relatively easily be transformed into comparable prices, the quality of wind turbines and components in China are also measured in terms of 'personal relations'/guanxi. That is, ”when the Chinese buy things, it's not just about the quality, but also about price, service, and relations" (Int. 45, 2012). In this way, "out here, having the best relation can justify that the product might not be the best […] But on the other hand, it doesn't work either, if the product is too bad. But quality is something different in China. And it's related to relations" (Int. 48, 2012).

Additionally, the attribution of associations of quality to a product is in a Chinese perspective dependent on the long-term upgrading potential. That is, wanting to be able to 'move things' in the longer run, the Chinese "want the technology, and we [foreign companies] want the money" (Int. 47, 2013). In the initial phase, Chinese and foreign actors in the emerging software-TEN had not considered that their framing and valuation of 'quality' might differ, and that their framing tools for establishing calculative agencies for valuating quality also differed. This can be claimed to have resulted in extensive overflowing in the software-TEN, with continuous destabilisation of relations. Yet, over time,

"you understand that it's because there's a lack of understanding of what the other party wants. What is it that I'm bringing, and what is it that my counterpart is bringing, and how can we make it succeed together […] Well, if you are not able to see this picture, then you'll not succeed, I think" (Int. 47, 2013).

Over time acknowledging the different "business cases" (Int. 47, 2013) and modes of valuation, relations have been temporarily stabilised, although "it is still difficult to navigate in" the Chinese 'spiderweb' (Int. 47, 2013).

The many faces of the 'system problem' and potential limits to a turn to quality

Above, the chapter has so far conducted a case study on how China's 'system problem' along with China's ongoing restructuring has produced a controversy over money in the wind power-TEN, revealing contested modes of valuation of quality between Chinese and foreign actors. In the following, the chapter concludes by looking into how the controversy over money produces matters of concern over the potential barriers to a turn to quality in the emerging wind power-TEN.

The (in)visible hand of the political pole

In the above account, the analysis has displayed overly unstable relations between Chinese and foreign actors around control systems. The overflowing nature of relations can in turn be related to the way in which marketisation of wind power in China is entangled in an overall unfinished 'restructuring' process. This makes the complete disentanglement and framing of the political, market, scientific, and technical poles as well as of the software-, wind power-, and power-TEN impossible. Not possible to bracket actors into ’stable frames’, poles and TENs are constantly overflowing. Indeed, in particular it seems that in Chinese wind power, the ’political pole’ pervades all poles. For instance, apart from operating as regulator, operator, and equipment manufacturer, the political pole also acts as i.a. a price-setter, a manager, a credit provider, and a monitor in SOEs. Hereby, despite attempts at moving towards ’modern corporate governance’ and disentangling the ‘market’ from the government, the political pole seems ubiquitous. Entangled in China’s ongoing ’capitalist transition’, rather than reflecting the ideal-type of ’external markets’ and ‘arms-length’ transactions, the Chinese political pole is heavily involved in the marketisation of wind power, amongst other things in *price-setting*. In a Chinese journal (2014*) on the ongoing and partly stalled reforms in China’s power-TEN, this pervasive role of the political is also reflected. As expressed in the article, the Chinese Government is currently in the process of shifting ’its old hands’ (by reference to Adam Smith’s (1776) ‘invisible hand of the market’) as well as its ‘wrist’, in order to be able continue the stalled market-oriented reforms in the power sector. Somewhat paradoxically, the article leaves no doubt that the wrist is attached firmly to the arm of the Chinese state, making the ‘invisible hand’ seem very visible instead (Caijing*, Mar. 24, 2014).

The construction of a ’nationalistic game’

Hereby, while China, on paper, in general pursues ”a market system that is uniform but open, orderly and competitive” (3rd Plenary Session of the 18th CPC Central Committee, Nov. 2013, III-Modern market system), the Chinese Government seems to steer the market with a ’strong hand’ (and heavy fist) within strategic pillar industries such as the power and wind power sectors. This is also visible in public tenders and local content requirements, where Chinese SOEs more or less exclusively have won the bids. Meanwhile, such preference for SOEs and their low-price bids has resulted in foreign WTMs and suppliers in China becoming increasingly weary of doing business in China, since it constitutes “a nationalistic game […] It is difficult to be in such a market, you really have to be smart to continue to make a good business here” (Int. 1, 2013). In this nationalistic game, an invisible boundary is being construed between the ’fair’ and the ’unfair’. While foreign actors argue that ”it is entirely fair” to aim towards building up a sound industry” (Int. 1, 2013), ”there has to be a balance. And I think that China may overstep that balance. I don’t actually think they wanted to get rid of foreign companies, I never think it was their intention” (Int. 1, 2013). Yet, as Chinese targets have been set strictly for GW, spurring a quest for the lowest price bid, and compromising traditional Western notions of quality, China is argued to have

”tinkered with the balance” and to have created an “unsound environment for foreign investment” (Int. 1, 2013). Overall, the framing of a ’nationalistic game’ produces processes of exclusion and inclusion.

Turn to quality or not – the issue of a blind market

This emerging ’nationalistic game’ and its inclusion and exclusion processes are construed around issues of low price versus quality. While foreign actors are fearing to be squeezed out of the market, as they cannot compete on the lowest prices, Chinese experts within wind power also raise concerns that the low-price focus is “no good for the country, the people, the industry” (Int., 8*, 2013). Although there are various traits of a potential turn to quality in Chinese policies, these Chinese experts argue that China’s system problem constitutes a potential barrier to such quality turn. That is, as indicated earlier, these actors are “worried about the basic system, it's not the driving force to improve that” (Int. 8*, 2013). The emerging stem issue of China’s ‘system problem’ is in turn used to explain how China’s wind power

“market is blind. I think under a mature market mechanism, players entering [the industry] are relatively smart, but under an immature market system, the players entering are very stupid” (Int. 19, 2013).*

Accordingly, instead of encouraging higher quality, some foreign actors predict that China’s emerging wind power-TEN will be marked by ”a huge market for scrap iron in the next years” (Int., 24, 2013), as a lot of turbines have to be demolished and not just retrofitted” (Int., 2, 2012). Overall, the framing of wind power as sustainable is being threatened, not only in terms of economic, technical, scientific, and financial sustainability, but also in terms of what may be termed ’political’ sustainability’. That is, if a turn to quality is being stalled by socio-technical barriers, e.g. due to the ‘political’ system problem, overflowing is likely to abound. In turn this may put the upgrading and catch-up potential of the emerging wind power-TEN into question, potentially delegitimising the emerging wind power-TEN.

Conclusion and theoretical considerations – controversy over money and a Chinese system problem

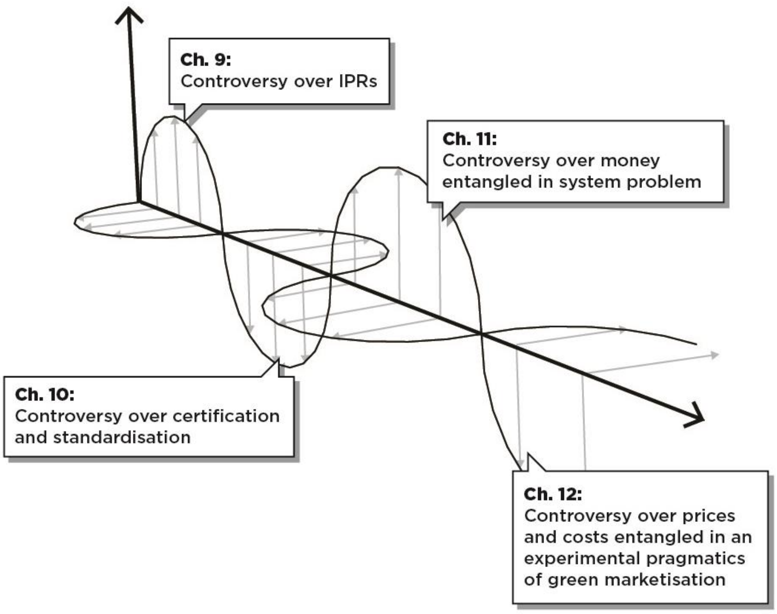
In *Chapter 11*, some of the ‘Chinese characteristics’ of marketisation within wind power have been traced. The chapter maps a controversy unfolding over money in the liquidity-constrained wind power-TEN, and how this has impacted relations between foreign control system suppliers and Chinese (state-owned) customers in the potential software-TEN. Hereby, while the two first controversy mappings in *Chapters 9 and 10* dived into the configuration of ‘micro-relations’ around software algorithms, and the *pacification of goods* through IPRs and standards, *Chapter 11* has inquired into dynamics related to *price-setting*, placed in a broader context of China's corporate restructuring in the power-TEN and China's so-called system problem. Illustrating how the potentially emerging software- and wind power-TENs are co-constituted by an unstable power-TEN, as well as co-configuring the power-TEN, the chapter sheds light on some of the highly complex, and sometimes paradoxical, dynamics of the software-TEN, where relations tend to unwind as soon as they have been established. In this way, further light is being shed on some of the roots of the overflowing relations between Chinese and foreign actors, depicted in *Chapters 9 and 10*. As boundaries between the political, market, scientific, and technical poles seem to overlap and overflow in the power-TEN, largely due to an overly 'activist' role of the Chinese Government and the entangled nature of actors, an account of a 'rhizomatic' and thick meshwork emerges, in which relations acquire agency, in themselves 'qualifying quality', so to say.

Overall, the last three *Chapters 9, 10, and 11* have offered a controversy mapping, which indicates some of the socio-material challenges for upgrading and for a potential turn to quality to take place. In the next and last chapter of the analysis, *Chapter 12*, the analysis inquires further into the dynamics of *price-setting,* and looks into the potentiality of a turn to quality of the wind power-TEN. This is done by diving into some of the 'power struggles' between wind power and fossil fuels in the power-TEN, as well as the role of price and cost calculations in this struggle. This produces an overall account of 'green marketisation' in a developmental context of China as a matter of experimentalism and pragmatism.

Chapter 12. Controversy over price- and cost-calculations entangled in a Chinese pragmatics of green marketisation

In the outskirts of Beijing on a full-blown Indian Summer day in 2013, I approach the end of my last field-trip to China. The courteous, elderly Chinese gentleman, one of Chinese wind power's 'grand old men', wraps up the development of China's wind power market in just a few sentences. What seemed like a riddle before, suddenly stands in a new light:

Figure 21: Controversy over cost- and price calculations in Chinese pragmatics of green marketisation



"In China [it's] very strange, maybe different from Europe, but in China every...we first do it – then to solve it! Xian zuo, cai jiejue [先做，才解决/first do it, then solve it]. Then you have the problems to force people to solve them […] If the problem had not appeared, nobody would have considered about that […] That is not strategy...that is a […] reality. To learn from the practice is much better than learn from the theory or learn from imagination […] It's the Chinese way".

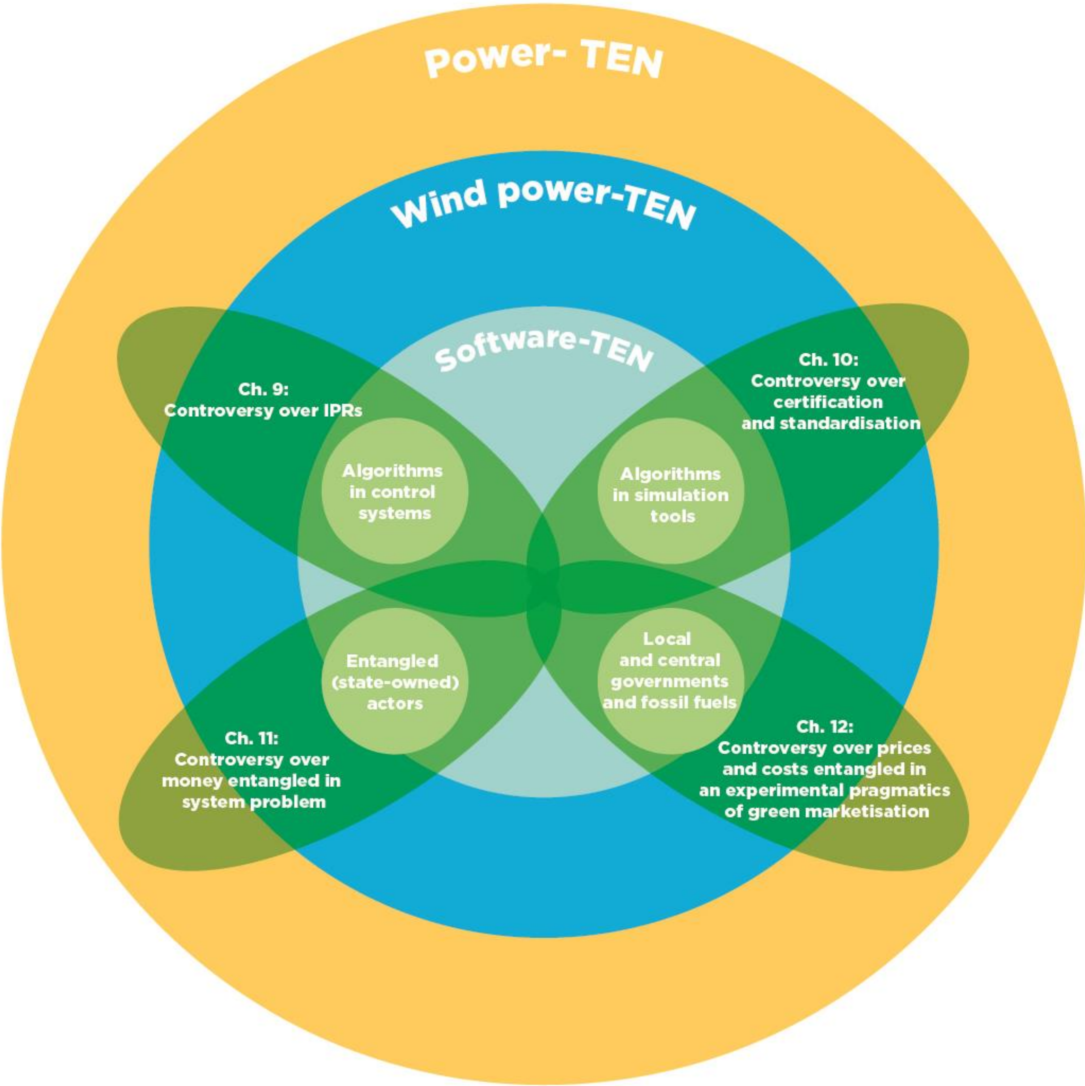
Finally, the story on the genesis, dynamics, and agency of Chinese wind power begins to take shape, properly taking into account its particular 'Chinese characteristics'. However, how the story will end up remains a riddle to me. Will it become a story of China's 'fight against windmills', or will it be a story of an actual turn to quality in wind power? And is the mapping of a potential, and controversial, turn to quality also a story of Chinese 'experimental greening', I wonder as I sit on the plane, returning home from my last field-trip to this both fascinating and bewildering country. I cannot wait to write up the rhizomatic story, so full of actors, relations, and controversies, and ripe with potential endings and new beginnings!

Power struggles in the power-TEN and Chinese experimentalist sustainability

In *Chapter 12*, the analysis dives further into dynamics of *price-setting* in the marketisation of wind power in China, some of which were illustrated in *Chapter 11.* The chapter offers a mapping of a controversy over cost- and price-calculations, and how these calculations construe a competitive space between wind power and fossil fuels (in this case, coal), as well as between local and central governments, and between Chinese and foreign companies. These power struggles are taking place within what the thesis dubs a potentially particular Chinese 'pragmatics of green marketisation', whose 'sustainability' in turn is being contested and negotiated. In this way, the last chapter of the analysis seeks indirectly to shed light on the previous chapters of the analysis, rendering a broader picture of (green) marketisation in China, and shedding further light on the paradoxical dynamics of simultaneously collaborative and competitive relations already depicted.

First, forming part of the emerging power-TEN, the chapter offers an account of a power struggle playing out between wind power and coal in the emerging wind power- and power-TENs. This is laid out as a battle of qualities associated to wind power and coal respectively, construed i.a. by contested framing tools (in particular in terms of price-setting), as well as by lacking coordination between local and central governments. Next, the chapter illustrates how this battle has resulted e.g. in sky-rocketing curtailment rates. This leads to a mapping of a controversy over China's seemingly experimental mode of 'greening' in which Chinese 'pragmatist experimentation with sustainability' is being contested. In this controversy, not only a competitive space may be constructed, but increasingly so also a collaborative space. The thesis hereby opens up towards the potential transformation of China's emerging wind power-TEN, i.e., inquiring into how the potentially self-disruptive and 'self-undermining' experimentalism may be flexibly handled by an agile political pole (and other poles), which respond(s) flexibly to ubiquitous overflowing. *Chapter 12* hereby not only links back to previous chapters, but also points forward to the discussion, conclusion, and wider implications of the thesis *(Chapters 13-15)* of Part IV. Below, in *figure 22,* it is illustrated how the fourth and last controversy-mapping of the analysis is now conducted, with a focus on price and cost calculations and the contested sustainability of China's potentially particular mode of green marketisation.

Figure 22: Zooming in on controversy over price- and cost-calculations entangled in a Chinese pragmatics of green marketisation



Source: Own design

The power struggle between wind and coal

To map the controversy unfolding over China's potential 'green marketisation', the chapter first maps how a power struggle is taking shape in the emerging power-TEN between wind power and fossil fuels (in this case, coal). This is done by inquiring into how wind power has been associated with qualities of ’trouble’ for grid companies, generating companies, and coal-fired power plants, and how a competitive space between coal and power has been construed, entangled in myriads of power struggles of the emerging power-TEN.

Wind, the ’trouble-maker’! The issue of associations to wind power and coal

In the following, the chapter offers an account of how wind power has been framed as a ’trouble-maker’ compared to coal, creating resistance from various actors against wind power.

Associations of ’reliability’ or ’disturbance’

Having installed enormous amounts of new wind power capacity, of a relatively poor quality, and integrating them into the grid within a short time frame, wind power in China has become associated with qualities of instability and grid disturbance. That is, since ”wind is random” (Int. 8, 2013), ”wind power has the reputation of messing up the voltage” (Int. 26, 2013). When wind power ”only takes up a small share, it is not so difficult to ensure system [load] balance” (Int. 26, 2013). Yet, as larger shares of wind power have been integrated into the grid, this requires a great deal of ’stability work’, as

”wind turbines are NOT synchronous generators! They are asynchronous…an asynchronous machine swinging in a synchronous system” (Int. 26, 2013).

With a vast amount of such asynchronous generators, integrated rapidly into the synchronous system of the grid without ensuring the proper amount of ’stability work’, the grid basically broke down several times in China during the early growth phase (Bloomberg/Bizweek, Mar. 15, 2012). In contrast, conventional coal-fired plants can follow load (demand) variations, providing a stable ’base load’ (Int. 26, 2013). For instance, this means that ”you wouldn’t worry about the voltage flicker and fault ride through, which is necessary in a wind plant” (Int. 26, 2013). Overall, associations to wind power and coal power are construing a boundary between ’stable’ and ’disruptive/disturbing’, and between ’controllable’ and ’non-controllable’ power sources. In turn, grid companies are generally interested in ’buying reliability’, when they integrate different power sources into the grid, to be able to dispatch stable power to consumers. Grid companies consequently tend to look at the stochastically fluctuating wind power source as

”rubbish! Because when we need, we don't have. But when [we] don't need, there’s too much” (Int. 8, 2013).

Grid companies are therefore often reluctant towards integrating large shares of wind power into the grid (Zhao et al., 2012a: 230), as wind power requires a great amount of work on operations and dispatch:

”When we get some information on the grid…it’s a bloody nuisance, right...you’re sitting there in the middle of the night, and then the wind stops blowing, and then you have to do a whole lot of things…then it’s pretty nice to be able to call a conventional power plant” (Int. 18, 2013).

That is, a conventional coal-fired thermal power plant, which is comparatively stable, is “really comforting to have” to grid operators (Int. 18, 2013). Conversely, framed as a ’disruptive’, ’disturbing’ power source, “there’s nothing surprising in the fact that there is huge resistance in parts of the State Grid [towards wind power]” (Int. 18, 2013); instead, this is ”understandable. For them it [the wind] is a trouble-maker...a trouble-maker, a trouble-maker!” (Int. 8, 2013).

Associations of economic loss – resistance from coal-fired power plants

Apart from grid companies, also thermal power plants in China tend to be reluctant towards wind power. That is, due to grid balancing requirements, if there is more space for wind power in the power grid, this will result in lower coal power production for thermal power plants, when demand is low and the wind is blowing (Int. 19, 2013). In this kind of situation, ”the only thing you can do is to turn down the coal-fired power plants” (Int. 18, 2013). At the same time, the primary basis of income for coal-fired power plants is their energy production (Gigawatt hours):

”That means that the coal-fired power plants are losing money. And there’s not really any…they are not being compensated for that loss” (Int. 18, 2013).

The issue of lost income is related to annual coal quota agreements, signed between coal-fired power plants and local governments. That is, they are “signing some agreements on how the power plant has to run on a yearly basis […] this is copied down to the local level” (Int. 18, 2013). The Chinese coal-fired power plants are

”delegated a quota to produce a certain amount of [Gigawatt] hours on a yearly basis. An equivalent…their yearly energy production – they are converting that into a so-called equivalent full load hours…a number...which has been set pretty high, 5,000 or something like that. That’s a heck of a lot! And apart from that, they have the right to supply electricity, when they are producing heat, because combined heat and power is good and efficient, energy-efficient” (Int. 18, 2013).

Without compensation for lost income from power production, coal-fired plants have no incentive to reduce their own production to allow for larger wind power shares in the grid (Zhao et al., 2012a: 229-230). That is, “if they come under the quota, to which they have a right, and which they negotiate with the local government on a yearly basis, then they lose money" (Int. 18, 2013).

Associations of (in)flexibilities – on being tied by your own 'constraining ropes'

In the above, "a big gap in the regulation in China" has been indicated as "there is no incentive for the [coal-fired] power plant owners to shut down" (Int. 63, 2012). In addition to this gap, China's coal-reliant power system is being framed as inflexible in both physical and institutitional terms. First, coal is being associated with 'physical inflexibility' (Int. 28, 2013), as coal-fired plants take relatively long to start up compared to wind farms, which is basically, "just...push the botton!" (Int. 8, 2013). Thereby, coal-fired power plants cannot adjust rapidly, when power balancing adjustments are necessary. Adjusting to large shares of wind power is consequently being framed as a challenge, due to the 'physical inflexibilities' of the grid and the coal-fired power plants. Second, in order to integrate larger shares of wind power, "physical flexibility is not enough; a market is also necessary", which in turn requires 'institutional flexibility' (Int. 28, 2013). Yet, as there are only limited means of short-term inter- and intra-provincial power trading in China[87] (Int. 28, 2013), the power-TEN in China is associated with a lack of 'institutional flexibility' (Int. 28, 2013; Int. 26, 2013). This 'institutional inflexibility' is also framed as a result of fixed power and wind power tariffs, which reduces price flexibility (Int. 28, 2013). Overall, these 'physical' and 'institutional' 'inflexibilities' are being constituted as a barrier to integrating larger shares of wind power into the grid, as these inflexibilities are tying China by its own "constraining ropes", some of which are regulative and institutional, while others are physical: "China is doing all the right things, but being tied by itself" (Int. 26, 2013). With such 'inflexibilities' of China's power grid and dispatching system, wind power integration is being associated with reduced grid maneuverability. That is, as wind penetration increases in the grid, "information is going up, options are going down" (Int. 26, 2013). In other words, since wind power adds another layer of complexity to grid operations, the power-TEN becomes "mathematically overconstrained" in its balancing operations (Int. 26, 2013). In addition lacking advanced forecasting tools and other control systems, rapid wind power penetration has resulted in heavy fluctuations in netload curves and has created troubles for grid operators (Int. 26, 2013). Consequently, wind power tends to be framed as a 'troublemaker' by grid operators, as they face increased information, while their room of maneuver to ensure grid balancing is being reduced. In this way, to 'deal with the variability' of wind, the

[87] for instance, there is only little integration between China's five-tier dispatching centres at national, regional, provincial, local, city, and county levels.

power grid and dispatching system must be made more ’flexible’ (China Energy Viewpoint, Sandholt, K., Feb. 11, 2013; Int. 8, 2013).

Associations of costly wind power – on dependence on subsidies

In addition, costs and prices of wind power play an important role in terms of the willingness or resistance towards introducing more wind power into China’s energy system. However, it is *“*very difficult for wind energy, also due to cheap coal. Wind turbines are still very expensive. But in the long-term, wind turbines should still have the market’*”* (Int. 31, 2012). At present, there is resistance towards wind power due to its framing as a relatively expensive power source when compared with fossil fuels. As expressed by a Chinese wind energy expert, there should ”not [be] too much wind in China. Why? Because, it's still expensive” (Int. 8, 2013). Another Chinese expert explains,

“we are not like Denmark. We have many resources of coal. So it is difficult, when and how you decide to promote these new energy sectors, since we have the low price [of] coal” (Int. 16, 2012).

Hereby, wind power is being associated with higher prices. In this way, prices and price-setting construct a competitive space between coal and wind, as price calculations make it possible to compare the relative costs and prices of wind power and fossil fuels. As wind power is still directly subsidised (like in many other countries), wind power is by various actors framed as relatively costly and lacking a ‘competitive advantage’ over coal:

“The most crucial part is the price of electricity, many [WTMs] need government support. If in the future, the price of coal and conventional electricity keeps increasing, then wind energy will have a competitive advantage. Now [wind turbine] manufacturers are dependent on direct support” (Int.16, 2013).

Overall, as coal prices are relatively low, it is widely acknowledged that improvements in turbine and wind farm performance, and reductions of the cost of energy (i.e. cost of power generation in terms of US dollars per kilowatt hour) are seen as key elements to improving the relative competitiveness of wind power, and to the successful diffusion and deployment of wind energy (Li, 2010: 1164).

Contesting calculative devices and their associations

Having illustrated how the qualities associated to wind power tend to create resistance towards wind power in China, and creating a competitive space between wind power and fossil fuels, the chapter in the following dives further into the power struggle between coal and wind power. This is done by looking into how calculative devices and the ’calculative agencies’ that they construe are being contested.

The political nature of (in)flexibilities – and the role of software tools in making wind comparable to conventional power

The calculative agencies that the associations of ’inflexibilities’ to coal and of lacking grid ‘maneuverability’ have construed, and their ‘competitive space’ between wind power and coal, are in turn contestable. For instance, inflexibilities can be reduced by imposing higher requirements on wind farms and wind turbines (China Energy Viewpoint, Sandholt, Feb. 06, 2014), which can e.g. be ensured through the introduction of higher standards, turbine- and plant-level software tools, grid codes, prediction and forecasting software tool kits, and technological tools to improve interregional dispatch and trading (Int. 26, 2013; Int. 36, 2013). Such tools and technologies can help create associations of higher grid operation flexibility and of more ‘controllable’, predictable, and less disruptive wind power, as they help ”increase your options and give you better information” (Int. 26, 2013). Hereby, wind farms can begin to act more “as ‘normal’ power plants” (China Energy Viewpoint, Sandholt, Feb. 06, 2014). While such technical improvements put more pressure on the Chinese WTMs “to be innovative and deliver with high quality” (China Energy Viewpoint, Sandholt, Feb. 06, 2014), this is constituted as necessary in order to make wind power ’comparable’ to conventional fuels, which in turn is required for reducing resistance towards wind power in the grid.

While putting pressure on technical improvements and innovations, the above at the same time indicates how associations of ‘(in)flexibility’, ‘disruptiveness’, and ‘uncertainty’ are negotiable and situational. Thus, wind power can be seen as “just adding an extra chunk of uncertainty […] just as there has always been uncertainty about the consumption of your load [energy production]” (Int. 26, 2013). In this way, rather than being incomparable to fossil fuels, wind power is framed as a matter of adding ”a little bit more of the same” into the grid (Int. 26, 2013), which requires additional ”economic planning and guessing at tomorrow’s load” (Int. 26, 2013). Framed in this way, ”if somebody says that wind power screws up your voltage, it’s a matter of bad planning and bad interconnection […] and backwardness in technologies” (Int. 26, 2013). Hereby, technologies i.a. for prediction emerge as important actors to translate larger shares of wind power into the grid, as the grid is like ”a lot of soldiers in need of a general” (Int. 26, 2013). Put simply, flexibility is ”what the battle [about wind penetration] is about”, and in this battle, ”technology matters” (Int. 26, 2013). Ultimately, increasing wind power penetration – at the expense of coal – is not so much about fluctuations, but ”about operations [and] commitment from the system operator [the grid companies]” (Int. 26, 2013).

Overall, this demonstrates how caution is being voiced over constructed associations of 'physical' and 'institutional' 'inflexibility', and the 'impossibility' of adding wind power to the grid. Instead, 'inflexibilities' are being construed as a 'political' matter. That is,

"[t]hat coal is inflexible is not written in stone! This is a caution for policy people: Coal production versus wind production. Why would a coal producer reduce his production and earn less money to accommodate wind?...He will say, it's not possible, I don't have flexibility" (Int. 26, 2013).

Overall, 'physical' and 'institutional' 'inflexibilities' framed largely as a 'matter of fact' seem to be transforming into a contested and 'political' 'matter of concern'. Hereby, the calculative devices used to frame wind power, coal, and the grid are being negotiated and contested, and technologies have emerged as important framing devices in the struggle against different competing framings.

Construing wind power as a 'real market product' – on the issue of subsidies and costs

At the same time, another struggle is taking place between framing tools, as part of the power struggle between wind power and coal in the emerging power-TEN. That is, a framing struggle is taking place to construe wind power as a so-called 'real market product', in order to qualify wind power as 'competitive' with fossil fuels.

Attempts at reducing the cost of energy – moving towards the next revolution

The struggle to construe wind power as a 'real market product' configures around attempts at reducing dependence of wind power on subsidies. Research institutions and WTMs in China and elsewhere "are putting a combined effort in bringing the wind industry out of a situation, where we need subsidies – and that's a global phenomenon. The pressure is on subsidies" (Int. 1, 2013). Hereby, the wind power-TEN is entangled in a 'global' pressure on subsidies, based on conventional neoliberal arguments that subsidisation is to avoided (Chang, 2003). Thus, as wind power so far is still reliant on subsidisation, in China, as well as elsewhere, wind power is being constituted as a 'political' product, rather than a 'real market product':

"So far, the wind industry is a policy product more than a real market product. The cost curve for wind energy is going down big time, but has still not reached the price of conventional energies. We [foreign WTM] are aiming at making the [cost] curve steeper. This is done by reducing cost of production, installation, and service, and by increasing efficiency" (Int. 64, 2012).

In the struggle against coal and other cheaper fossil fuels, attempts are thereby made at dissociating wind power from subsidies and construing associations of economic 'viability' and 'performance', in order to construe wind power as a so-called 'real market product'. The wind power-TEN is consequently, on a world-wide basis, in general striving to decrease the ‘cost of energy’ and the lifetime generating cost of wind power (Int. 64, 2012). In turn, reducing the cost of energy is largely a matter of increasing “how much electricity you can squeeze out of the wind. That’s the first thing. The other thing is the cost of capital” (Int. 1, 2013). In this way, the next ‘breakthrough’ in the wind power-TEN is predicted to be, “if the learning continues” (Int. 1, 2013), when wind power will ’break even’ with conventional energy. Such a ‘revolution’ would make it possible to associate wind power with ‘real market prices’, and dissociating wind from subsidisation (Int. 1, 2013):

“I don’t think the next breakthrough in the industry will come in technology. I think we will continue to see improvements. I think the next breakthrough will be to bring down our costs of energy, where we can compete at market prices – when that happens – once the incremental breakthrough in technology has made the costs of energy so low that we can compete at market prices, we are going see a revolution again. And that is not going to happen tomorrow” (Int. 1, 2013).

Also in China, “many studies [are conducted] on how to calculate [cost of energy] based on different methodologies, [that is] we [China] also have many discussions related to the cost of energy, it is not only wind energy, but nuclear. We also had some discussions after the earthquake in Japan – and also on water energy [hydro-power]” (Int. 16, 2011). A battle-line between wind power and coal, as well as other power sources, is hereby construed around cost-minimisation and ‘breakeven’, in which i.a. cost curves and market price calculations play a performative role.

Attempts at including the cost of pollution into coal prices

The various comparative cost and price calculations, some of which have been indicated above, as well as the selected calculative devices and the calculative agencies that they construe, are not dissociated from politics, however. Instead, cost calculations are i.a. co-performing the struggle between wind power and coal. That is, proponents of wind power attempt to counter conventional calculations of breakeven and subsidies, which tend to frame wind power as non-competitive, through other calculative means. Thus, wind power proponents seek to make coal and wind power more comparable in terms of costs (and subsidisation), as they point to how ‘actual’ costs of fossil fuels are much higher than reflected in the price of coal. That is, the environmental costs of fossil fuels are ’hidden’ as they are not being included into the price of fossil fuels. Since fossil fuel prices are “not taking externalities into consideration”, they do not account for “what pollution has of extra costs” (Int. 63, 2012). Hereby, since power prices in China do not “compensate for negative externalities of fossil fuels” (García, 2013: 140), it is argued that fossil fuels ”receive subsidies indirectly on the electricity price” (Int. 63, 2012). This makes it difficult for wind power to “compete on equal terms” (Int. 63, 2012). Yet, “if counting the negative externalities of fossil fuels, wind energy is competitive [and] wind can compete….but also without any formal subsidy” (Int. 63, 2012). This issue of the ‘real cost of energy’, i.e. whether or not to include the cost of pollution in the price of fossil fuels, is, however, also constituted as ‘political’:

“That’s the big debate – because everyone is asking, when to get rid of subsidies [of wind power]. And nobody is talking about the enormous amount of subsidies going into fossil fuels – and the real cost of polluting with such things. So it’s a struggle” (Int. 1, 2013).

According to a Chinese official, this ”is a very interesting topic, but frankly speaking this is also part of a political discussion” (Int. 65, 2012). In this way, coal and their cost calculations are being constituted as a politically sensitive issue. To avoid such associations of ‘sensitivity’, and to produce resistance, foreign WTMs attempt to frame the issue, not as an issue of “bashing coal in China”, which is “a bad idea” (Int. 1, 2013), but instead by “bringing some examples of real cost of energy” (Int. 1, 2013). This expresses a desire for employing and developing pacifying, ‘innocent’ calculative devices for comparative cost calculations. Yet, from the above, it seems that the very calculative devices and the calculative agencies they construe, are open for debate and thus can become ‘political’, as they are entangled in a qualification struggle between wind power and coal in the power-TEN.

The issue of curtailment and environmental sustainability

While myriads of attempts are taking place at framing wind power as a sustainable power source, which can be compared to conventional fuels in terms of flexibilities, prices, costs etc., resistance against wind power in the emerging power-TEN is, however, still regarded as pervasive. Indeed, a ”battle between the traditional power plant interests and the new technologies” (Int. 18, 2013) is taking place in China. The resistance against wind power, i.a. due to associations of ‘disruptiveness’ and ‘inflexibilities’, has in turn overflowed in terms of curtailed wind power. That is, to ease the balancing operations in the grid, grid companies have often decided to curtail wind farms. This is often chosen as the solution, as coal-fired power plants on their part lack incentives to reduce own production, which makes it ”pretty understandable that the coal-fired power plants are saying, well, it’s not smart to have wind in the system” (Int. 18, 2013). Further, grid operators often lack the required advanced forecasting tools and other software tools to increase flexibilities. Consequently, as ”a matter of balancing wind and coal” (Int. 19*, 2013), ”it’s the grid-connected wind turbines, which are being curtailed […] because there’s not enough space on the grid. That’s simply the reason why!” (Int. 8, 2013):

”The first thing they shut off is the wind power…because the coal is cheaper and makes more money. So, if I were Chinese, I’d do the same thing. There’s no question about that” (Int. 63, 2012).

Hereby, in terms of curtailment, ”there’s an outright conflict there [between coal and wind], that’s obvious” (Int. 18, 2013). Since ”curtailment – that’s electricity not being used!” (Int. 26) – high curtailment rates somewhat paradoxically produce further resistance towards wind power i.a. amongst investors, grid operators, developers, and generating companies, as associations of ‘waste(d resources)’ are being construed to wind power. In this way, ”when the high wind comes simultaneously with low demand […] this is what makes everybody in China crazy!” (Int. 26, 2013). Apart from producing associations of wasted money, curtailed wind power also threatens to destabilise the framing of wind power as ‘environmentally sustainable’. Set into an equation, it reads:

”Curtailed wind power = more pollution + more costs + less incentives for new wind power” (China Energy Viewpoint, Sandholt, Jan. 27, 2013).

Overall, the issue of curtailment (i.e., when wind turbines are able to deliver electricity, but not allowed to) – as well as of lacking grid connection (i.e., when wind farms are not connected due to technical issues) – are expressed increasingly as a matter of concern for China’s ‘sustainable transition’ by actors in the emerging wind power-TEN. That is, socio-material resistances to wind power integration such as curtailment and grid connection issues, some of which have been illustrated in the above, are likely to continue the dominance of fossil fuels such as coal in the grid, and to create further resistance against wind power due to associations of ‘waste’ and technical unsustainability. Put simply, the reduction of coal consumption by adding wind in China, ”that’s what the battle is about!” (Int. 26, 2013).

The environment lost in translation – and found again

Suddenly, it seems the ‘the environmental’ reappears in the analysis. That is, it can be claimed that ‘the environment(al)’ and the issue of a potential ‘sustainable transition’ has so far largely ‘been lost in translation’, as the controversy-mapping of marketisation of Chinese wind power has been centred around associations of i.a. technical, scientific, and economic sustainability, rather than environmental sustainability. Yet, as worries over wasted resources from curtailed wind power seem to increase, in tandem with the ongoing quality crisis and the qualification struggle it has produced, the framing of wind power as ‘environmentally (un)sustainable’ begins to be voiced as a matter of concern amongst actors in the emerging wind power-TEN. This concern for the unsustainability of wasted resources from curtailment is expressed below. That is, curtailment means that

”you have a lot of coal-based power plants, which just stand there and burn off a lot of power, and they actually don’t care. They are just producing like crazy. And that’s not sustainable. That’s a matter of a resource waste of unimaginable dimensions” (Int. 2, 2013).

In turn, if the quality of ‘environmental sustainability’ starts to fall apart, the overall rationale of engaging in renewable energies and wind power in China (as e.g. expressed in the Renewable Energy Law (REL)) may start to unravel, potentially destabilising the emerging wind power-TEN. Yet, the concern for the ‘environmental’ seems to surface amongst different actors in the emerging wind power-TEN, not just in the political pole as an official discourse, but also in the market, scientific, and technical poles (Int. 2, 2012; Int. 9, 2012; Int. 18, 2013). The concern for ‘the environmental’ in the market pole still seems led largely by the political pole, however: For instance, a Chinese domestic component supplier, for instance, refers to how the National Energy Administration (NEA) under the National Development and Reform Commission (NDRC) has recently emphasised the need to make *“*the development of China's new energy development a matter of environmental protection. For that [environmental protection] you need development of new energy, and what is included in these new energies? That’s photovoltaic, wind power, nuclear energy, and biomass power, that’s called the New Energy” (Interview 6*, 2013). Overall, it is also claimed that “the attitude of [Chinese] people may be changing slowly, so renewable energies as wind may become very important, thinking that coal has to die, and that oil has to die” (Int. 6*, 2013). Hereby, the issue of the environmental costs is being raised as a matter of concern. Conversely, there is still vast resistance to renewable energies in China’s emerging power-TEN, where

“they [’traditional forces of fossil fuels’] still think that renewable energy cannot become a mainstream energy, that it cannot replace the traditional energy sources, chemical energy sources. They think they are nothing, that they are illusory, they think that within the next 50 years, 100 years, 200 years, we have to rely on coal, have to rely on oil, and the forces of this understanding are very strong” (Int. 6, 2013).*

Likewise, according to a Chinese expert on wind power, in China “it’s like a ferocious scream. Everyone is calling, but the sound of the traditional forces [fossil fuels] are much greater than the forces engaged in renewable energy (Int. 21*, 2013). Overall, this indicates that marketisation of wind power is entangled in a power struggle of China’s power-TEN in which wind and coal, amongst others, are competing, involving myriads of heterogeneous actors.

Diving deeper into socio-technical barriers to wind power penetration

In the above, it has been indicated how a controversy is evolving over cost and price calculations, which has construed a competitive space between wind power and fossil fuels such as coal in China, as well as producing concerns over the environmental sustainability of wind power. To dive further into the power struggle between wind power and coal, the thesis in the following traces further potential socio-technical barriers to wind power penetration, which may be 'particular' to marketisation of wind power in China, by taking outset in the curtailment and grid connection issues, and relating it to a potentially particular 'fragmented' mode of marketisation in Chinese wind power.

Lack of coordination between grid expansion and wind power installations

The issues of curtailment and lacking grid connection are linked to issues of coordination of grid expansions and new wind farm projects. That is, while wind farms are relatively quickly installed, grid expansion has not been able to keep pace (Int. 28, 2013). As expressed quite bluntly,

"they [China] have this disconnect…because maybe the nuclear power plants decide they want some wind turbines…but it's typical of China…you start out big… And then you assume that there will be people to buy it all. You don't ask yourself: 'What's the demand for this?'" (Int. 42, 2012).

The issue of curtailment (and grid connection) is hereby largely being framed as a matter of poor planning, since "in the planning, it has not been considered how to integrate all the wind. This has resulted in wind curtailment. A big concern. The capacity of the grid has been exceeded" (Int. 28, 2013). Accordingly, Chinese actors acknowledge that there has been a lack of coordination in both the planning and the development phase:

"We have more installed capacity, but the grid connection cannot be established this fast. At first, during the planning stage, the power grid company doesn't know where to develop wind, how much wind will be developed. So they cannot make their own grid connection plan. So the second one, also for big connection, the transmission line...eh...the feasibility study to approve the procedure and the cost of construction...the period of this [is] much longer than for wind. So...the first is, you...eh...we already completed the construction of the wind farm, but we still have to wait at least half a year to one year or even more, for the grid connection" (Int. 8, 2013).

In particular, this issue is being linked to lacking coordination between central and local development plans. During the initial growth phase of the wind power market, provincial governments were allowed to approve wind farm projects below 50 MW, where "the rules of the game are much freer than for the larger wind farms" (Int.1, 2012):

"Until recently, there was a rule that regional governments could approve wind farms themselves up to 50 MW without approval from the central government, whereas parks above 50 MW must go through an approval by the central government. It's sort of like a market controlled by Beijing, and then a free market. Of course, there's no such thing as a free market in a Chinese context, but it will simply be easier to get a project approval, if your project is below 50 megawatts – you don't have to go through Beijing" (Int. 1, 2013).

However, such decentralisation of control has resulted in extensive overflowing, as also briefly illustrated in earlier chapters, in terms of lacking grid connection and curtailment. The seemingly 'careless' behaviour of local governments, which have often allowed wind farms to be established regardless of the demand for wind power, can in turn be linked to how economic performance of local provinces in China remains a ”principal yardstick for cadre evaluation under CCP's nomenklatura system and state administrative hierarchy” (McNally, 2006: 20). This implies that many provincial officials have not been concerned about whether wind farms could be connected, or whether they all had “to be reinstalled, reinvested, retro-fitted, because then it will again figure as 1,000 wind turbines, and thus increasing local GDP [gross domestic production]” (Int. 24, 2013). That is, as incentives for local officials have conventionally been based on local growth rates (GDP figures), many provinces have gone ”beyond target, so that the wind power was not integrated into the system” (Int. 28, 2013; Int. 18, 2013). Over time, however, China's political leadership has assigned higher performance ratings for environment- and energy-related work and technological innovation, rather than just favouring GDP growth (PWC, 2013: 2), which may help to solve part of the overflowing, i.e. , the grid connection and curtailment issue.

China's matrix muddle – and Chinese fragmented marketisation in wind power

In turn, the lack of coordination is being framed as ”one of the main problems for China […] That it's uncoordinated, what's going on, in relation to how much is actually happening” (Int. 20, 2013):

”It's obvious, that a streamlined, coordinated planning, they don't have that. And that's also…also a problem in other places. In the US, they had this long discussion, a chicken and egg discussion. Like – what's coming first? Is it the wind turbines, and then the grid afterwards, or is it installment of lines to areas of wind and then hoping that someone will install [wind turbines]?” (Int. 8, 2013).

Although poor coordination may not be unique to China, the issue of insufficient and 'fragmented' coordination runs through all areas and industries of China. Overall, the uncoordinated mode of marketisation of wind power seems to convey a story on China's so-called 'fragmented authoritarianism' (Lieberthal, 2004(1995): 187). That is, China is divided into different “crisscrossing jurisdictions: the vertical bureaucracies are called lines (*tiao* [条]), while the horizontal coordinating bodies at various levels are called pieces (*kuai* [块]). The relationships between the vertical and horizontal bodies are called *tiao/kuai guanxi”* (Lieberthal, 2004(1995): 187). This implies that geographical vertical coordination lines between ‘centre’ and ‘locality’ (Lieberthal, 2004(1995: 186)[88] run along horizontal coordination lines (within a given geographic area), which in turn are segregated into bureaucratic/functional silos (Lieberthal 2004(1995)). At each geographical jurisdictional level, CPC and government bodies (functional silos) are being duplicated, resulting in jurisdictions of decentralised, compartmentalised structures along both horizontal and vertical lines. This is conventionally framed as China’s so-called ‘matrix muddle’ (Lieberthal, 2004(1995): 186-188). In turn, this Chinese matrix muddle is conventionally assumed to produce multiple power struggles and vested interests along both horizontal and vertical lines. That is, in China,

”powerful vested interests further increases fragmentation and strains the existing political and economic order. Vested interests are closely intertwined with the iron triangle of business-Party-state relations” (Brødsgaard, 2012b: 5).

Since decision-making is influenced by bureaucracies at both national and provincial level (Brødsgaard, 2012b), the matrix muddle and mode of fragmented authoritarianism make coordination and decision-making processes protracted in China, as they must be negotiated across administrative ’silos’, which tend to work poorly particularly along ‘horizontal’ lines. That is, governing along intersecting lines and across different levels is highly complex in China, as it produces power struggles both along kuai- and tiao-lines, e.g. as officials of any given office have a number of bosses in different places (Lieberthal, 2004(1995)). The “fragmentation of authority in the Chinese political administrative hierarchy makes it relatively easy for one actor to frustrate the adoption or successful implementation of important policies, especially since units (and officials) of the same bureaucratic rank cannot issue bindings orders to each other” (Lieberthal 2004(1995): 188). This tends to exacerbate the issue of weak local enforcement of central policies (Lieberthal 2004(1995); García, 2013: 134-135). In the case of wind power,

”what’s challenging in China, that’s…to a larger extent than in other places, that you are operating very much within decision silos. That is, the ministries are very…they have a very efficient – I think – vertical communication, and the local governments…There are good connections [from the local level]...to the central [level]….But across [horizontal]…and that goes all the way up and down, in that regard it’s really troublesome” (Int. 18, 2013).

In this way, the uncoordinated mode of wind power installments and grid integration depicted above seems entangled in China’s matrix muddle and may be claimed to perform a specific mode of Chinese market construction, i.e. constituting what may be treated as ‘fragmented marketisation’ of wind power.

[88] According to China’s four territorial entities, i.e. state, province, county, and city levels (Lieberthal, 2004(1995): 179-185).

Vested interests in the emerging wind power- and power-TENs

As the Chinese potentially emerging wind power-TEN is entangled in a power struggle between wind power and fossil fuels of the power-TEN, marketisation of wind power in China indeed seems characterised by multiple ‘stakeholders’ (García, 2013: 134-135) with “a lot of very powerful interests” (Int. 63, 2012) across bureaucratic silos. These are e.g. the SASAC-listed ‘Big Five’ generating companies and the State Grid, as well as coal companies and a variety of different ministries involved in different power sources (Int. 1, 2013; Int. 18, 2013). In addition, there are diverse factional infights (García, 2013: 134-135) in the power-TEN, for instance as the State Grid “does not have a clear attitude towards wind” (Int. 18, 2013). In this way, the power-TEN, which co-constitutes and is co-constituted by the wind power-TEN, seems characterised by ’vested interests’. Such vested interests in China are “in particular powerful in the case of SOEs located in the heavy-industrial sectors of the economy, such as oil and gas, steel, power generation, and machine-building” (Brødsgaard, 2012b: 5). Although the Chinese Government has supported the renewable energy sector massively, there thus seems to be powerful resistance against wind power in the power-TEN, since those fighting renewable energies ”are engaging more in getting stronger than those engaging in renewable energies, and this is China's biggest problem” (Int. 21*, 2013). These various power struggles amongst heterogeneous actors can indeed be claimed to produce Chinese ‘institutional ropes’, which are constraining wind power (Int. 26, 2013).

Power sector reforms – a revolution of the power-TEN or harmless changes

From the above, it becomes clear that while coal is ”a competitor [to wind]” (Int. 18, 2013), the power-TEN is constituted by myriads of power struggles – and a lack of consensus – along criss-crossing lines, which produce further barriers to the integration of wind power into the power grid, as well as to a ’revolution of China’s energy system’:

“So you think, asking whether it’s a revolution of China's energy system? To reduce the use of coal, right? […] Enhancing the use of renewable energy? This is the most fundamental issue, i.e. the awareness of renewable energy. Do you think that in the future, like in Denmark, in Germany, there will be a reliance on renewable energy, and where not only 20, 30, 50, but 100 per cent should come from renewable energy sources? Originally, it was 20, then 30, then 50 per cent – like in Germany and Denmark now…In a century,would the share rise to 100 per cent renewable energy?…I think this is the most important direction. However, China's biggest problem is that there is no consensus on the structure of China's future energy system, there is no consensus, there is great resistance, from those engaged in traditional energy sources, like coal, nuclear, and those engaged in oil (Int. 21, 2013).*

Facing resistance from not only coal, but also from nuclear power and oil, the analysis renders a picture of heterogeneous socio-technical barriers to sustainable transition. Accordingly, rather than attempting a ‘revolution’ in the power-TEN, the State Grid is “not interested in changes” (Int. 63, 2012). Conversely, the State Grid is conservative and ”very stubborn. The State Grid still thinks that the future is coal. The concepts of the State Grid have not changed” (Int. 21*, 2013). However, ”there’s nothing strange in the way that there’s huge resistance in parts of the State Grid. And it’s not surprising that some of them can see that in the longer run, well, yeah, of course we need to change this” (Int. 18, 2013). That is, integrating larger shares of wind power into the grid, constituting a potential revolution of China’s energy system, will no doubt produce multiple controversies, vested interests, and power struggles. While power sector reforms are upcoming, instead of attempting a ’revolution’, only smaller, cautious steps are therefore taken. Thus,

”it’s difficult to find out how the State Grid is developing. Everybody talks about the State Grid having to develop. Everybody is talking about this Power Sector Reform. That’s in the Five-Year Plans, it’s in NEA’s [National Energy Administration] plan. And it’s being mentioned at the Central Committee meeting, so something will happen, I think everybody is agreeing on that. But there’s huge disagreement as to what is going to happen. [Instead of large changes] they are going for the small victories instead of…because when they speak about power sector reforms, then they are talking about some adjustments now, and ’then from 2020 we can make something bigger’, and ’then from 2030 we can do some things fundamentally different’…but they try to articulate the necessity to change things in a somewhat ’harmless’ way. It’s not right now that things are going to change. But at the same time you are thinking, if you can do something tomorrow, then let’s try it, haha. But the way that they are talking about it, it’s by making it ’harmless’” (Int. 18, 2013).

As State Grid frames changes and reforms as ’harmless’ in order to reduce resistance, it is indicated how an ongoing ”battle between the traditional power plant interests and the new technologies” (Int. 183, 2013) is taking place in the Chinese power-TEN.

Voicing concerns over the need to improve coordination

As China’s fragmented mode of marketisation has produced extensive overflowing, e.g. lacking grid connection, curtailment issues, and resistance to wind power, concern is being voiced by actors in the emerging wind power-TEN over the need to improve coordination and ensure consensus on wind power integration. That is, involved actors should ”sit down together” to align targets and ambitions of conventional and renewable power sources (Int. 28, 2013). That is, the ”fairly ambitious wind power plans, but also very ambitious coal expansion plans” of local governments should be aligned (Int. 18, 2013). While such an alignment of interests amongst functional silos is still lacking, a move has been made to improve central-local coordination across geographical jurisdictions. That is, the Chinese Central Government has engaged in an effort to minimise the ’provincial free-riding’ (Int. 1, 2013), by centralising the approval process of new wind farm projects (as depicted in *Chapter 7*). That is, “they [the Chinese Government] said they want to take full control of the market. They don't want to accept this provincial free riding…the provincial free markets" (Int. 1, 2013).

Zooming in on potential particularities of Chinese green marketisation

Having conveyed an account of some of the multiple socio-technical resistances to China's sustainable translation, and having inquired into a controversy over cost and price calculations, which is entangled in a seemingly particular Chinese mode of fragmented marketisation, the analysis in the following zooms further in on some of the potential (experimental) particularities of green marketisation in China.

Fragmentation as a means of rapid industrial scale-up

While the above account has offered a somewhat bleak account of the 'fragmented marketisation', there is also another way to frame the issue. That is,

"[f]ragmentation in China's energy governance has allowed for a fast-growing wind turbine market. In times when industry development was sorely needed in order to create domestic wind turbine manufacturers, local governments were allowed to approve wind farm projects, and the media and other actors focused solely on noncritical issues with development. In times of overcapacity, the tune changed radically. This was especially evident after 2011, when the full force of centralising power was levied onto the industry and the wind industry growth rate declined. The government is indeed flexing all the muscles in its institutional body in order to navigate the development (Korsnes, 2014: 196)

The above quote indicates that the development of the wind power-TEN is a matter (perhaps first and foremost) of Chinese industrial policy, and an agenda of upgrading and catch-up. That is, the construction of a wind power market-TEN has been influenced by "all these agendas. They also had this industrial policy agenda with it, right, and that was quite obvious, and they didn't hide that either [They are] more acknowledging that this was industrial policy" (Int. 20, 2013). Also expressed by an expert within China's wind power industry, "there are some powerful drivers...the industry driver is huge in China, no doubt about that. […] One part is the energy policy, that they really want…they want this green industry. So therefore, they want to do a lot to ensure that there will be enough wind power" (Int. 18, 2013). Overall, resembling a strategy of rapid scale-up, the Chinese "leadership is very good, identifying areas, 'here's a spot – it's not really well-developed…and with our speed and capital we can get that up to a level, where we can become leaders'" (Int. 1, 2013). With such agenda of rapid industrial development, the political pole allowed local governments and developers to invest in new installments in a 'fragmented mode' in the initial phase. This resulted in the rapid growth of the wind power-TEN, creating a momentum for industrial development.

Gradually fine-tuning policies in the wind-power TEN

However, as illustrated throughout the analysis, this mode of rapid industrial scale-up has fostered continuous overflowing. For instance, in the initial phase, China

”just wanted some capacity, but was not interested in whether anything [electricity] was generated. But that means…that may be a good strategy to get started, that you don’t set up a lot of big barriers in the beginning. And it’s obvious that this will result in some problems…these turbines are not very good at adapting to the grid. And in 2010 and ’11, then you had some pretty large black-outs due to the voltage *fluctuation” (Int. 18, 2013).*

The ‘fragmented approach’ to industrial development in the emerging wind power-TEN has further been characterised by a gradualist fine-tuning of policies, as overflowing have occurred along the way. That is, ”dependent on different stages, different needs, different circumstances, different appropriate policies will be enacted. I think this is also a help in the development of the whole industry” (Int. 37*, 2013). While gradual adaptation of wind power policies is not unique to China, Chinese policy-making (and capitalist transition) is often characterised as a matter of ’groping for the stones under-foot while crossing the river’ (Goldstein, 1996: 149)[89]. This further denotes a fragmented and experimental mode of policy-making, where industrial policy is also often “rolled out informally and allowed to develop organically with shifts in producer practices on the ground. Only after practices disseminate and prove successful are the policies then formally announced and institutionalized” (Nahm and Steinfeld, 2012: 31). This is, indeed, visible in various policies related to wind power. For instance, gradual adjustment of policies has been witnessed in the case of price-setting for wind power during concession projects (setting the FITs), the introduction and abolition of local content requirements, and the potential shift in target-setting from pure capacity installations towards energy feed-in (through the Renewable Portfolio Standard (RPS) currently in hearing). In addition, it has been witnessed in new technical standards to raise quality of wind turbines and of grid connection, and in the constant oscillation between centralisation and decentralisation of approvals of new wind farms (see also *Chapters 6, 7, and 8).*

Such gradualist fine-tuning in Chinese policy-making is often framed as a matter of ‘experimentation’ (Heilmann, 2008; 2009; 2011; Korsnes, 2014). Taking wind power and concession projects and price-setting as an example, this is thus claimed to have functioned “as an experimental point for policy development” (Korsnes, 2014: 185). That is, up to 2009

[89] The notion of ‘groping for the stones while feeling for the stones under-foot’ is normally related to China’s incremental post-Mao market reforms, constituting a gradualist ‘capitalist’ transition (Goldstein, 1996: 149).

when the FITs was set, concessions were useful for experimenting and gaining experience with pricing policies, which facilitated the coordination of further wind power projects through the national FIT (Korsnes, 2014: 186). As explained by a Chinese expert in wind power, ”from year 2003 to 2009, we gained experience with the incentives structure [with the] purpose for [the] government…[to] try...first for developers...try to lower the generating cost” (Int. 8. 2013) as nobody knew in the initial phase ”what is the reasonable cost for wind, because of the lack of experience by commercial projects” (Int. 8, 2013). Not knowing the ’appropriate’ price, ”the Government tried to use this way to bring down the cost of wind generating electricity” (Int. 8, 2013). However, this meant that the first prices were ”even lower than coal” (Int. 8, 2013). Since it was the lowest price, which would win the bid in the initial phase, and as the bidders ”only want to win the bid”, prices were too low in the initial phase (Int. 8, 2013). Through consultations with the Chinese Government, Chinese wind power experts ”always strongly convince[d] the government [that this was] nonsense” (Int. 8, 2013), as the low prices led to unprofitable projects and poor quality turbines. Over time, the Chinese Government seems to have realised that ”it's better, not to take the lowest price. Should be the average price, by all offered bidding prices, haha, that way should be better. Better than lower [lowest], but [still] not reasonable” (Int. 8, 2013). Finally, after more experiments and fine-tuning of the FIT, ”we have a benchmark feed-in tariff on wind power...that in fact [in] year 2009 [is] for a whole life-time…it's much better. So this is a big incentive for developers” (Int. 8, 2013). In this way,

“gradualism and fragmentation are not entirely negative: Experimentation has paved the way for new policies, contributing to a quality check of policies with a smaller impact area, which have then been scaled up. The concession rounds amounted to 43 per cent of the total installed wind power capacity by the end of the last centrally given concession, meaning that they were not the largest source of turbine installations at that point. However, the concession rounds predated the Renewable Energy Law and provided useful experience for fine-tuning the legislative measures” (Korsnes, 2014: 194).

First do it, then solve it!

The gradualist adjustment of policies over time is often being characterised as a particular ‘Chinese way’ of experimentation, characterised by an approach of ‘first doing it, and then solving it’. This is ”impossible in Europe. I call this a political project. It's very special” (Int. 8, 2013). Rather than spending long time on planning or coordination, the Chinese approach involves experimentation along the way.

”In China, [it’s] very strange, maybe different from Europe, but in China every...we first do it - then to solve it! […] In Europe, you [are] waiting to experiment, to try to...to make...but that maybe saves the money, but the problem will take more time to solve, I guess, haha” (Int. 8, 2013).

Following such experimental marketisation mode – i.e., of ‘doing it first’, and then producing “more problems” (Int. 8, 2013) – may help provide a partial explanation for the rapid development and scale-up of wind power installments, as well as for the resulting overflowing (e.g. in terms of quality, lacking generated electricity, and curtailment). In the explanation offered by the Chinese, ’doing things fast’ is largely framed in positive terms. That is, as the trial-and-error approach produces problems faster (due to the ‘appropriate’ lack of planning), China has been forced to be innovative in solving them, and thus to learn faster from the overflowing. Thus, by experimenting,

”then you have the problems, which force people to solve them. […] If the problem had not appeared, nobody would have considered that [a potential problem]” (Int. 8, 2013).

In this perspective, the issue of curtailment “is good thing. For example, for this kind of curtailment, only five or six years ago, I think...it should have happened in the year 2020 [reaching Gigawatt-target in installed capacity], but almost ten years ahead of that…So we are facing this problem, so it will force us to have the solutions. This is good” (Int. 8, 2013).

On seizing the opportunity of the crisis - and ’Human Wave Attack’ tactics

In this account, failures and crises are framed as opportunities for learning. Thus, curtailment amongst other things is framed as a matter of seizing not only the ‘threat’ but also the opportunity’ of the crisis. This may be claimed to reflect how, in Chinese, the characters for ’crisis’ (危机 (*weiji*)) literally mean threat (*wei*) and opportunity (*ji*):

”This is a very difficult time, but you know in Chinese, it's 危机 [weiji, crisis], you know, crisis, so wei (危) means threat, ji (机) means opportunity, so a smart company will find an opportunity in the worst time” (Int. 5, 2012).

Accordingly, foreign actors frame China as a large ’laboratory’, as they are experimenting more (Int. 15, 2012). Yet, ”we don’t really understand the scale in China […] So we think that it’s terrible” with the failing wind turbines, while ”they just say, it’s fun trying it off… There’s a long way to 2020, so now we’ve got this, and then we’ll figure out what to do next” (Int. 15, 2012). In terms of WTMs, this experimental mode is also reflected in how they

”put the components faster into the turbines for example […] Where we would instead have…if you take Vestas for example, they do most of it in the laboratory. And they have a project leader, and they calculate and make plans. Here – they don’t make plans. They just jump into it, and then sometimes they make some mistakes. And then they re-adjust. So the time you would use on planning, you could use instead on… [learning from your mistakes]” (Int. 15, 2012).

The experimental mode of ’doing it’, and then learning from the mistakes, is also being framed as ”the Chinese way” of the so-called *’Human Wave Attack’,* which is an old Chinese offensive tactics, in which an attacker conducts an unprotected frontal assault with densely concentrated infantry formations against the enemy line, intended to overrun the defenders. That is, ”the Chinese way, you know, we call ’renhaizhanshu’ [’Human Wave Attack’/人海战术], zhidao ma? [知道吗?/do you know that?]” (Int. 8, 2013). Framing China’s wind power -TEN through this metaphor, an account of gradual learning-by-doing, experimental trial and error from flooding the world market, not with infantry, but with wind turbines emerges. Consequently, the wind power-TEN is currently experimenting with means to contain the overflowing, as a qualification struggle unfolds. In this way, the Chinese may have begun running before walking. That is, while ”in Europe, you have developed wind energy for many years, so you know how it works, they know how to walk. China is just a beginner and we are walking and running, and learning. Sometimes we fall. Maybe I should walk or run with slower speed” (Int. 7, 2011). However, although falling from the high speed, the wind power-TEN has emerged rapidly and is now “attempting to consolidate and to transition towards quality” (Int. 20, 2013).

A pragmatics of marketisation

The above account displays how the vast amount of overflows in Chinese wind power is framed as a success story of gradual learning-by-doing and pragmatism rather than a failure. According to a Chinese expert on wind power, ”to learn from practice is much better than learn[ing] from theory or learn[ing] from imagination […] It's the Chinese way. The situation, the Chinese still have money […] Sometimes I think, too much money! (Int. 8, 2013). Accordingly, a foreign actors explains,

”maybe that’s how they [the Chinese Government] have looked at it. Let’s try to start up something. Let’s see what happens! [Then] they [the Chinese Government] make some policies, and then people follow those policies. And then they stop them. And then they look to see, what did we get out of that? And then they make some new [policies]” (Int.15, 2012).

In Chinese, even the very notion of “pragmatism” translates as *shiyan zhuyi* (实验主义), which literally means “experimentalism” (Heilmann, 2008: 18). However, rather than blind trial and error, experimentalism in China is supposed to be “guided by intentional anticipation” (Heilmann, 2008: 18) and learning through direct practical experience (Heilmann, 2008: 19), as well as from failure. This learning-by-doing may be claimed to be what is taking place now, in the current ‘qualification struggle’:

”Now the second wave is coming, now that they have realised that it may not be the best quality…it’s cheap, the prices have been pushed all the way to the bottom, which has been hard for the Western

manufacturers, because they have not been able to sell their turbines…they have decided that the price per kilowatt or per gigawatt has to be this and this low, and nobody can sell a quality turbine at that price. So, then around one, one and a half year ago or so, then the government intervened and changed its standpoint. Okay, we have to recognise that they are not good enough. They are not as they are supposed to be, so we need to…focus on quality…so that you […] and that's kind of the situation that we are facing now" (Int. 13, 2013).

Indeed, China and Chinese WTMs seem to be learning from overflowing in the current qualification struggle. As expressed by a foreign WTM, "one of the things I've learned by studying China the last ten years is never to underestimate the capability of a Chinese company to learn from mistakes and move fast. I see them definitely being able to come up to world class level in the next three to five years" (Int. 1, 2013). Further, with gradually shifting goals and priorities of the political pole, along the learning process, grid companies and power generating companies now must change their "mindset" and "*have* to handle it [wind power]" (Int. 8, 2013):

"In the future…now, I think they understand. If...without coal, without power, some day must it be exhausted, haha. Yeah, so you have to, now, for the transition stage, to try to find [a] way" (Int. 8, 2013).

Apart from being 'fragmented', China's mode of incremental learning in the emerging wind power-TEN may be termed a particular Chinese experimental 'pragmatics of marketisation'.

Adaptive responsiveness

This seemingly particular mode of marketisation requires an 'agile' Chinese Government. Indeed, the political pole of China's potential wind power-TEN is framed as "extremely good at adapting" (Int. 9, 2012). The different actors and poles of the emerging wind power-TEN have "just [been] allowed to [try out]…and that with an entirely different budget, because it's concession policy, right. […] According to our standards, it was quite a lot of money, but not according to their [standards]…it's petty cash in their economy, because their scope is so huge…ehm…but then they close the gate, then they impose stricter requirements, and then they are sorting out [the poor [WTMs] from the good ones]" (Int. 20, 2013). Apart from an agile government, also the market, scientific, and technical poles of the potential wind power-TEN must be agile, following adjustments in the policies of the political pole. Indeed, Chinese WTMs seem to 'just go for it' (Int. 9, 2012). While the political pole has motivated WTMs and other actors to enter the market, the rapid growth rates have also been a result of local experimentation 'from bottom-up':

"I don't think this [rapid growth] really [comes] from the Government. This [comes] from the bottom up. The Government also does not like to develop so fast, for the Government, planning [is] always behind. […] For onshore [wind power], the Government said, the year 2010, only five Gigawatt, but we had 30...50-70 Gigawatt" (Int. 8, 2013).

This indicates that the emerging wind power-TEN is not just a matter of a 'top-down master discourse', but that there are also bottom-up indicators (Christensen, 2013: 77, 99-100). Indeed, there is room for local experimentation, as "[t]he institutional traits inducing the rapid growth of China's wind power industry are based on legitimacy, alignment of expectations, and visions of incumbent and upcoming actors" (Korsnes, 2014: 196). In this way, "[i]n practice, the government has induced policy experiments, which have set in motion some of the large state-owned enterprises (SOEs). These, in turn, have had an influence both locally and nationally, and have lobbied towards increased policy support for wind energy" (Korsnes, 2014: 196). However, the simultaneous fragmented (and uncoordinated) mode of experimental marketisation may, at the same time, lead to overflowing, as Chinese WTMs are like "rascals. When they realise that this is where it's going, then they all throw themselves after it. Maybe that's the weakness in their network, because then it is transferred to…then they all talk together, and then they all do the same at the same time" (Int. 15, 2012). As reflected in the account of China's emerging wind power-TEN, WTMs have indeed moved rapidly, and often simultaneously, which amongst other things has produced issues of overcapacity.

Mapping the controversy – prices, costs, and contested sustainability in China's pragmatics of marketisation

In the above, an account of a potentially particular Chinese *pragmatics of marketisation*, constituted as a matter of experimental green marketisation, has been outlined, reflecting what may be framed as a particular tension between *designing* (e.g. through extensive 5YPs) and *experimenting* (Callon, 2009). While the picture that emerges is one, which does not stress either the 'positive' or the 'negative' side of this marketisation mode, a controversy, however, seems to emerge over the very sustainability of this particular marketisation mode. In the following, the analysis concludes with a mapping of how the controversy of cost and price calculations is intertwined with a controversy over the negotiated sustainability of China's marketisation mode. This is done by pointing to how China's marketisation in wind power constitutes a potentially 'self-undermining' strategy, whilst another account renders the development of the potential software-TEN as a matter of 'agile' learning-by-doing and of foresight.

Fighting against (own) windmills – on a potentially self-undermining 'Human Wave Attack'

So far, the chapter has illustrated how China "has mustered an impressive ingenuity in fine-tuning policy mechanisms to induce the growth of a new industry" (Korsnes, 2014: 195). At the same time, however, “[t]o be sure, the industry is facing considerable challenges; a quick industry buildup comes with a price” (Korsnes, 2014: 195). As displayed throughout the thesis, China’s “choice of governance carries with it several ‘nuisances’ that lead to goals being reached only partially or with several consequences. One recurrent topic is the priority of quantity over quality, and policies are often created without any enforcement mechanisms in place” (Korsnes, 2014: 192). The thesis has illustrated how China in the initial phase pursued a deliberate low-price strategy, made possible by low labour and manufacturing costs and plenty of land (Int. 20, 2013; Int. 8, 2013). In this approach, China did ”not need to do [research and] development. We can make do with the second-last generation” (Int. 20, 2013). Yet, focused on price-competitiveness, and entangled in a Chinese ‘system problem’ (see *Chapter 11*), Chinese WTM have for long not been focused on upgrading quality. That is, concerned with wind power as constituting a means of industrial policy, when to ”become competitive, when they would be able to supply quality turbines […] That was not the most important. The most important thing was to let the industry try…try produce some turbines. And then see whether any turbines would come out of that, and see whether any of them [WTMs] would become good at it” (Int. 20, 2013). However, according to some, this constitutes a ‘senseless policy’, since “it’s not just a car, which you can throw in the garbage (Int. 20, 2013). Indeed, the experimental learning from mistakes, e.g. by setting standards low to create incentives for installation of generation capacity or not feeding power into the grid (García, 2013: 140), seems to have flooded (and overflowed) the Chinese ‘market’ in an enormous wave – the ‘human wave attack’ – of poor quality turbines. As expressed below,

“China’s quest for rapid growth has come at the expense of quality. For instance, the development goals set by the government have consistently been measured in terms of installed capacity, and not in terms of total electricity generated and delivered to the grid. A lack of incentive to ensure long-term electricity generation permeates the whole industry chain from component suppliers to local governments approving wind farms, SOEs investing in the wind farms and grid utilities managing the wind farms” (Korsnes, 2014: 196).

The resulting overflowing in terms of quality issues has e.g. led to a need for retrofitting, which ”is expensive – everybody hates retrofit, it makes everybody really angry. It’s better to think ahead!” (Int. 26, 2013). By degrading quality and pursuing a ‘scale-up strategy’ (Nahm and Steinfeld, 2012; 2013/forthcoming), i.e. as wind turbine installments have skyrocketed while wind turbines have been ”downgraded to be cheap” (Int. 20, 2013), not ‘leading at the cusp of novel-product innovation’ (Breznitz and Murphree, n.d.), China’s wind power-TEN may somewhat ironically destabilise itself, as it undermines the very framing of wind power as sustainable. That is, if overflowing results in even larger resistance, this strategy may be ’self-victimising’ or ’self-disruptive’. In this way, there may be a trade-off between quality and rapid catch-up, as the analysis indicates. That is, “the preference for low-quality, state-owned projects, induced by government investment, is potentially destructive” (Korsnes, 2014: 193). Paradoxically, China is potentially ’fighting against [its own] windmills’.

Delegitimising wind power – and destroying the global reputation of wind power?

The low-cost strategy produces concerns for the future of the wind power-TEN. As expressed by a Chinese expert, the project of the Chinese Government is “very low price and very large installed capacity. Nobody cares about twenty years of generating costs”, which in turn has resulted in lacking incentives for improving quality (Int. 8, 2013). Apart from potentially ‘undermining’ itself, i.e. suffering from overflowing turbines in China as well as constituting ”a concern for Chinese companies seeking to export their products” (Gosens and Lu in Korsnes, 2014: 197), the Chinese experimental marketisation mode is being framed as a ‘global matter of concern’ for wind power. That is, China’s curtailed wind turbines risk delegitimising wind power globally:

”Instead of having 40 factories, they could stick to a few […] It’s completely insane. It’s really worrying. In my world view, it’s really worrying that they do it in this way. Because it destroys the reputation of wind power, right. […] What do people think about wind power? People here, they taunt wind power when they read that 30 to 50 per cent of the wind turbines in China don’t work, then they taunt us and say, ’what the heck is this about?’ […] And that damages the reputation of wind power ” (Int. 20).

Having focused on capacity rather than quality and generated electricity, and on low turbine prices rather than a low cost of energy – overflowing into wind turbines which are curtailed and/or cannot efficiently deliver energy at a reasonable cost – renewable energy development risks being framed as ‘politically’ unsustainable. The analysis has so far illustrated how the framing of wind power has become unstable in terms of technical, scientific, economic, financial, as well as environmental and political sustainability. In turn, the consistent and potentially self-disruptive overflowing may even delegitimise the emerging wind power-TEN, as wind power as a means to Scientific Development risks being undermined, in turn also threatening the qualification of wind power as ‘developmentally’ sustainable.

Construing a collaborative space between Chinese and foreign actors?

Having displayed how Chinese experimental marketisation may destabilise the framing of the potentially emerging wind power-TEN as sustainable, there are however signs that China is learning from the overflowing, gradually moving towards a larger focus on quality. This has e.g. been illustrated in the case of new and higher standards, experimentation with targets for generated electricity, as well as experimentation with new calculative tools. Indeed, actors in the Chinese wind power-TEN are working on ”how to develop a renewable energy industry, which […] is capable of surviving in the first place” (Int. 18 2013).

As regards calculative tools for cost and price calculations, for example, these are gradually being aligned with those of foreign companies. That is, in the initial phase, Chinese public tendering practices have been based wind power installments (GW), spurring a focus on “the price of the turbine, not the cost of the energy” (Int. 63, 2013). In contrast, Western companies have been competing on the lowest lifetime generating cost and cost of energy, e.g. measured in terms of the cost of Gigawatt per hour (GWh), and thus being ”focused on generating the highest amount of energy at the lowest possible price (Int. 1, 2013). Since competing on the lowest cost of energy “didn’t really resonate with the Chinese” (Int. 1, 2013), a competitive space, which “was totally skewed – it had no resemblance of a competitive market” was construed in the initial phase of the wind power market in China (Int. 1, 2013). While “a practical way of keeping foreign companies out of tendering, because we [foreign WTM] could not compete in cost of Megawatt” (Int. 1, 2013), this created “one field over here with Chinese players, and a little bubble over here with foreign ones that were not competing” (Int. 1, 2013). Competing on completely different criteria in the initial phase, criteria (e.g. standards and targets) and cost and cost calculations seem to be gradually merging, which may eventually place foreign “players into the same competitive space as the Chinese” (Int. 1, 2013). Thus, as China increasingly aligns calculative devices of costs and prices, foreign WTMs are becoming “a bit hopeful again. Because all the value propositions that X [foreign WTM] has can suddenly come back into play” (Int. 1, 2013). At the same time, Western WTMs and component suppliers acknowledge that they can “learn from the Chinese”, e.g. in terms of cost reductions (Int. 15, 2012). A collaborative space for common research, where “both sides can win”, is hereby potentially under construction in a mutual struggle on reducing the costs of energy to make wind power ’competitive’ in the battle with fossil fuels (Int. 1, 2013). Indeed, myriads of international collaborations are already taking place, to improve the ’controllability’ of wind power (e.g. smart forecasting tools, simulation tools, energy storage, ultrahigh voltage transmission lines, and integration with flexible hydro-power stations ‘smoothing out’ the fluctuating output of wind power).

On contested sustainability – and creative foresightedness

In the above, a controversy over the sustainability of China’s seeming experimental, fragmented mode of green marketisation has been illustrated, entangled in a controversy over cost and price calculations. While the analysis has dubbed marketisation in wind power as a Chinese pragmatics of green marketisation, the very sustainability of this is contested. While some frame China's green marketisation mode as sustainable in the long term, others see it as a threat not only to China's development, but also to the global development of wind power. For instance, a foreign WTM argues that "bad Chinese quality, it is bad for everyone. The reputation of the whole industry suffers from it. We all have an interest in improving quality. We want to do what we can to help out" (Int. 1, 2013). However, the analysis has also displayed how the Chinese Government's seeming "navigational skills" (Korsnes, 2014: 196) seems to have avoided a complete collapse from overcapacity issues. In a Western perspective, however, this experimental approach is framed as ”a funny approach to this. It's very different from ours, and we simply don't get it. And it may be that they get something else out of it than we do, and that's interesting" (Int. 20, 2013). Overall, the seeming gradual "change from fragmentation to alignment have been dominated by considerable policy flexibility" (Korsnes, 2014: 196) in the construction of a market for wind power in China. In this way, the Chinese political leadership seems highly agile, navigating new overflowing along the way. In this way, the analysis underlines how there is indeed more to the story of rapid growth (and consolidation) in Chinese wind power than just formal laws and regulations (Korsnes, 2014: 177, 195). The analysis further highlights how heterogeneous actors and entities are involved in the *pacification* and *price-setting* of wind power, as well as how these qualification processes engender controversy and overflowing, co-constituting a particular Chinese pragmatics of green and fragmented marketisation.

Conclusion and theoretical considerations – the controversy over cost and price calculations and a Chinese pragmatics of green marketisation

Chapter 12 has sought to bring together insights of the previous chapters of the analysis. The chapter has inquired into a configuring controversy over cost and price calculations in the struggle between coal and wind power. This illustrates how prices, and particularly the calculative tools employed in price-setting, are themselves negotiable, rendering the qualities they produce unstable. In this way, the chapter sheds light on some of the dynamics and controversies that *price-setting* can engender in the marketisation of wind in China. The mapped controversy is, in turn, part and parcel of a controversy over the sustainability of a seemingly particular Chinese mode of green marketisation, or what the thesis frames as a specific Chinese 'experimental pragmatics of marketisation'. Several power struggles have been illustrated in the power-TEN, e.g. between wind power and fossil fuels, between central and local governments, and between foreign and Chinese companies.

The chapter illustrates how the employment of calculative tools for price-setting, which have favoured growth in capacity rather than generated electricity, has been a matter of Chinese gradualist and experimental industrial policy. Yet, the seeming agnosticism in planning is framed, by some, as pure ’waste’, which in turn threatens to destabilise the very framing of wind power as environmentally sustainable. That is, the Chinese emerging wind power-TEN has produced ongoing and extensive overflowing, which threatens to qualify the emerging good of wind power as not only technically, scientifically, economically, and developmentally unsustainable, but even as environmentally unsustainable. Such extensive destabilisation of wind power’s framing in China risks, in turn, to destabilise the framing of wind power-TEN not only in China, but also to overflow to other countries. By tracing associations assembling around the unsustainability of wind power, the chapter maps the overflowing that entails an incomplete and therefore unstable translation of a wind power-TEN. Such extensive overflowing of both the wind power-TEN and the co-constituting software-TEN, as illustrated in earlier chapters, can in turn be coupled to the way in which the power-TEN is itself overly unstable and consistently being negotiated, i.a. between multiple power sources and local and central bureaucracies.

While some voice concerns that China’s strategy of pursuing a low-cost/high-quantity approach has potentially been self-disruptive, others point to how such targets and calculative tools, as well as the related agnosticism in planning and coordination, display foresight through learning-by-doing and trial and error of the Chinese political pole. Overall, the sustainability of China’s emerging wind power-TEN is being debated and contested, entangled in a controversy over the sustainability of China’s experimental, pragmatic mode of marketisation. Rather than offering a bleak picture of decline and collapse, a favourable account of the Chinese agile, pragmatic experimentation proposes that the myriads of overflows in Chinese wind power may, admittedly, be framed as a matter of necessary ’casualties’ in the short term, while eventually paying off in the long term. This indicates a story of marketisation as a subtle tension between *designing* and *experimenting* (Callon, 2009: 536), in which the Chinese political pole has engaged with sensitivity, agile movements, foresight, adaptation, and flexible containment of overflowing, engendering intended - or at least hoped for - adjustments of the market pole, and over time increasingly also of the scientific and technical poles.

The chapter has illustrated potential risks of socio-material lock-in into fossil fuels, as associations of volatile and disruptive wind power have been construed. These associations have i.a. been construed by heterogeneous actors and entities such as coal quota, local government contracts and incentive measures, vertical and horizontal lines of coordination, GW targets, life-time generating cost, concession pricing, grid inflexibilities, cost and price calculations, and forecasting tools. Nevertheless, the analysis points to experimental and agile agencies of the Chinese political pole and other poles that are potentially able to overcome these overflows during the seeming turn to quality. This indicates how China's 'sustainability journey' (Garud and Gehman, 2012), despite the many barriers encountered along the way, might in fact be an account of agile and sensitive adjustment rather than systemic failure. Apart from gradual adjustments of policies, targets, and standards, such creativity and agile agency is reflected in how the political pole has creatively employed a 'great narrative' of China's renaissance and revitalisation. This can assist in sense-making in emerging situations of 'crisis', and in terms of finding ways to deal with these crises. By construing a narrative of China's long-term, comprehensive, holistic, sustainable development, a space has been opened up for flexible interpretation, which may produce a better understanding of China's development. Hereby, narrative devices concerning China's sustainable development seem to have had powerful performative capacities in the marketisation of wind power and the potential turn to quality. This, in turn, displays an agile ability to manage experimentally the constantly emerging overflowing, and the "resourcefulness and improvisation on the part of involved actors" (Garud and Karnøe, 2003: 278). Through experimental learning-by-doing, e.g. reflected by an oscillation between centralisation and decentralisation and the introduction of new calculative devices (e.g. standards and targets), a gradual convergence of calculative tools for cost and price calculations of foreign and Chinese actors is illustrated in the chapter. As calculative tools may be converging, a less contested space than the competitive space illustrated in previous chapters may be under construction.

Overall, the thesis hereby leaves open whether or not the seemingly adaptive, fragmented, experimental, and pragmatic mode of marketisation can perform a turn to quality in time to reframe wind power as sustainable. Yet, the analysis illustrates how marketisation as a qualification struggle, can be seen as a matter of an 'art of interessement' (Akrich et al., 2002). That is, playing on the notion of the art of interessement in processes of translation and framing, normally attributed to technological innovation, the thesis can be said to illustrate the construction of a market for wind power in China as an 'art of marketisation'. This indicates how China's seemingly particular 'pragmatics of green marketisation' can be likened to its own particular form of innovation, as heterogeneous actors are translated into the emerging wind power-TEN, e.g. through the creative construction and employment of associations in the pursuit of constructing worth to wind power, and through gradualist, pragmatic trial-and-error.

Summarising findings of the analysis (Part III)

Together, the respective narratives of *Chapters 6-12* serve to provide an account of green marketisation within wind power in China, which displays how ”we need to give up the idea of substantial definitions of the economy and politics that can serve to distinguish between that which is economic and that which is political” (Callon, 2007: 139). Indeed, the analysis conveys an account of ‘the negotiated market’ (Callon, 1998: 264), which is contested and produces controversy. This renders marketisation a messy, rhizomatic tale – each time the narrative has approached an ending, there seems to be many new beginnings.

Before moving to the final *Part IV* of the thesis, which presents a discussion and conclusion on some of the implications of the inquiry, *Part III* concludes by reflecting briefly on where the inquiry has led, since it set out. This is done by linking back to the theoretical and methodological constructivist ‘tool box’, developed in *Part II*, and which was founded on a constructivist *pragmatics of valuation* of the *Anthropology of Markets’* (AoM’s) performativity programme, and which was combined with the methodological tools of the *Mapping Controversies*. With an interest in *how* collaborative collectives between Chinese and foreign actors around wind power and software have emerged and stabilised over time, in the ongoing qualification struggle in the wind power-TEN, the thesis has traced processes of relationship-building. This has been done by mapping processes of valuation, as heterogeneous actors engage in the controversial construction of associations of sustainability to wind power.

Processes of qualifying wind power as sustainable – and controversies over framing

The thesis has provided an account of processes of qualification and the controversies, they engender. This was done, firstly, by diving into controversies over attempts at *pacifying* the quality of the emerging good of wind power, by following framing tools of IPRs and standards, which are normally seen to work to stabilise the framing of a potentially emerging good. However, the thesis illustrates how such pacification is controversial and up for debate, as well as how the very framing tools, which are normally seen as stabilising, are in fact themselves negotiable. In the two ‘algorithmic case studies’ on the pacification of goods, a number of heterogeneous actors emerged and, amongst these, software algorithms. Having displayed how the framing of wind power is still not stabilised, and how relations of the emerging wind power-TEN and software-TEN are consistently unravelling due to overflowing, the last two controversy mappings inquired into processes of *price-setting* in

Chinese wind power. This was done by ‘following the money’ as well as by following cost and price calculations in the Chinese wind power- and power-TEN. These controversy mappings displayed how controversies over framing and price-setting (and their calculative tools) are being contested, as well as being entangled in controversies over China’s ‘system problem’ and the sustainability of China’s fragmented and experimental *‘pragmatics of green marketisation*’. In this way, ‘mundane’ artefacts such as algorithms and money and cost calculations have been transformed from intermediaries into actors throughout the analysis, as they configure and produce controversy, and thereby in turn de- and reconfiguring relations. Indeed, having illustrated how framing and the employed calculative tools can be rejected as ‘betrayal’ (*tradutore-traditore*) (Callon, 1986a), due to the inclusion and exclusion dynamics they produce, the analysis illustrates how the “various calculating devices [e.g. IPR, standards and certificates, money, cost and price calculations] equipping market socio-technical agencements”, i.e (m)STAs, or what in the thesis has been treated as ‘markets as TEN’, can help further our

“understanding of relations of domination. Inequalities derive from the unequal power of calculating agencies that loop back to reinforce themselves. Due to these asymmetries, the most powerful agencies are able to impose their valuations on others and consequently to impact strongly on the distribution of value” (Callon and Çalişkan, 2010b: 13, drawing on Bourdieu 2005 and Fligstein 2001).

Calculating (or ‘calculative’) devices of Chinese and Western actors respectively seem to collide over and over again in the emerging market for wind power in China, as seen in the colliding emphasis on quantitative growth (GW) versus ‘growth in quality’ (often measured through generated electricity, GWh). In this way, the colliding calculative agencies, produced by the employment of different calculative devices, have produced overflowing and trials of strength. However, the analysis also displays how calculative devices of Chinese and foreign actors over time seem increasingly to converge in the ongoing qualification struggle and potential turn to quality, which can - potentially - construe a less conflictual space for simultaneous collaboration and competition.

While primarily having zoomed in on the dynamics of the *pacification of goods* and *price-setting*, which constitute two of the five types of framing required by the theory of marketisation, the thesis, nevertheless, indirectly also sheds light on the three remaining aspects of *marketising agencies*, *framing of market encounters,* and *the construction and maintenance of markets* (Callon and Çalişkan, 2010b).

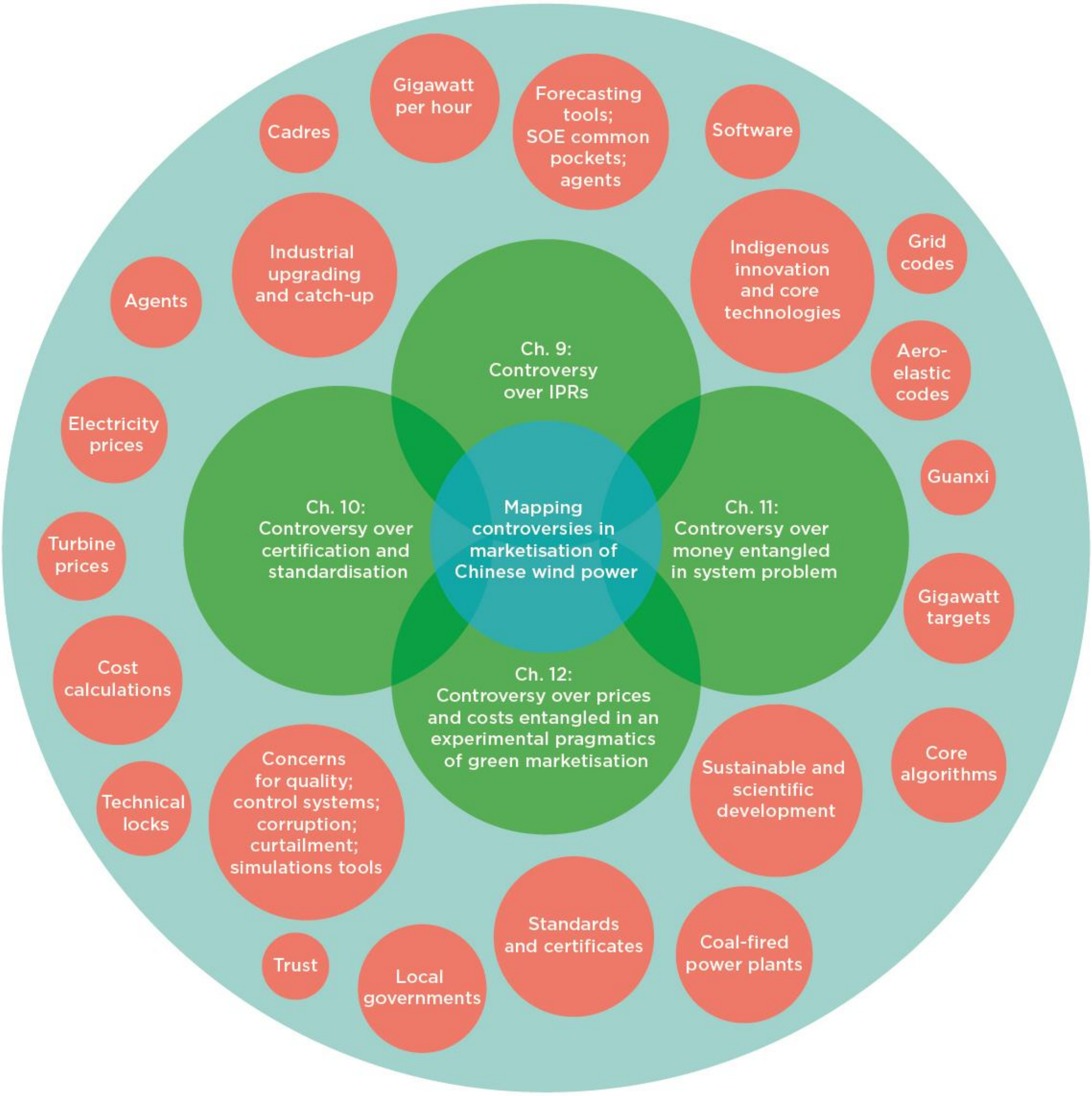
Firstly, by setting the mapping of controversies over the performation of the market into the particular context of China’s ‘system problem’ as well as a particular Chinese pragmatics of green marketisation, the thesis has at the same time, almost unavoidably, inquired into aspects of *marketising agencies*. The thesis has thus traced some of the multiple and heterogeneous actors, who compete in defining and valuing wind power (Callon and Çalişkan, 2010b: 8). These actors include, among others, money, agents, SOEs, concession rules, cost and price calculations, standards, guanxi, algorithms, grid codes, coal quotas, coal-fired plants, agents, discursive and narrative devices on Scientific and Sustainable Development, as well as industrial upgrading and catch-up.

Secondly, the thesis has, to some extent, also indirectly shed light on parts of the processes of the *framing of encounters.* This is e.g. reflected in the case of large concession projects (largely through state-controlled bidding and concessions) and processes of grid connection and dispatching in the electricity grid within and between provinces, in which e.g. coal-fired power plants, quota, central and local administrations and bureaucracies, grid-connection lines, Renewable Energy Fund, FITs, guanxi, agents, are mobilised to help in aiding that the wind is actually transformed into power, transmitted, and distributed, and thus ensuring market encounters.

Lastly, by exploring the potentiality of a turn to quality, the thesis also inquires into processes of *market construction and maintenance*, by exploring the various and transforming means employed to construe associations of technical, scientific, economic, environmental, social, political, and developmental sustainability to wind power, and the socio-material work needed for maintaining these associations and, indeed, the inherent fragility of those framings. In doing this, the analysis displays the political and contested nature of calculative tools needed to construe associations and the resulting fragility of the calculative agencies.

Indeed, it may be claimed that wind as a 'thing' cannot even be claimed to have been transformed or stabilised into a finalised 'good' (Callon and Çalişkan, 2009: 2010a; 2010b), as its qualities, price, and value have not been settled. In Latour's wording, the analysis thus displays how wind power and a market for wind power is not a 'matter of fact', but rather constitutes a 'matter of concern'. That is, rather than looking into markets as black-boxed 'objectified matters of fact', the thesis has sought to inquire into how these objectified 'matters of fact' instead often entail controversies and negotiations, constituting politicised 'matters of concern' (Latour, 2004). In turn, the inability to pacify and qualify wind power as 'sustainable' seems to create socio-technical barriers to the circulation of wind power, i.e. to market transactions, which is reflected in the extensive 'overflowing', i.e. wasted and curtailed wind power. Below, examples of some of the myriads of more or less unexpected actors that have emerged throughout the analysis are depicted in *figure 23*.

Figure 23: Examples of unexpected actors in the marketisation of wind power



Source: Own design.

Extensive overflowing in a developmental context – on simultaneously collaborative and competitive spaces

The analysis has been set into a particular ‘developmental’ context of China, and looked into Sino-foreign collaborations around software and wind turbines. This has provided an account of fragile framing and overflowing as the norm. The extensive overflowing may be said to be particularly pervasive exactly because the study has been set into this specific context, as China can be said to face conflicting forces of globally interdependent markets and of demands by its national community economy (Callon and Çalişkan, 2010a).

Further, facing the multiple and rapidly shifting and/or colliding agendas involved i.a. in opening up to foreign markets and protection of its own SOEs, as well as of learning, upgrading, and technology leverage from international collaborations, while simultaneously pursuing indigenous innovation, a hybrid, contested and paradoxical space of collaboration and competition has been depicted. In such a space, actions of framing and assignment of ownership can trigger legal, ethical, scientific, or economic debates (Callon and Çalişkan, 2010b: 8). By illustrating the multiple, colliding concerns and issues, and how even algorithms and processes of price-setting can become ‘political’, reflecting how the construction of a market for wind power is entangled in concerns for China’s Scientific and Sustainable Development, the emerging wind power-TEN becomes, as it were, inherently political. This vividly illustrates how marketisation in China is entangled in processes of *politicisation.* Apart from this, marketisation is also entangled in processes of *scientification* and *economisation*. First, the constitution of wind power and software as a scientific matter, e.g. to be qualified through algorithms and entangled in a concern for China’s Scientific Development, shows how scientification is part and parcel of the construction of a market for wind power. Second, marketisation is entangled in processes of economisation, e.g. in processes of price-setting and cost and price calculations. In the case of China, the ‘system problem’, i.e. being entangled in China’s overall corporate restructuring along China’s ‘capitalist transition’, illustrates how the construction of ‘the economy’ and ‘the market’ are entangled. This means that disentanglement of political and market poles becomes practically impossible, and that the power-, wind power-, and software-TEN, in mutually intertwined and unfinished processes of translation and framing, render marketisation of Chinese wind power unstable. In addition, the thesis displays marketisation as entangled in processes of what the thesis proposes to be termed *‘technification’.* This notion seeks to take into account the role of technologies and ambitions of technological and industrial upgrading in a developmental context, hereunder the role of collaborations on innovation and technologies between diverse foreign and Chinese actors in the construction of a wind power market in China. In other words, technologies can be seen as taking part in the de- and requalification of China's wind power market during the current quality crisis.

The particular mode of Chinese marketisation – and the art of marketisation

Lastly, mapping controversies in specific sites of valuation, namely marketisation of wind power in the developmental context of China, has illustrated how the process of attributing associations of economic worth to wind power is colliding with another kind of worth, namely what the thesis dubs 'developmental worth'. Constructing a market for wind power constitutes part of the developmental goals of e.g. Scientific and Sustainable Development, along the route towards a Harmonious Socialist Society. While marketisation studies have focused on the construction of economic worth, and in the case of market construction in renewable energies have highlighted i.a. how the construction of a market for green products depends on the economisation of environmental concerns to construe associations of environmental quality (cleanliness) and economic worth (price) (Karnøe and Doganova, 2014, forthcoming), the thesis illustrates how such processes of economisation are contested in the marketisation of Chinese wind power. In this particular site of Chinese wind power, the socio-material work of constructing economic worth is entangled and colliding with the construction of qualities of upgrading and 'developmental worth'. That is, the concern for industrial and technological catch-up is reflected in the need to construe associations of i.a. technical, scientific, economic, social, political, environmental sustainability to wind power, which can in turn construe developmental worth. The collision of these two concerns may be one of the reasons why the framing of the wind power-TEN as sustainable tends to fall apart time and again, and why relations in the software-TEN, which co-constitutes and is co-constituted by the wind power-TEN, keeps unravelling. In turn, entangled in a Chinese system problem, characterised by a cautious piecemeal 'capitalist transition', multiple vested interests, and fragmented coordination, the thesis illustrates how marketisation of wind power is inherently 'big politics' in China, which necessitated the introduction of a 'political pole' to the marketisation account in the analysis. As not only the wind power- and the software-TEN, but also the power-TEN are characterised by multiple power struggles, green marketisation in wind power seems one of lability and hybridity (or of magmatic spaces), in which potential socio-technical barriers and potentialities for sustainable transition and upgrading exist.

Lastly, the thesis can be said, indirectly, to illustrate a potentially particular, specific, and characteristic mode of Chinese (green) marketisation. That is, adopting a constructivist perspective of the Anthropology of Markets (AoM) has turned out to be "useful for elucidating the range of possible choices (in terms of calculative equipment, modalities of framing goods, socio-technical algorithms for market encounters, price-setting, etc.)" (Callon and Çalişkan, 2010b: 24). The present ethnographic controversy mapping of marketisation in Chinese wind power has thus provided an insight into the experimentation of markets, exploring "the potential diversity of markets" (Callon and Çalişkan, 2010b: 24). Looking into markets as *potentiality*, it has been illustrated how the emerging wind power market in China has still not been made 'irreversible', how processes of marketisation are being stalled in China, and how calculative agencies and worth are not exclusively centred around the construction of economic worth, but also around developmental worth and sometimes trapped in China's so-called 'capitalist transition' and struggles of the Chinese political pole to (re-)install legitimacy. That is,

"despite emerging tendencies, the idea of a market is indeed sufficiently open that original significations and alternative forms of organization are still imaginable. Moreover, the movement towards markets is by no means irreversible; other forms of economization can always be envisaged" (Callon and Çalişkan, 2010b: 23).

Hereby, marketisation studies in China arguably constitute interesting sites of further exploration into the potentiality of "new forms of organization and theorization" (Callon and Çalişkan, 2010b: 23). Having illustrated the "economic engineering based on trial and error" (Callon and Çalişkan, 2010b: 23) in the marketisation of wind power in China, the thesis helps open up "an explicitly political dimension into the process of economization, especially when it means marketizing objects and behaviours that have previously defied marketization" (Callon and Çalişkan, 2010b: 23). Indeed, in the 'socialist' market economy of China, the analysis should explore the alternative possibilities of markets (Callon and Çalişkan, 2010b: 23). That is, "[m]arkets have a history; they also have a future that cannot be reduced simply to an extrapolation of the past" (Callon and Çalişkan, 2010b: 24). In the context of a newly industrialised country as China, marketisation may be construed as a matter of industrial policy and upgrading, largely *designed* through myriads of plans and policies. At the same time, however, often lacking specific experience and knowledge within the field, there may also be a high degree of *experimentation*, sometimes even involving basic trial and error. Thus, while the analysis has illustrated the risk of China 'fighting against (its own) windmills', the depicted pragmatics of marketisation in Chinese wind power also holds the door open to the ability of, in a manner of speaking, 'breaking the waves', i.e. to potentially break away from industrial 'downgrading' or lagging behind, and potentially succeeding in industrial upgrading. Having summarised the analysis, the thesis proceeds to the last part, namely Part IV (*Chapters 13-15*).

Part IV: Discussion – Ambiguous Winds of Change and Fighting Against Windmills

"The most interesting places lie on the boundaries between order and disorder, or where different orders rub up against one another" (Law, 2009: 144)

Throughout Part III (*Chapters 6-12)*, the analysis has inquired into the potentially particular 'Chinese characteristics' of marketisation in Chinese wind power. This was amongst other things done in order to explore whether and how a constructivist perspective can give insight into the *genesis, dynamics, and agency* of a potential GIN around software programmes in the Chinese wind power market, which was enabled through a pragmatist tunnel (*Chapter 2*). In Part IV, a discussion is provided in regard to (1) how the 'black-boxed' understanding of *genesis, dynamics, and agency* of the traditional GIN literature can be properly unfolded, traced and qualified through the adoption of a constructivist perspective (*Chapter 13*). In addition, (2) an overall, final conclusion of the collected inquiry (*Chapter 14*) is provided, as well as a (3) discussion of some of the wider implications of the thesis for related literatures as well as critical reflections on limitations of the thesis (*Chapter 15*).

After a discussion of the contributions to the GIN literature of the constructivist approach, *Chapter 13* renders a constructive critique of the somewhat binary dialectics between framing and overflowing, a critique emerging from the findings by the constructivist perspective. With the aim of pointing to larger patterns, while not falling into the trap of a dichotomous binarism, a second 'pragmatist tunnel' of the thesis is introduced through the notion of *figuration* (Elias, 1978). This is done in order to inquire into how and whether the notion of figuration can help illuminate the dynamics of GIN and market construction in China's wind power market, its ambiguous winds of change, and China's potentially paradoxical fight against windmills. This leads, in *Chapter 14,* to an answer to the inquiry's main research question. Finally, and as a way of rounding off and looking forward, *Chapter 15* offers a two-pronged discussion: First, the wider implications of the findings are discussed, particularly related to China studies, to structural and hierarchical accounts of Varieties-of-Capitalism and global value chain (GVC) governance, and to the upgrading and industrial policy literatures. Pointing to the need for cross-fertilising perspectives to include both structural and processual elements, this leads to a tentative proposal for a new research agenda within New Economic Sociology (NES) for exploring market (and GIN) construction in a developmental context (of China). Second, the discussion offers a reflexive critique of the constructivist account and its limitations.

Chapter 13. Implications for the GIN Literature and a Second Pragmatist Tunnel

To venture into a discussion of the findings and potential contributions to the GIN literature from the adopted constructivist perspective, *Chapter 13* revisits the notion of 'GIN'. That is, the notion of GIN was left in Part II of the thesis, as the analysis instead engaged in a constructivist marketisation analysis within Chinese wind power and adopted the constructivist notion of markets as *techno-economic-networks* (TEN). The thesis hereby somewhat paradoxically had to 'look away' from GINs in order to shed light on whether and how a relational, lateral, and processual constructionist perspective could (though indirectly) qualify insights into the *genesis, agency, and dynamics* of GINs, through a 'micro-relational' lens. Having pointed to what the thesis coins as a particularly Chinese 'pragmatics of (green) market construction', the discussion in the following first discusses contributions offered by the present inquiry to the GIN-literature in terms of genesis, dynamics, and agency. Second, this leads to the introduction of a second 'pragmatist tunnel' (through Elias's (1978) '*figurational sociology*'). Hereby, the thesis seeks to move beyond both the GIN perspective and the constructivist perspective, in order to overcome the inadvertently dualistic account of framing versus overflowing that has emerged throughout the constructivist analysis, as well as to provide a broader picture of China's potential turn to quality within wind power.

Requalifying the GIN literature through a constructivist perspective – capturing 'the relational'

First, the potential contributions from a constructivist account to the GIN literature are outlined in terms of how it renders a lens for *genesis, dynamics,* and *agency*.

Qualifying the understanding of the genesis of GINs

In the literature review (*Chapter 2*) in *Part II*, the thesis outlined how the GIN framework has recently been adopted to inquire into GINs in China's wind turbine industry, and how different GINs have been identified in the shape of Chinese WTMs, which have distributed their R&D-activities globally, and engaged in globalised technology sourcing patterns and/or contractual R&D collaborations (Silva and Klagge, 2013)[90]. With its structural, formalistic, as well as rather hierarchical and positivistic perspective, and a meso-level

[90] Also, more or less interchangeably, dubbed 'collaborative innovation networks' (Chen et al., 2014) or 'global learning networks' within China's wind turbine industry (Lewis, 2013).

account of spaces and scales in the global-local nexus, often seen in a co-evolutionary perspective, the thesis argues that the extant GIN literature tends to look at GINs from the outside, and as embedded in constraining (or enabling) institutional structures. Despite valuable insights into the structure and effects of GINs, and also having detected GIN-emergence based on formal structures, the thesis argues that the GIN-literature paradoxically risks missing out on how GINs have been constructed in the first place, and how such GINs may require ongoing work of maintenance. By not tracing how relations are constructed in the first place, the thesis argues that the GIN literature risks missing out on the 'micro'-processual and –relational (and potentially controversial) aspects of GIN-construction, as well as on the distributed agency involved in constructing GINs involving heterogeneous (human and non-human) actors. In short, risking to be seduced by its own network construct of 'GINs', the socio-material work involved in the *genesis* of GINs tends to be black-boxed and assumed away.

To overcome these shortcomings, and to shed light on genesis, as well as on the dynamics and agency of GIN construction, the thesis has argued that in order to trace GIN genesis, dynamics, and agency it is somewhat paradoxically necessary to 'look away' from GINs, in order to trace the socio-material aspects of their *potential* construction. That is, instead of employing the metaphor of GINs, the thesis has conducted an analysis based on a constructivist marketisation perspective, which is argued to offer a relational and processual account of the socio-material work implied in constructing networks. By tracing the construction of associations (framings/qualifications), which are argued to be necessary for relating, translating and enrolling heterogeneous actors into an emerging network, and the controversies these associations may produce, the thesis treats GINs as *verb* rather than *noun.* Looking at GINs as a matter of *becoming*, by looking into the very *networking* of GIN (or processes of 'gin-ing') (networks as *verb*) [91], the thesis seeks to move beyond assumptions of stabilised relations and the institutionalised structures (networks as *noun*) they would thereby constitute at the outset. Hereby, the relational constructivist perspective of marketisation is argued to open up to a lens for the potentially highly volatile and disruptive, as well as controversial, nature of GIN emergence and genesis.

To reiterate, in order to inquire into GIN genesis, dynamics, and agency, the thesis has conducted a marketisation analysis by mapping controversies in the ongoing struggle of

[91] Or even as entangled processes of what could be termed 'gin-ification' along with marketisation (and politicisation, scientification, economisation, and technification) as indicated in the overall conclusion of the constructivist analysis.

qualifying wind power in China as sustainable. In the qualification of wind power as sustainable in a Chinese ‘comprehensive’ way, i.e. taking into account how sustainability is linked to China’s Scientific Development and upgrading and construction of indigenous innovation capabilities in core technologies, e.g. through linking up to foreign companies and technologies, attempted translations of collaborative - and competitive - relations between Chinese and foreign actors around the core component of software have played a performative role. The thesis has illustrated how Sino-foreign collaborative networks (‘GINs’) around core components such as software in Chinese wind power are part and parcel of the qualification of wind power as sustainable. That is, in the process of qualifying wind power as ‘sustainable’ in a way that is in alignment with the Chinese comprehensive notion of sustainability and Sustainable and Scientific Development, the construction of Sino-foreign collaborations has been seen as critical for the wind power market in China since its very beginning. With new ambitions for indigenous innovation, as part of the stated strategy for attaining a Harmonious Socialist Society through Scientific Development, i.a. to be achieved through Sino-foreign collaborations, the thesis argues that it makes sense to trace GIN-construction as part and parcel of the framing/qualification of the emerging Chinese wind power market.

Conducting a marketisation analysis, and adopting the Mapping Controversies approach, the thesis looks into the struggles and negotiations involved in the process of qualifying the emerging good of wind power, and how these produce controversies, de- and reconfiguring relations between Chinese and foreign actors around wind turbine technologies and software tools. Treating GINs not as a ‘Matter of Fact’, but as ‘Matter of Concern’, and as part of a qualification process in the marketisation process, the thesis argues that by looking beyond the traditional formalistic use of the GIN-metaphor, it has been possible to shed light on GIN genesis, dynamics, and agency within Chinese wind power. That is, GIN-construction in Chinese wind power is shown to be part and parcel of the process of qualifying wind power as ‘sustainable’.

Further, the thesis has disassembled the wind turbine, and traced the construction and maintenance of *relations* around the critical component of software. In this way, the thesis treats the construction of network relations as part and parcel of the performance of associations of sustainability to wind power. The thesis has consequently fundamentally reconceptualised GINs. By not adopting the traditional notion of GINs, hereunder not looking at GINs by taking its outset in WTMs and their formal, structural networks within the entire wind turbine industry, the thesis has disassembled the wind turbine to trace the meticulous work of translation of Sino-foreign collaborative networks around one critical core component, namely software in the process of marketisation of wind power.

Although the thesis has thus treated ‘GINs’ in a radically different way, the thesis argues that there are lessons to be learned for the GIN literature, notably in terms of genesis, dynamics, and agency. Surely, in the conventional structural and formal GIN perspective, the wind turbine industry in China would be claimed ripe with mature GINs. In contrast, the thesis illustrates that if zooming in on micro-processes of relationship-building around a particular core component within the wind turbine industry, the picture becomes a different and arguably more fine-grained, but also complex, one.

Nevertheless, if briefly adopting the lens of the traditional GIN-literature and economic geography, which was reviewed in *Chapter 2,* the thesis can be argued to have illustrated, indirectly, that is, how China from the outset has ventured into the wind power industry by becoming part of a global value chain (GVC), namely largely by acquiring foreign technologies in conventional customer-supplier supply-chain relationships. Over time, China has moved up the value chain, upgrading in specific components and having built own indigenous capabilities in terms of manufacturing, and gradually becoming part of a global production network (GPN). Engaging in reverse engineering, and engaging in diverse forms of technology sourcing, a GPN has been constructed, whereby China is benefiting from general “changes in the global production of services and products”, which have spatially fragmented industries and services, resulting in the geographical clustering of activities rather than necessarily of entire industries (Breznitz and Murphree, 2011: 2). Further, as Chinese WTMs have engaged in the ‘modularisation’ of the wind turbine, outsourcing most components to domestic and foreign suppliers, they have been able to squeeze component and turbine prices. This has created a competitive advantage over foreign WTMs, who have mostly pursued a more expensive strategy of insourcing. In this process, emerging Chinese component suppliers have been able to upgrade capabilities within a variety of wind turbine components. Over time, however, Chinese WTMs have acknowledged the potential dangers of such modularisation and outsourcing, e.g. in terms of lacking overview of the wind turbine, its control, and aerodynamic optimisation, and potential detrimental implications for quality. As a turn to quality may take place, Chinese WTMs are gradually moving towards a higher degree of internalisation. Not only intent on engaging in specific activities, but also to build its own indigenous wind turbine industry, which is independent from foreign technology sourcing, the Chinese wind turbine industry has evolved with rapid pace, yet it is also facing considerable challenges in terms of quality and continued reliance on foreign core components.

In this view, the findings of the inquiry indicate how the emergence of Chinese WTMs and component suppliers has taken place through processes of integration into GVC and GPNs and resulting upgrading. Emerging GIN relations are thereby indicated as well. This is e.g. seen in the case of Chinese WTMs such as Goldwind and Envision, which have acquired design houses, hired software specialists, and/or set up foreign R&D departments and collaborations abroad, and as Chinese certification bodies, test laboratories, and research institutes with newly built competencies increasingly collaborate with foreign partners. GIN relations are increasingly emerging around core technologies such as software for i.a. design tools, control systems, and forecasting tools. For instance, taking the case of simulation tools for wind turbine design and certification, universities, research institutions, certification bodies, WTMs, and design houses in and from different countries are involved.

When zooming further into software components, however, the analysis illustrated how most relations largely remain part of a conventional GVC. That is, knowledge and technologies tend to be commodified and transferred primarily through conventional technology transfer mechanisms, rather than being co-created and synergistically produced and shared within GINs. When not commodified, there furthermore seems to be barriers to knowledge- and technology-sharing, since Chinese actors, which tend to be framed as 'inferior', are often excluded from international collaborations on software algorithms.

Overall, the thesis illustrates how software controllers and design tools still largely form part of the value chain, and that there are powerful exclusion mechanisms in international collaborations, e.g. due to IPRs and standards. Nevertheless, the thesis also points to how governance relations are in flux, that is, for instance customer-supplier relations are being vigorously and increasingly contested and negotiated. Along with rising capabilities of Chinese actors, governance relations gradually shift from pure market-based relations to network governance, which in turn are gradually becoming less captive and increasingly relational (Gereffi et al., 2005). While the GVC literature points to the importance of supplier capabilities for the choice of governance mode, the thesis, however, illustrates how customer (WTM) capabilities also play a critical role in the choice of governance mode. That is, the thesis has zoomed into customer-supplier relations where to begin with it was foreign suppliers who seemed to determine how they governed their relations with Chinese WTMs. However, as Chinese WTMs have gradually learned from foreign customer-supplier relationships and built capabilities, Chinese customers have started contesting the governance mode, e.g. by revolting against the internationally set standards. Chinese actors (e.g. WTMs, certification bodies, government agencies) increasingly aim at setting industrial standards themselves, and to develop own, indigenous turbine designs, and thereby to gain more ‘power’ in the value chain and govern it themselves. Overall, this indicates an ongoing power struggle for moving up the value chain, and for deeper and stronger integration into and control of GINs.

By breaking up the wind turbine industry, and zooming in on the component of software, the thesis contributes to the GIN-literature by illustrating how there can exist socio-technical barriers to GIN construction within relatively innovative and dynamic sub-sectors of the wind turbine industry, namely within the sub-sector of software. This is somewhat in contrast to Cooke (2013), who has illustrated that it is the most innovative and dynamic sub-sectors within the ICT-industry in Singapore that are most conducive to GIN construction, while the less dynamic and relatively *un*innovative sub-sector (of hard disk drives) is still dominated by a GPN with a few large dominating MNCs. Hereby, the thesis contributes to the GIN-literature by displaying that socio-technical mechanisms of exclusion may prevent even very innovate actors for becoming part of a GIN within the relatively innovative sub-sector of software within the wind turbine industry. On the other hand, the thesis also illustrates that *technology matters* for GIN-construction, and thereby confirms Cooke’s (2013) other argument that proposes that there can be vast differences in regard to GIN emergence between sub-sectors within the same industry. That is, a more fine-grained understanding of GIN genesis can be gained by disassembling the industry into its component parts, and dive into specific components. Lastly, these findings may furthermore feed into the stream of the GIN-literature which looks into the variety of industrial knowledge bases, and how their knowledge base determines the propensity with which firms engage in GINs or not (Herstad et al., 2013; Liu et al., 2013). That is, representing synthetic and thus relatively more ‘sticky’ knowledge, software, and the basic research it contains, seems less prone to certain types of GIN formation.

To reiterate, these findings contribute to the GIN-literature, by pointing to the necessity of breaking up industries into smaller sub-sectors, by ‘diving deeper’ and zooming in on particular component technologies, and the arduous work of constructing relations around them. When doing so, another more complex and blurred picture emerges, which illustrates the socio-material work of building and maintaining relations. The thesis therewith sheds light on the political, scientific, and technological controversies that different component technologies may produce in the developmental context of Chinese greening.

Overall, the thesis warns against assuming integration into GINs to be automatic and to be detected only based on an exogenous, formalistic, and structural lens 'from the outside'. Instead, the thesis suggests that a focus on the socio-material work of relationship-building and -maintenance is necessary, to capture the potential socio-technical barriers to and controversies of GIN-genesis, and to shed light on the quality, dynamics, and agency of relations. Thus, the construction of GINs cannot be taken for granted, but must be traced myopically 'from within', and including all the potential heterogeneous actors involved. One of the overarching findings of the thesis is the illustration of how GIN relations tend to unravel, as soon as they are being constituted. This is largely due to the negotiated relations, positions, roles, and identities.

Summing up, the thesis illustrates how the risk of barriers to GIN construction can be disruptive to the entire Chinese wind power market, as it jeopardises the overall framing of wind power as sustainable in comprehensive, 'developmental' terms, i.e. in terms of prospects for Scientific and Sustainable Development towards a Harmonious Socialist Society. In this way, the thesis indicates the entangled nature of market and GIN construction in Chinese wind power. Further, the findings shed light on seemingly contradictory dynamics of GIN construction in Chinese wind power. China's initial strategy of low costs and prices, which enabled the integration into and upgrading within the GVC, has over time induced extensive externalities (overflowing) in terms of e.g. poor quality and wasted energy. This threatens not only to destabilise the wind power market, but also to disrupt the emergent GIN relations between Chinese and foreign actors in Chinese wind power, as 'skewed' 'competitive spaces' have been constructed. For instance, weary, suspicious, and concerned with the Chinese pursuit of indigenous innovation (Breznitz and Murphree, 2011: 13), e.g. reflected in controversies over IPRs and international and domestic standards, foreign MNCs and component suppliers have left or are considering to scale down engagement in China and/or leaving the Chinese wind power market, as the state-supported low-cost focus has created an 'uneven' playing field (Interviews; energiwatch.dk, Jun. 10, 2013). Conversely, the current potential turn to quality taking place in Chinese wind power seems to change these skewed competitive dynamics, potentially creating a larger space for collaboration, and thereby potentially for more relational governance modes and/or GIN configurations. For instance, a collaborative space is gradually opening up for the Chinese and foreign actors to engage in mutual learning on the common challenge of finding the proper balance between price and quality, and in which calculative devices are gradually aligned. Paradoxically, however, while the Chinese political leadership seems to intervene to steer the wind power market towards more focus on quality, which can potentially keep foreign actors in the market, the simultaneous Chinese quest for indigenous innovation (e.g. by engaging in strategic games over IPRs and domestic standards) may at the same time destabilise the very GIN relations that it seeks to promote. This instability of GIN emergence is in many ways related to the constant urge of Chinese actors to push the boundaries of knowledge and technology acquisition and learning, as Chinese actors build new competencies and shift ambitions. This seemingly paradoxical strategy indicates that while GINs may be part of China's development strategy, China may even seek to move beyond GINs, i.e. to become entirely independent of GIN relations. Such dual-pronged strategy and ambition is likely contributing to the overly volatile and overflowing nature of GINs in Chinese wind power. In particular, this paradoxical nature of GIN construction as simultaneously collaborative and competitive, in the current qualification struggle of China's wind power market, has been illustrated in the case of GINs around software and the ongoing potential turn to quality. Depicting the paradoxical coexistence of collaboration and competition in the constitution of GINs in China's wind power market, the thesis displays the importance of inquiring into controversies in GIN construction, e.g. over IPRs, standards, money entangled in the Chinese 'system problem', as well as over cost and price calculations entangled in a Chinese pragmatics of green marketisation.

Work of containing overflows – qualifying the understanding of GIN *dynamics*

In addition to having provided insight into the genesis of and socio-material barriers to GIN genesis around software within Chinese wind power, the constructivist approach also qualifies the understanding of GIN *dynamics*. The analysis displays how the work on qualifying wind power as sustainable performs ongoing trials of strength and controversies, which de- and reconfigure relations in collaborative Sino-foreign networks (or what may be termed 'emerging 'GINs) around software on an ongoing basis. The thesis displays how 'pacifying' calculative tools (e.g. IPRs and standards) and processes of valuation and price-setting (e.g. through money, and cost and price calculations), and the framings they perform, are contested. The contested nature of framing processes and framing tools is linked to the inherently "incomplete and imperfect" nature of framings and to the "selective inclusions and exclusions" they produce (Callon and Çalişkan, 2010a: 8). As framings exclude, they tend to produce controversy and overflowing, as displayed throughout the analysis. Hereby, as the thesis sheds light on the overflowing nature of relations, the thesis points to the need to inquire into the socio-material work of framing/qualification and of containing overflowing.

The overflowing, volatile nature of dynamics of GIN-construction in Chinese wind power is intricately linked to the way in which roles, identities, positions, priorities, means, and strategies of the heterogeneous actors involved in the continuous assembling of GINs are constantly shifting. By inquiring into the shifting ontology of the constituting parts of the potentially emerging GIN, the ontology of the (potential) GIN is also considered variable. By opening up to a variable ontology (or even multiple ontologies) of actors and networks, the thesis argues that the black box of GINs can be opened, as it becomes possible to trace how different entities and the quality of relations, and the network they constitute, are being transformed over time. For instance, large WTMs in China's wind power market are constituted by multiple, heterogeneous, and transforming agendas, entangled in an unstable power sector and ambiguous and colliding ambitions of the political pole. Hereby, Chinese, often (partially) state-owned, WTMs are often intent on capturing core technologies from foreign firms in order to upgrade capabilities for indigenous innovation through collaborative means, as well as by pursuing a simultaneously competitive agenda. This produces contradictory dynamics of simultaneous collaboration and competition in the studied networks, which destabilise them. Adding to this ambiguity, actors in the Chinese wind power market often do not know their own end-goal or agendas, but experiment and grope forward, as the boundaries of learning are consistently pushed further. The thesis coins this China's consistent pushing of its own 'horizon of opportunity and potentiality'. Yet, such transformative ambitions render the identity and goals of its constituting parts unstable. In turn, this produces volatile GIN dynamics. Indeed, over and over again, when looking into emergent GIN relations, the analysis has displayed how relations often disintegrate, displaying a large degree of contingency in relations. The thesis hereby offers a story on GIN dynamics around software within Chinese wind power as a matter of contingent, disruptive emergence.

The ongoing negotiation of roles and positions in emerging GINs bears resemblance to what Herrigel (2010) has coined sustained contingent collaboration. That is, "role ambiguity and the need for suppliers and customers to continuously innovate and upgrade have given rise to what it [Herrigel] calls 'sustained contingent collaboration' (SCC) as the modal relation in supply chains" (Herrigel, 2010: 24)[92]. According to Herrigel, vertical disintegration in manufacturing has resulted in more unstable, complex customer-supplier relations (Herrigel,

[92] Based on an in-depth analysis of transformation of European and US automobile and machinery industries over the past thirty years, Herrigel inquires into processes of vertical disintegration in manufacturing and implications for customer-supplier relations (Herrigel, 2010)

2010: 141)[93]. This instability is evidenced in the lack of a clear role division between customers and suppliers over time, as well as of a stable division between design and production (Herrigel, 2010: 145). As global competition "creates unremitting pressures to innovate, while at the same time continuously reduce costs" (Herrigel, 2010: 24), Herrigel argues

"that relations in the disintegrated supply chain are extremely unstable, requiring suppliers and customers to play a broad array of potential roles. Moreover, which role(s) will be played and who will play them is typically unclear to all players ex ante. Governance problems, both at the level of production relations and the surrounding institutional context, are generated by this pervasive role ambiguity. Processes of recomposition in manufacturing are in many ways provoking recomposition of the entire architecture of political and economic relations in these societies" (Herrigel, 2010: 24).

In turn, the thesis may be argued to have illustrated the emergence of sustained contingent relations around software in China's emerging wind power market. These relations seem even more volatile and potentially self-disruptive than depicted in the existing literature due to the extensive role ambiguity detected in China's wind power market, where roles, identities, position, and relations are continuously contested and transformed.

Algorithms and their consequences – sensitisation to *agency*

Lastly, the thesis illustrates a highly active role of the Chinese political leadership in terms of moulding and shaping its own industries, and the wind power market in particular, as well as in moulding and directing the integration of the Chinese economy into GVCs, GPNs, and GINs. This renders the 'upgrading country' with a high degree of agency in the process of assembling networks. In addition, the thesis has displayed the highly variable ontology of actors. Apart from shifting ambitions and roles of Chinese WTMs, also seemingly mundane or 'innocent' artefacts such as algorithms, money, and cost and price calculations have been transformed from intermediaries without agency into actors/mediators (Latour, 2005a), as they produce diverse and politicised controversies, which in turn configure relations and the networks they come to constitute. Hereby, non-human actors such as algorithms have come to have consequences for GIN construction. Rather than assuming agency of spaces, scales, systems, structures, institutions, or hierarchies, the constructivist account contributes to the GIN literature by providing a lateral and symmetrical perspective of distributed agency (Doganova, 2009, Akrich et al., 2002), rendering potential agency to non-human actors.

[93] Herrigel lists five types of emerging original equipment manufacturer-supplier relations: (1) arm's length/spot market relation, (2) autocrative or captive supplier relations; (3), contract manufacturing, (4) relational contracting, and (5) sustained contingent collaboration (Herrigel, 2010: 145).

In addition, the thesis displays how emerging GINs, e.g. around software programmes may be able to acquire disruptive agency in terms of market construction. That is, the analysis has illustrated how the translation – or the failed translation – of a GIN around software in Chinese wind power can potentially destabilise the entire framing of wind power as sustainable. In this way, the thesis sensitises the GIN lens to how potentially emerging GINs, as co-constitutive elements of marketisation, may be disruptive to the very market they are co-constituting.

Rendering a high degree of agency to both human and non-human actors, and having illustrated a creative, agile, and experimental pragmatics of marketisation in Chinese wind power, the thesis illustrates how actors are not just constrained by embedding institutional contexts, but rather also co-shaping them, i.a. through creative construction of associations. To some extent, the thesis hereby corresponds with the lens of Herrigel (2010), who emphasises the agency of actors to manipulate, rearrange, discard, and ignore institutional contexts, engaging in 'creative action' and experimentation and pervasive re-composition, rather than being constrained by them (Herrigel, 2010: 8-9, 228-229). In turn, these ideas also bear a clear resemblance to constructivist notions of path creation instead of institutional path-dependence (Garud and Karnøe, 2001; Garud et al., 2010b; Karnøe and Garud, 2012), which smoothes out the distinction between agency and structure, "entertaining a relational perspective where agency emerges from interaction in sociotechnical action-nets" (Czarniawska, 2004 in Karnøe and Garud, 2012).

A second pragmatic move towards the notion of figuration

Having briefly summed up the contributions from a constructivist perspective to the GIN-literature in terms of genesis, dynamics, and agency, and pointing towards how the story offered in the thesis links to the notion of the paradoxical and somewhat counterintuitive notion of 'sustained contingent relations', the thesis arrives at a 'second pragmatist tunnel'. This has already been indicated above, as the introduction of Herrigel's (2010) relational perspective on unstable customer-supplier relations is founded in American pragmatist philosophy.

A second pragmatist tunnel is introduced in the last sections of the chapter due to the limitations encountered in the GIN framework in terms of providing a micro-processual account of genesis, dynamics, and agency, and in particular to account for the instability of GIN relations. As relations often unravel at the very moment of their constitution, it becomes difficult to even classify the investigated network as an irreversible GIN unity. This begs the question of whether the depicted network could be better captured as something else, as already indicated through the brief introduction of the notion of sustained contingent collaboration. Additionally, the adopted constructivist perspective has inadvertently also reached its own limits. That is, as the findings of the empirical analysis display a constant dynamic between framing and overflowing, a certain dialectics seems to emerge, inherently containing a dichotomous duality within it. To some extent, this seems to reconstruct the (false) distinction between genesis and structure, as well as to erode the very notion of overflowing. That is, as overflowing seems to become ubiquitous, deriving from a variety of different sources, the notion of overflowing in the thesis has, to some extent, become empty. In this way, the ANT language can be claimed to contain within it a paradoxical tendency to ascribe more or less 'blindly' to a new type of (theorised) generalisation despite its pragmatist 'modest sociology' and inherent quest to avoid "'higher' philosophical truths" (du Gay, 2010: 178) that are central to more positivist causal explanations typical of i.a. the GIN-literature. In this way, although favouring a lens of empiricist particularity, the constructivist account that emerges from the analysis is one which inadvertently risks to subscribe to generalisations of ubiquitous performativity and translation, as well as to a dialectics of framing/overflowing (du Gay, 2010: 177; Whittle and Spicer, 2008).

Simultaneously with admitting to the limits of the ANT-language, the thesis at the same time aims to look for potential avenues for synthesising the relational constructivist perspective with more structural perspectives (which is to be discussed in *Chapter 15* in particular). Further, this links up with how the thesis subscribes both to the principle of empiricist *modest method* as well as to an ambition of discussing potential wider implications of the empirical findings, and maybe even so more than conventionally made possible through a constructivist perspective. Consequently, having pointed to gaps both in the GIN- and constructivist perspectives, the thesis in the following sets out in an exploration of whether and how the pragmatism of Elias's figurational sociology (2006 [1969]; 1978) can help shed new light on the findings, by discussing the potential turn to quality in Chinese wind power.

Introducing the pragmatist lens of Elias's figurational sociology

> *"We say, 'The wind is blowing', as if the wind were actually a thing at rest which, at a given point in time, begins to move and blow. We speak as if the wind were separate from its blowing, as if a wind could exist which did not blow" (Elias, 1978: 112)*

With the aim of potentially finding larger 'patterns' than the constructivist approach normally allows, and in order to overcome the inherent dualism of the framing-overflowing dialectic, as well as to overcome the limitations of the GIN approach in terms of disregarding micro-dynamics and ‘the relational’, the rest of the chapter looks into whether and how the findings might be captured through the metaphor of figuration. As the analytical tools of ANT tend to ’overflow’ themselves, Elias’s figurational sociology may be helpful, as it renders a non-dualistic, intendedly paradoxical lens[94] (Stacey, 2003: 295, 296), with key words being interdependency, power and process (Brandtstädter, 2003: 92). Developed in order to inquire into the ‘civilising process’ in Europe between the years 1400 and 1800 (Elias, 1978 in Law, 1994), and to overcome the gap between individual and society, the notion of figuration seeks to account for a “’web of interdependences formed among human beings and which connects them: that is to say, a structure of mutually oriented and dependent persons’” (Elias cited in Quintaneiro, 2006: 3-4). Further, Elias’s figurational sociology aligns itself with constructivist perspectives, in that it offers a symmetrical analysis in terms of “treat[ing] size as a product or an effect, a process worth studying in its own right rather than something given in the order of things” (Law, 1994: 11). Sharing an interest in process, the relational, the symmetrical, and the entangledness of individual and society, the constructivist ANT lens and pragmatist philosophy of Elias are closely related, even though the latter does not explicitly take into account the potential agency of non-human actors.

A lens of paradoxical transformation and figurational games

Elias not only defies the division between individual and society, but also between change and stability, instead rendering a lens of permanent, paradoxical transformation (Quintaneiro, 2006: 2) neither planned or intended, nor the result of unstructured changes. Through this processual and relational lens, it becomes impossible to speak of the wind as blowing ”as if the wind was separate from its blowing [and a] wind could exist which did not blow” (Elias, 1978: 112). Additionally, although people may act in intentional, planned ways in local situations, the global, long-term consequences of these individual actions cannot be foreseen, as they only emerge gradually (Stacey, 2003: 299), over time giving ‘‘rise to changes and patterns that no individual person has planned or created. From this interdependence of people arise an order sui generis, an order more compelling and stronger than the will and reason of the individual people composing it” (Elias cited in Stacey, 2003: 299). In this way, self-organisation and emergence form an ”essentially paradoxical process in which individuals form groups while being formed by them at the same time”,

[94] Largely set up in opposition to Kantian dialectics, but with inspiration from Hegel’s dialectic, where ”one thinks of the individual and the social in much the same way” (Stacey, 2003: 295-296).

”constructing the future as continuity and transformation” (Stacey, 2003: 299). This ”transformative process” constitutes a new unity, a new dynamic,

”in which stability is always found in instability and vice versa. New meaning emerges in the tension of opposites and the paradox remains. Indeed the paradox is the source of the new meaning. The ’edge of chaos’ is also a concept of a dynamic characterised by stability and instability at the same time. In all of these cases there is no notion of moving from stability to instability and back again – the opposition of stability and instability is always present at the same time” (Stacey, 2003: 296).

The notion of figuration and unplanned change is at the same time closely linked to the notion of strategic ’games’ and to power. Expressing the ”complex chain of interdependencies and power relationships that constitute the real stuff of social reality” (Layder, 1986: 370), the constitution of figurations can be likened to games. Through this lens, as players engage in the game, with more players making it more complex (Layder, 1986: 370), a game process emerges, which ”none of the individual players has planned, determined or anticipated’” (Elias, 1978: 131 in Layder, 1986: 370). Despite being unplanned and not immediately controllable,

”the overall process of development of a society is not in the least incomprehensible. There are no ’mysterious’ social forces behind it. It is a question of the consequences flowing from the intermeshing of the actions of numerous people…As the moves of interdependent players intertwine, no single player nor any group of players acting alone can determine the course of the game no matter how powerful they may be…It involves a partly self-regulating change in a partly self-organizing and self-reproducing figuration of interdependent people, whole processes tending in a certain direction” (Elias cited in Stacey, 2003: 298).

In turn, figurations and their strategic games can produce competitive tensions. Thus, ”[b]y a ’whole’ [of the notion of ’society’] we generally mean something more or less harmonious. But the social life of human beings is full of contradictions, tensions and explosions” (Elias cited in Stacey, 2003: 297). The configuration of ”[s]ocial figurations of power” (Brandtstädter, 2003: 87) directs attention towards ”the processual nature of figurations; to the ever-changing balances of power within complex and interweaving sets of interdependencies” (Layder, 1986: 371). Hereby, ”[a]t the core of changing figurations – indeed the very hub of the figuration process – is a fluctuating tensile equilibrium, a balance of power moving to and fro, inclining first to one side and then to the other. This kind of fluctuating balance of power is a structural characteristic of the flow of every figuration” (Elias, 1978: 131 in Layder, 1986: 371).

Elias’s notion of figuration may be used as a pragmatic means to understanding the larger pattern of GIN construction in the construction of a Chinese wind power market and the de- and reconfiguration of new strategic games. In the following, the chapter looks into how and whether the qualitative reconfiguring of China's wind power market may be captured through the notion of figuration and reconfigurative games.

Moving from figuration I to figuration II – and transformative reconfigurative games?

The Chinese wind power market may be seen as a reconfigurative game from one figuration to another, as well as a move from one strategic game to another. That is, the thesis has pointed to a potential turn to quality. Overall, China's emerging wind power market can be seen as undergoing a transformation from what may be termed *figuration I* of quantity and low costs towards an emerging *figuration II* with higher focus on quality. As *figuration I* has led to self-disruptive forces of overflowing (i.e. 'defeating itself' through low-quality turbines), the thesis has displayed what may be termed unplanned or unintended effects. At the same time, the analysis has offered an account of the transformative and somewhat paradoxical process of de- and reconfiguring relations, in processes of simultaneous competition and cooperation between Chinese and foreign actors. Moving from the old 'platform' of ordering (*figuration I*) towards a new one has fostered a reconfigurative game, in which control systems and simulation tools and their black-boxed algorithms have entered the stage as central actors and have become highly controversial, politicised entities. This has ignited a reconfigurative game, which is transforming the quality of relations, and making them overly unstable.

The instability and overflowing is largely deriving from the coexistence of multiple agendas and strategies (some explicit and conscious, some not), or what Herrigel (2010) refers to as role ambiguity and the configuration of sustained contingent collaboration. As policies and the dynamics of the figurative game have changed over time, a radical, non-linear, as well as largely unplanned and non-path-dependent transformational change has taken place. In this change, algorithms and quality, as well as IPRs and standards, money, price and cost calculations have become critical actors, which perform intensive trials of strength. Attempts at moving from one figuration to another may be seen as an attempt to break free from unplanned effects ('overflowing') of *Figuration I*'s 'upgrading as upscaling' (i.e. upscaling production volumes through numerical targets of GW), which to some extent may be claimed to have resulted in 'upscaling as downgrading' instead, as manufacturers have engaged in degrading quality. Pursuing a strategy of tempo, volume, and cost (Nahm and Steinfeld, 2013/forthcoming: 30), China has enabled rapid quantitative growth, yet, has produced extensive overflowing effects from the resulting poor quality. This has produced the paradoxical effect of China 'fighting against its own wind turbines'.

As *Figuration II* emerges, a new ambiguous reconfigurative game takes place, e.g. over IPRs and standards, money, and cost and price calculations, and in the words of the analysis, struggles over the pacifications of goods and price-setting. In this emerging game, quality (e.g. 'algorithmic quality') has become increasingly central. That is, in the formative years of the wind power market, policies on wind power have been deliberately 'open' for interpretation, allowing for local, fragmented experimentation. Over time, as unlimited growth led to overflowing, approval of wind farms has been centralised, reflecting a gradual move towards higher emphasis on quality, which is also reflected in recent attempts at introducing new targets and standards, e.g. with indications of higher emphasis on generated electricity (GWh) (Bloomberg, 2012). With increasing capabilities and levels of (e.g. technical) knowledge of Chinese actors, quantitative targets and technological ambitions have likewise been flexibly adapted. As these 'ambiguous winds of change' blow in China's wind power market, algorithms have emerged as critical actors, and producing multiple power struggles between Chinese and foreign actors.

The thesis points to how Elias's pragmatist philosophy can help illuminate the specific type of "order(ing)", however self-disruptive and chaotic, arising "in specific dynamics of social interweaving in particular places at particular times" (Stacey, 2003: 299). Elias's theory has already been linked to an ethnographic approach and 'taken to China' (Brandtstädter, 2003: 88). Indeed, China constitutes an interesting case for anthropologically inspired constructivist studies, inquiring into figurations of power "for a political anthropology of institutional emergence" (Brandtstädter, 2003: 87). By combining the constructivist account of the genesis of the wind power market in China (e.g. insisting on the potential agency of non-human actors) with Elias's figurational sociology, a larger picture of a particular kind of emerging (and constantly transformative) 'order(ing)' (or 'figurational game') can arguably be rendered, while retaining the situational and specific.

GIN construction as part of a complex 'Chinese figuration'

Having pointed to the reconfigurative game(s) and qualitative change taking place in the figuration during the qualification struggle of China's wind power market, the thesis illustrates larger complexity and more games than envisioned by the functionalistic, institutional, structuralist, systemic, and hierarchical imaginary of the GIN framework and of economic geography. To account for the transformational dynamics of China during processes of globalisation, the thesis suggests that rather than being 'seduced' by the GIN metaphor and letting it steer the inquiry, GIN analyses can benefit from 'diving deeper' and zooming in on the micro-relational in an inquiry into GIN genesis, dynamics, and agency.

Additionally, GIN construction in Chinese wind power may even be seen as part and parcel of transformative processes of China, which in itself may be treated as a complex figuration. That is, entangled in the two simultaneous, but contradictory forces of national "community economies" and "global interdependent markets" (Callon and Çalişkan, 2010a: 42, 43), respectively, and undergoing a so-called capitalist transition, China sits amidst hybrid and paradoxical forces of simultaneous collaboration and competition.

The analysis has illustrated how the Chinese political leadership and the Chinese wind turbine industry has displayed creative, agile, and disruptive moves of upgrading, where 'fragmented' marketisation characterised by local experimentation along with centralised control has moved in tandem. In this particular Chinese 'figuration', new structures tend to be dissolved or reconfigured by new radical interventions (or by radical neglect of intervention) by the Chinese political leadership, before they add up to complementary, stabilised structures. This produces an overly self-disruptive rather than reproductive figuration in China, enabling actors to 'break the waves', and at times even resulting in what may be likened to Schumpeterian (1934) creative destruction. Overall, the thesis has in the above inquired into how a coupling of a pragmatist and constructivist account, through their common 'micro'-relational roots, together can help move beyond structural and functionalistic accounts.

GIN construction in China as games of reconfiguration?

As contradictory forces of integration into GINs along with a perceived need for national protectionism engender simultaneous, contradictory multiple games of competition and cooperation, and as ambitions and roles of actors are consistently negotiated, relations have become overly complex and difficult to manage e.g. through conventional means of contracting. This can be argued to render GIN construction in China a constant reconfigurative game. Indeed, a key characteristic of GIN construction in Chinese wind power is the very multiplicity of simultaneous and often contradictory (and unconscious) matters of concerns, issues, strategies, and agendas. This renders the figuration and reconfigurative games highly volatile.

Overall, to account for these particularly disruptive characteristics of the Chinese configuration, reflecting ambiguous 'winds of change', the thesis suggests that there may be grounds for cross-fertilising figurational sociology with the constructivist perspective, set into a developmental context of China. That is, whereas Elias's figurational sociology has offered a picture of a larger pattern than that of myriads of overflows, the constructivist perspective contributes to figurational sociology by displaying the *multiplicity* of simultaneous directions, games, and conflicting identities and roles, which complicate the strategic games further. Herrigel's (2010) notion of sustained contingent collaboration bridges these different accounts. In addition, the constructivist account adds to the pragmatist accounts of Elias (1978) and Herrigel (2010), by illustrating how not only human and 'social' forces and actors play a role, but also how non-human actors may 'come to have consequences'. Further, the thesis points to the benefits of adopting an ethnographically inspired constructivist approach, in order to trace how Chinese actors in specific sites and at specific times are able to requalify themselves, constantly engaging in transformative reconfigurative games, and engaging in 'creative action' (Herrigel, 2010).

By synthesising the constructivist perspective of ANT with figurational sociology (Elias, 1978) and Herrigel's notion of sustained, contingent collaboration (2010), it becomes evident how not only one game is taking place, but multiple simultaneous games alongside the global disintegration of manufacturing. Such a lens fosters a more open-ended approach than what the GIN lens conventionally offers. Indeed, the Chinese experimental way of policy-making and the seemingly high agility and resilience in terms of China's ability at self-correction, as well as the intricate linkages between top-down and bottom-up processes, offer a promise of a potential for China to transform and *'reconfigure'* its own figuration, as it constructs new games through the construction of associations. Through such associational moves, China may be able to 'break the waves', instead of 'fighting against (its own) windmills'.

Lastly, by diving into marketisation in Chinese wind power, and exploring GIN genesis, dynamics, and agency, the thesis contributes to the constructivist perspective by shedding light on a particular experimental Chinese pragmatics of green marketisation, in which Sino-foreign collaborations play a critical role in the qualification of the emerging market as sustainable. In this way, the thesis draws on but also critically adapts the GIN literature, which thereby allows for a contribution to the literature by the very coupling of the different perspectives.

Life lurking in the magmatic spaces between order and disorder

The thesis has inquired into the labile, 'magmatic space' of controversy at the "boundaries between order and disorder, or where different orders rub up against one another" (Serres 1974 in Law, 2009: 144). The thesis displays how multiple ontologies of the investigated emerging GIN and its constituting parts has followed and construed its own figurational ‘logic’ of strategic games. These multiple realities and games ”*may* dovetail, but equally they may be held apart, contradict, or include one another in complex ways” (paraphrasing Serres, in Law, 2009: 152). Demonstrating some of the fissures, fractures and gaps, i.e. how “’life lurks in the interstices” (Whitehead 1978: 105 in Fraser, 2010: 74) between order and disorder, the thesis has engaged in an inquiry into how GINs emerge, are activated, and how they are made durable, i.e., diving into how the first act has come to be performed in this particular way, rather than starting out with the second act (Powell et al., 2012). With this final open-ended note on the scientific journey (cf. *Chapter* 4) of the inquiry, the thesis proceeds with a conclusion in *Chapter 14.*

Chapter 14. Concluding the Inquiry

Chapter 14 provides a conclusion to the dually motivated research question that has guided the inquiry. First, a conclusion to the *empirical research question* is rendered, i.e.:

How may a 'turn to quality' in Chinese wind power - reflecting a Chinese mode of green market construction - be de- and reconfiguring relations between Chinese and foreign actors around software?

Upon unprecedented growth rates of the Chinese wind power market, China's wind power market is today the world's largest in terms of accumulative installed wind power capacity. Yet, the Chinese wind power market increasingly faces severe quality issues. These quality issues are i.a. a result of an extensive focus on high-speed growth in installed capacity through an emphasis on quantity and low prices of wind turbine installations, rather than on quality, generated electricity, or lifetime generating costs. As associations of low quality and low-performing wind turbines to Chinese wind turbines have had detrimental implications for the reputation of Chinese wind turbines, an ongoing struggle for qualifying Chinese wind power as a sustainable, renewable energy power source is taking place. The thesis illustrates how a so-called potential 'turn to quality' is emerging in China's emerging wind power market. This potential, yet ambiguous, turn to quality is i.a. reflected in the gradual centralisation of wind farm approvals, the raising of technical standards, and trends towards a focus on generated electricity (GWh) rather than pure wind power capacity (GW). While the development of a Chinese wind power market by the Chinese political leadership has been construed as a means of Scientific Development to obtain China's Sustainable Development and an economically, socially, and environmentally Harmonious Socialist Society, the quality crisis has destabilised the comprehensive framing of wind power as 'sustainable'.

In the ongoing qualification struggle of the Chinese wind power market, the development and upgrading of indigenous core technologies such as software tools have increasingly been constituted as critical. However, largely founded on a background in foreign licenses and technology transfer as well as on collaborations with foreign companies, the Chinese wind power market is to a large extent still reliant on advanced foreign technologies and designs. That is, although having upgraded rapidly in numerous component technologies, when it comes to indigenous development of critical, advanced software programmes used, for instance, as in the case of this inquiry, in the wind turbine's main control and in simulation tools for turbine design, the Chinese wind power market is still dependent on foreign technologies as well as on engagement in diverse Sino-foreign collaborations. The thesis traces the socio-material translation of heterogeneous actors into Sino-foreign collaborations around software programmes, in the process of qualifying wind power as e.g. technically, scientifically, economically, politically, and environmentally 'sustainable'. Engaging in an ethnographic inquiry into the marketisation of wind power, the thesis maps how entangled controversies consistently unfold over the qualification of wind power. This mapping is done by tracing controversies over IPRs, standards, and money, as well as over price and cost calculations in these collaborations. Thus, by mapping controversies over the pacification of the emerging good of wind power, as well as over price-setting, the thesis illustrates how framing processes, and the framing tools employed, have engendered conflict and trials of strength between Chinese and foreign actors in Chinese wind power. This renders an account of marketisation in Chinese wind power as consistently overflowing, and as ripe with controversy. The inherent instability of the wind power market is in turn linked to how the marketisation of wind power market is entangled in a controversy over China's so-called 'system problem', which is largely constituted by state-owned and –controlled actors in China's power sector and part and parcel of China's iterative processes of corporate restructuring of its industrial system during 'capitalist transition'. Further, the mapped controversies over the pacification of goods and price-setting are in turn entangled in an overarching controversy over the very sustainability of China's experimental mode of constructing a 'green' market, and what the thesis dubs a specific Chinese fragmented and experimental 'pragmatics of green marketisation'. In this way, the thesis illustrates a potentially particular Chinese mode of green marketisation, which i.a. is characterised by trial-and-error and 'fragmented authoritarianism', which, besides the conflicts between Chinese and foreign actors, also produces ongoing struggles between central and local Chinese governments as well as between wind power and fossil fuels.

The thesis depicts the seemingly paradoxical way in which China seems to be 'fighting against its own windmills', as it has produced potentially self-disruptive overflowing, which e.g. threatens to produce socio-material lock-in into fossil fuels. Yet, while the Chinese pragmatics of green marketisation seems to engender disruptive conflict and overflowing, undermining the Sino-foreign collaborations that it relies on, it has also resulted in the rapid and unprecedented growth of a Chinese wind power market, and the rapid build-up of capabilities, as well as in potentially enabling an agile turn to quality in time to restabilise the framing of wind power as sustainable. Hereby, the bricolage-like mode of designing and experimenting green markets seems to be resilient. A quality turn seems to be taking place, although slowly and ambiguously, incrementally transforming the ‘competitive spaces’ between Chinese and foreign actors out of which emerge more ‘collaborative spaces’, e.g. as calculative tools on costs and prices of Chinese and foreign actors are gradually aligned. Overall, the thesis displays how the potential turn to quality has de- and reconfigured relations, placing core technologies such as software and their algorithms at centre-stage in ongoing trials of strength over relative positions, roles, and identities in networks around particular component technologies. In this way, the thesis also illustrates how non-human actors can acquire agency, as they de- and reconfigure relations and the networks they constitute.

Illustrating a high degree of instability of the wind power market, and of collaborative networks around software, since the identity, role, and positioning of actors are debated and contested, the thesis renders an account of a highly variable ontology of actors in the Chinese wind power market, and where governance modes are transformed. This is largely due to the way in which Chinese actors consistently push the ‘horizon of possibility and potentiality’, as they upgrade. Not necessarily knowing the final goal at the outset, Chinese actors are moving impatiently forward, transforming and negotiating their role, identity, relations, and ontology. In this way, the particular TENs have produced a certain type of agency, which is largely of a self-disruptive, and yet resilient nature.

Overall, the thesis outlines how framing processes and the employment of calculative framing devices, such as IPRs, standards, as well as processes of price-setting and valuation, e.g. involving money and cost and price calculations, are contested in the qualification struggle of wind power as ‘sustainable’. This sometimes renders calculative framing devices with agency, resulting in complex dynamics of overflowing, which de- and reconfigure relations in what may constitute highly volatile, yet sustained, contingent relations. Summing up, the thesis indirectly, i.e. through a marketisation account, points to the potential emergence of international networks of collaboration around critical core components and to the role of these in the marketisation of wind power in China.

In addition to having provided a conclusion to the empirically motivated research question, the thesis has provided a conclusion to the *meta-theoretical research question,* namely:

As the GIN literature generally does not pay much attention to the question of genesis, dynamics, or agency, how may a constructivist perspective qualify the understanding of GIN genesis, dynamics, and agency in a Chinese developmental context?

While the GIN-literature has detected GINs in China's wind turbine industry, the thesis is interested in *how* these GINs have emerged, in order to understand their potential role in the qualification of wind power as sustainable and in processes of green marketisation in a developmental context. Yet, displaying how the GIN-literature's rather positivistic, structuralistic, and formalistic perspective does not put emphasis on how relations are construed or maintained, but instead tends to look at GINs after the fact (as results and formal structures), the thesis proposes that a constructivist marketisation perspective may be better suited to trace issues of GIN genesis, dynamics, and agency. Treating GIN construction as part and parcel of the qualification of China's wind power market as sustainable, the thesis adopts a constructivist and relational marketisation perspective. Further, the thesis fundamentally reconceptualises GINs, namely 'diving deeper' into socio-material processes of GIN-construction by looking at potential GINs around one critical component of the wind turbine, i.e., software, instead of detecting multiple GINs (constituted largely by WTMs and their global R&D-networks, and embedded within institutional contexts) within the entire wind turbine industry. Although not adopting the traditional GIN-metaphor, but instead paradoxically 'looking away' from GINs to inquire into their potential construction, the thesis argues that the thesis contributes to the GIN-literature by illustrating the multiple controversies that GIN-construction engender, and some of the potential socio-material barriers to GIN-construction.

Thus, while the existing literature has illustrated the emergence of GINs in Chinese wind power, the thesis illustrates that by diving deeper, into one particular and critical core component, and into the construction of associations in processes of relationship-building, there is no detectable stabilised GIN to be found. Instead, although GIN-relations are taking shape around control systems and simulation tools, relations tend to unravel as soon as they are constructed due to controversies over e.g. IPR, standards, money, and cost and price calculations. Further, knowledge and technologies around software tends to be commodified, implying that the detected networks still largely remain part of conventional value chains in customer-supplier relationships. Nevertheless, relations are taking shape with more mutual knowledge sharing. However, these relations are volatile, e.g. as the collaborations are characterised by simultaneous competitive dynamics. Further, while the Chinese political leadership promotes Sino-foreign collaborations on technologies and innovation, it also strives towards independence from foreign technologies. This produces ambiguous collaborations characterised by simultaneous collaboration and competition. Overall, the thesis illustrates that GIN construction is not automatic.

On this basis, the thesis argues that the GIN-literature can benefit from decomposing industries into component technologies. This can render a more fine-grained understanding of potential barriers to GIN construction and potential differences within industries in regard to GIN construction. That is, through in-depth micro-studies, and by disassembling the wind turbine, the thesis illustrates how technology matters. Further, the thesis illustrates what may be gained from a processual and relational constructivist perspective, namely sensitising our understanding of how GINs can be part and parcel of socio-material construction of markets. The thesis thus contributes by displaying how non-human actors such as specific component technologies and algorithms can have disruptive agency on the entire constitution of GIN relations and on entangled processes of market construction, as well as how China as an emerging economy is actively shaping its development and upgrading. The volatile and self-disruptive dynamics depicted in terms of GIN genesis is linked to the rapidly shifting agendas and ambitions of Chinese actors, which renders relations contestable. Further, China may even attempt to move beyond GINs within Chinese wind power. This is e.g. seen in the introduction of domestic Chinese standards, which displays how Chinese actors seek to shape and mould governance of relations themselves. Further, the pursuit of indigenous innovation paradoxically seems to disrupt potential GIN-emergence. Overall, the highly volatile nature of GINs in Chinese wind power points to how the GIN-literature can benefit from making more ethnographically inspired studies into micro-processes and relations, and from looking into GINs within a specific context.

Displaying how the constructivist approach renders insights into genesis, dynamics, and agency of GINs, the thesis points not only to the limitations of the GIN-literature, but also of the ANT vocabulary. Due to the constant dialectics between framing and overflowing, which emerges from the findings of the analysis, the notion of overflowing tends to 'overflow' itself. As the thesis simultaneously aims at identifying larger patterns of GIN construction in China, a 'pragmatist move' is made through the use of Elias's figurational sociology. Hereby, the thesis renders an alternative understanding of the Chinese wind power market, namely, not so much as a GIN, but how and whether it may be captured as a *figuration*. With the notion of *figuration*, the thesis points to how the findings of the analysis display a gradual move from *figuration I* to *figuration II,* namely from a focus on speedy low cost-production towards a focus on quality. In this move towards *figuration II,* a new strategic and more complex game between Chinese and foreign actors is emerging, in which dynamics of collaboration and competition coexist. In these paradoxical relations of *figuration II*, software programmes have become centre-stage of contestation. The socio-material resistance to obtaining access to algorithms has produced an intense power struggle and multiple matters of concern for e.g. indigenous innovation, leapfrogging, and catch-up. The emerging figuration of GIN construction in China is one which contains contradictory self-disruptive dynamics, due to the experimentalist and gradualist trial and error approach of constructing new green industries. This renders the wind power figuration in China highly resilient to overflowing. This provides an open-ended account in terms of China's possibilities for upgrading, market construction, and for GIN construction. Having concluded on the research question, the final *Chapter 15* presents a discussion on wider implications for related literature streams, an outline for future research, as well as offering reflexive perspectives on the delimitations and (ontological) 'politics' of the thesis.

Chapter 15. Future Research, Wider Implications, and Reflexive Critique

”Where there is an end, there is a beginning” (Deleuze and Guattari (2011 [1980]), “RHIZOME”)

After discussing and concluding on the research question, i.a. regarding its contributions to the GIN literature through a constructivist marketisation perspective, which has been enabled by so-called pragmatist tunnels, *Chapter 15* inquires further into how the findings of the thesis also resonate with a number of other audiences. Based on an account of the wider implications for related literatures, the chapter also introduces a tentative new research agenda for studying GIN and market construction in a developmental context (of China) for New Economic Sociology. The chapter concludes by engaging in a reflexive critique of the findings.

Wider implications

In the following section, wider implications for selected affiliated literature streams are presented. These include contributions to the China literature, and to structural and hierarchical accounts of the Varieties of Capitalism lens and the GVC literature. This leads to a discussion of implications for the upgrading and industrial policy literature within a developmental context.

A story of bricolage, fragmented authoritarianism, and structured uncertainty?

The thesis has provided a story on GIN construction as part of green marketisation, not in general, but explicitly as a situational study of China in an era of global disintegration of production and innovation activities. Apart from contributions to the GIN literature, the thesis can hereby also inform the China literature. In particular, the findings of the thesis resonate with other studies on China’s experimental, ’adaptive governance’ (Heilmann and Perry, 2011; Heilmann, 2011), which confirm that China pragmatically ‘gropes for the stones under-foot while crossing the river’ (Goldstein, 1996; Breznitz and Murphree, 2011: 48), i.a. in its gradualist capitalist transition and industrial policy.

In the analysis, the Chinese seemingly piecemeal and pragmatic mode of marketisation, in China’s gradual attempt at performing a turn to quality, was dubbed a ‘particular fragmented and experimental Chinese pragmatics of green marketisation’. This pragmatics of green marketisation was e.g. reflected in the constant oscillation between centralisation and decentralisation and in the gradual shift from GW targets to include targets for generated electricity (GWh). In a constructivist perspective, this can be claimed to reflect a bricolage-like way of marketisation, engaging in simultaneous *designing* and *experimenting*, as the market is constructed based on both top-down and bottom-up creative, agnostic processes (Callon, 2009). Hereby, the thesis is concerned with a "condition that has received insufficient scholarly attention in China-studies" (Breznitz and Murphree, 2011: 34), namely, that "while responsibility has been delegated to the provinces, the center firmly retains control over major institutional and technological features crucial to the development of high-technology industry" (Breznitz and Murphree, 2011: 34).

While this issue might still deserve further scholarly attention, different China-scholars have already looked into the issue of an agile oscillation between centralisation and decentralisation in China through the lens of 'fragmented authoritarianism' (Lieberthal, 2004(1995); Mertha, 2009), and related notions of experimentation under hierarchy (Heilmann, 2008: 29) and structured uncertainty (Breznitz and Murphree, 2011; Breznitz and Murphree, 2013). As also indicated in the analysis (*Chapter 12*), fragmented authoritarianism is closely coupled to China's 'matrix muddle' of geographically and bureaucratically segregated governance structures, which creates a large space for political bargaining (Lieberthal, 2004(1995); Mertha, 2009), which was e.g. seen in regard to the bargaining between wind power and fossil fuels. In a newly published article on the development of wind power in China (Korsnes, 2014), the authoritative, yet responsive and flexible quality of China's leadership has recently been linked directly to wind power, marking a Chinese policy of flexibility, institutional adaptability, and resilience (Korsnes, 2014). Indeed, the China literature is generally concerned with the particular adaptive, agile, pragmatic, and experimental governance mode of China's political leadership (e.g. Heilmann, 2005; 2008; 2009; 2011; Nahm and Steinfeld, 2012; 2013/forthcoming; Breznitz and Murphree, 2011). As was hinted at in the analysis (*Chapter 12*), China's political leadership has been inspired directly by the (democratic) pragmatism coined by the American pragmatist John Dewey (cf. Wang, 2007), whose thoughts on experimentation, as "guided by intentional anticipation instead of being blind trial and error", was picked up by Chinese leaders such as Mao with great enthusiasm (Heilmann, 2008: 18). Whilst Dewey argued for the virtue of intentional anticipation, he also argued for the "legitimacy of decentralized experimentation" (Heilmann, 2008: 2) with an emphasis on learning through direct practical experience (Heilmann, 2008: 19). The pragmatic legitimacy of decentralised experimentation in China is e.g. reflected in loosely defined policy goals. For instance, while the “official goals of the CCP and its ongoing reforms are ‘scientific development’ and the creation of a ‘harmonious society’ […] the exact definition of these goals is uncertain; interpretations range from simple social stability to comprehensive redistributive justice” (Breznitz and Murphree, 2011: 48), as well as an increased focus on the environment (Christensen, 2013; Fan, 2006).

Wind power in China as a case of a specific form(s) of capitalism(s)

The specific experimentalist mode of governance identified in China also resonates with the China-related literature, which is based on the Varieties of Capitalism (VoC) paradigm of (institutional) comparative political economy (e.g. Hall and Soskice, 2001; McNally, 2007; Witt, 2010; Hall and Gingerich, 2009; Hall and Thelen, 2009). In addition, it resonates with VoC affiliated literatures on business systems, which adopt a more sociological (and sometimes East Asian) focus[95], as well as with the more recent variant of variegated capitalism (e.g. Peck and Theodore, 2007; Zhang and Peck, 2014; Peck and Zhang, 2013; Fligstein and Zhang, 2010), which seeks to account for multiple forms of capitalism(s) within China’s national borders. As regards the VoC literature, it is assumed that institutional complementarities across political-economic realms can create an institutional comparative advantage (Hall and Soskice, 2001). Hall and Soskice (2001) develop two ideal types of liberal market economies (LME) and coordinated market economies (CME) respectively (Hall and Soskice, 2001). Based on an inherent logic of institutional complementarities between political-economic realms[96], the VoC literature argues that intermediate positions between CMEs and LMEs are less viable, “as a combination of institutional complementarities and competitive synergies would tend to drive national capitalisms towards one or other of the two poles” (Zhang and Peck, 2014: 3). That is, “nations with a particular type of coordination in one sphere of the economy should tend to develop complementary practices in other spheres as well” (Hall and Soskice, 2001: 17), resulting in national-level differences between CMEs and LMEs.

The firm-centric and transaction cost-based VoC theory seeks to explain institutional variety across countries, and was developed and employed for analysing *developed* OECD countries (Hall and Soskice, 2001). Yet, as interest has gradually grown for characterising non-OECD countries, and emerging ‘transition’ economies such as China, the VoC framework has

[95] Looking into corporate governance and emphasising the role of politics and the state (e.g. Carney and Witt, 2013: 3; Whitley 1992; 1999; Redding and Witt, 2006, 2008, 2009, 2010).
[96] Corporate structure, financial system, education and training regime, industrial relations, and inter-firm relations (Hall and Soskice, 2001: 6-7)

proved problematic. That is, China is often characterised as an ‘odd case’ “off the grid” (Zhang and Peck, 2014: 3) of the binary LME-CME dichotomy. This has resulted in VoC studies sometimes reaching diverging conclusions as regards the type of China’s national VoC. For instance, Witt (2010) has adopted the VoC framework, concluding that China constitutes a quasi-LME (Witt, 2010), while Fligstein and Zhang (2011) conversely conclude that China’s capitalism is an awkward kind of CME (Fligstein and Zhang, 2011). Other studies treat China as a *hybrid* on the transition path towards the Western-biased notions of capitalism of the VoC framework, as it “engages in a general pattern of *hybridisation* where institutions transferred from other contexts are adapted and reconfigured to China’s existing institutional structure” (Redding and Witt, 2009: 390). Lastly, others have left such grand theorisations and instead claim that China constitute a case *sui generis* (e.g. McNally, 2007), e.g. as China’s emergent type of capitalism displays three salient institutional features, namely East Asian state-led capitalism, network/guanxi capitalism, and new global capitalism (McNally, 2007: 176-196). Dissatisfied with these approaches, which seek to accommodate China to a Western-biased framework, the emerging literature stream of ‘variegated capitalism’ (Peck and Theodore, 2007; Jessop, 2011) seeks to account for the “pertinent sources and dimensions of variation *within and beyond this national model”,* e.g. due to “regional ‘subformations’ of capitalism and their (constitutive) extra-local connections” (Zhang and Peck, 2014: 7). In this way allowing for the patterned heterogeneity of the Chinese model of capitalism (Zhang and Peck, 2014: 7), the literature stream of variegated capitalism privileges “the relational analysis of unevenly developed multi-scalar and polymorphic capitalism over the search for institutionally stabilized ‘system integrity’ at the national scale, and hold elements of connectivity and commonality *across* capitalism(s) in creative tension with the search for geographical divergence and difference” (Zhang and Peck, 2014: 3).

Beyond accounts of mutually binding complementary structures – an account of China as persistently uninstitutionalised

Overall, the emergent literature, which allows for the coexistence of multiple capitalisms within Chinese borders, breaks with the VoC framework’s assumption of the superiority and comparative institutional competitiveness of complementary capitalist institutions. That is, the emerging variegated capitalism approach points to heterogeneity as the basis for China’s mode of capitalism(s), which constitutes “uneven development of globalizing but polymorphic capitalism(s)” (Zhang and Peck, 2014: 5). On a related note, the thesis points to how the VoC assumption of the superiority of “‘coherence’ of national models, expressed institutionally" (Zhang and Peck, 2014: 5), in terms of institutional complementarity, does not align with the Chinese experience. Instead, the thesis aligns more with the variegated capitalism stream, as the thesis illustrates how the Chinese wind power market is not a story of mutually binding, path-dependent institutional complementarities, but rather a story of continuous disruption of emerging structures. In the muddle matrix of China's fragmented authoritarianism with myriads of conflicting vested interests, it becomes difficult to 'bind' relations into stable institutionalised structures. Indeed, according to Breznitz and Murphree (2011; 2013) and their account of *structured uncertainty*, China is "unique in being persistently uninstitutionalized" (Lieberthal, 2004 in Breznitz and Murphree, 2011: 11). This lack of institutionalisation is in turn coupled to how Chinese politics are marked by a "volatile yet productive combination of decentralized experimentation with ad hoc central interference, resulting in the selective integration of local experiences into national policy-making" (Heilmann, 2008: 29). Accordingly, one of the most important institutional features of the Chinese political economy is the consistent presence of what Breznitz and Murphree (2011) term "structured uncertainty" (Breznitz and Murphree, 2011: 11). Such structured uncertainty denotes

> *"an agreement to disagree about the goals and methods of policy, which leads to intrinsic unpredictability and to inherent ambiguity in implementation. Thus, structured uncertainty is an institutional condition that cements multiplicity of action without legitimizing any specific course or form of behavior as the proper one. This ambiguity consequently leads to some tolerance for multiple interpretations and implementations of the same policy" (Breznitz and Murphree, 2011: 38).*

In a constant move to experiment with industrial upgrading and scientific and sustainable development, and in a constant oscillation between central control and local experimentation, Chinese policy-making at times seems (potentially purposely) self-disruptive. This is i.a. seen in the support of heedless growth in GW installations, which has ultimately led to a non-linear, non-path-dependent, non-accumulative, and non-complementary development of Chinese wind power. While this can turn out as a 'fight against own wind mills', the thesis has illustrated that it is also this very structured uncertainty that has allowed for agile adjustments and a potentially timely turn to quality.

Dis- and reassembling hierarchical structures

On a related note to the resonance between the findings of the thesis and the variegated capitalism lens, the findings also have implications for the structural, hierarchical, and functionalistic literature on GVC governance, which is closely linked to the GIN literature, as outlined in *Chapter 2*. In the experimentalist Chinese context of policy-making, in which institutional structures do not necessarily 'add up' through efficiency and complementarity, actors in the Chinese wind power market seem to engage in multiple simultaneous and sometimes conflicting supplier-customer modes of governance. This has already been indicated in *Chapter 13* with the introduction of Herrigel's (2010) notion of sustained contingent collaboration.

Overall, the thesis displays how a simplistic transaction-based logic of governance, as represented by the transaction cost-based 'governance as coordination' lens (in Gibbon et al., 2008), does not render a fulfilling notion for understanding governance in China's wind power market. The findings of the thesis display how such transaction cost-based predictions are not always straightforward, but rather opaque in the Chinese wind power market. For instance, choices of suppliers and partners may be co-configured by multiple government agendas to build core competencies and indigenous innovation capabilities, by narrative and discursive devices, by standards and IPRs, and by protectionist policies in favour of liquidity-constrained domestic SOEs. This adds to the complexity in governance of customer-supplier relations, establishing simultaneous collaborative and competitive dynamics, along with role ambiguity, as discussed earlier (*Chapter 13*).

Nevertheless, it may be claimed that the thesis can contribute to the *governance as coordination* lens, by displaying how convergence between Chinese and foreign WTMs in terms of governance modes is taking place in the qualification struggle of wind power. Thus, the thesis indicates how Western WTMs are experimenting with more modular governance modes, gradually moving away from pure internalisation and relational governance modes, in order to lower costs. Conversely, Chinese companies, who are facing the consequences for quality of a market-based and/or modularised governance structure, e.g. as outsourcing of many components risks jeopardising the overview of the systemic (algorithmic) interplay of the turbines' thousands of components, are moving towards more internalised and relational governance modes, as they gradually build capabilities. This illustrates mutual learning as well as upgrading on part of Chinese WTMs.

At the same time, however, the findings of the thesis relate even more directly to the *governance as normalisation* (in Gibbon et al., 2008; Ponte, 2009; Gibbon and Ponte, 2005) and governmentality (Gibbon and Ponte, 2008) lens, which acknowledges the role of quality standards in shaping governance relations. The thesis contributes by illustrating how standards (and their normative, discursive work) co-configure customer-supplier relations, but also contributes by illustrating how these produce controversy and trials of strength over the exclusion effects of standards, as well as over the very right to define quality. The governance as normalisation literature is concerned with how certification and codification facilitates the emergence of industrial market conventions and of economies of scale (Gibbon and Ponte, 2005: 21). It illustrates how powerful lead firms can govern the GVC by exerting their power over suppliers in a hands-off way through control at a distance (Gibbon and Ponte, 2005), namely through employment of quality standards and dominating industrial market quality conventions. Although the literature on governance as normalisation (as well as the *governmentality* lens or the so-called 'programme of government' approach) (Gibbon and Ponte, 2008: 367) also admits to how there is a politics to the measuring "instruments" and tools employed for standardisation (Ponte and Cheyns, 2013: 461; Ponte, 2009: 241; Gibbon and Ponte, 2008), these perspectives mainly provide a social constructivist perspective with a focus on human actors. In turn, the thesis contributes by illustrating how the fight over such quality conventions are not just socially constructed through e.g. discursive and normative conventions, but produced through socio-material processes (e.g. involving non-human actors such as algorithms, aero-elastic codes, simulation tools).

Breaking with hierarchical and structural imageries – on disruptive governance

Rather than producing stable governance structures, the Chinese highly politicised market for wind power renders the relative positioning of firms in the value chain highly volatile and unpredictable, as governance relations (e.g. produced through contested standards) are inherently political. This is particularly the case in the ongoing 'quality crisis' of the wind power market, where Chinese and foreign companies consistently experiment with new modes of governance. These are characterised by paradoxical dynamics of simultaneous collaborative and competitive forces. With extensive role ambiguity, the thesis has earlier dubbed emerging collaborative networks as modes of 'sustained contingent collaboration' (Herrigel, 2010). Yet, as also the ambitions, goals, and identities of actors are shifting, the specific governance mode is rendered contested, variable, and situational. In this way, the detected collaborations may even be characterised as *variegated* and/or *disruptive governance*, i.e. reflecting their hybrid, heterogeneous, paradoxical, and experimental nature within and across the wind turbine industry and industrial sub-sectors.

The thesis therefore proposes that the conventional and relatively more structural and hierarchical notion of GVC should be modified, allowing for a look into the socio-material work of maintaining and disrupting such structural hierarchies. With its focus on the work of construing *associations*, and on the potentially disruptive 'creative destruction' of Chinese experimental and pragmatic governance, the constructivist perspective of the thesis indirectly breaks with the largely structural, functionalistic, and hierarchical accounts of the

GVC literature and the VoC literature and their tendency towards path-dependent lock-in. Instead, the analysis of the thesis points to how Chinese actors at times are disrupting value chain structures, engaging in experimental moves of building associations to their product, and oscillating between centralisation and decentralisation in an experimental mode of pragmatist trial and error. Seeking to open some of the black boxes of the value chain (and GIN) approach(es), as well as of different VoCs, by way of tracing micro-processes of relationship-building and of construing associations, the thesis has indirectly rendered an account of governance as political, messy, and self-disruptive ordering, in experimental moves of trial and error and network relations. In this account, positions along the chain are not fixed, but rather fluid and agile, and unpredictable. Thus, rather than adopting a structuralist perspective of GINs or GVCs, the thesis instead emphasises that notions of heterogeneous and recursive *modes of ordering* (Law, 1994, 2003), or relatedly *agencements/assemblages* (Callon and Çalişkan, 2009, 2010a, 2010b) and/or *configurations and compositions* (Latour, 2005a). These more processual and relational notions may provide a fruitful starting point for opening up black-boxed (governance) relations, structures, chains, and networks.

Implications for the upgrading literature within the GVC-framework

The seeming ability of the Chinese 'figuration' to disrupt governance structures also has indirect implications for the upgrading literature. As illustrated in *Chapter 2*, upgrading has been conceptualised in a variety of ways, originally taking place as a trajectory, and generally treated as contingent on the specific type of governance mode (Schmitz, 2004: 6; Gereffi, 1994a, 1999, Gereffi, 2005; Gereffi and Kaplinsky, 2001; Humphrey and Schmitz, 2002; Morrison et al., 2008). That is, prospects for local enterprises to upgrade are dependent on the type of GVC that it is tied into (Schmitz, 2004: 1). Overall, the existing literature tends to look at the 'results' and structural barriers in terms of upgrading, but overlook the micro-processes and the role of socio-material actors in resisting upgrading. The story of wind power in China can be seen as a story of upgrading and learning through relationship-building, that is, of integration into GVCs, GPNs, and gradually also GINs. Such integration into global chains and networks has already been argued to bring about local and regional development (LoRD) (Parrilli et al., 2013: 967, 968). This aligns with Mathews' (2002) notion a *linkage-leverage-and-learning* of MNCs from emerging economies (Mathews, 2002).

While having illustrated rapid upgrading within Chinese wind power, and attempts at becoming parts of GINs through processes of relationship-building (via the construction of associations), the thesis warns against conceiving of such networking and linkage-leverage-learning as automatic, and against assuming that integration into and upgrading and learning through GINs or GVCs is automatic. Instead, it is necessary to myopically trace *how* relations are built, what they contain (i.e., their quality, and what kind of knowledge is shared, and what kind of knowledge is not), and how power struggles may take shape as potential socio-technical barriers to upgrading emerge. The thesis has e.g. illustrated how 'core algorithms' tend to resist translation, as well as how certain actors can be excluded from research collaborations due to lacking associations of 'algorithmic quality'. This indicates potential socio-technical exclusion mechanisms and barriers to GIN integration and upgrading. It is thus necessary to inquire into the socio-material work of building relations through the construction of associations. The thesis opens up the issue of upgrading as a matter of translation and qualification as well as a matter of the ability to construe associations (e.g. of quality and sustainability). At the same time, the depicted experimental mode of ordering and the resulting disruptive governance mode, which is marked by radical intervention and sometimes even by radical *non*-intervention, can potentially enable disruptive upgrading in radical moves for industrial development.

Disrupting structures through innovative manufacturing and China's Run of the Red Queen?

The account emerging from the analysis may at first sight seem a somewhat pessimistic outlook for China's potential for upgrading from manufacturing. This corresponds to a host of studies on manufacturing in China (e.g. Steinfeld, 2004; Dongsheng and Fujimoto, 2004), which are concerned that China's value chain integration through cost-cutting manufacturing is shallow (Steinfeld, 2004: 1971). That is, whilst China may have become number one in the world in terms of production volume, China is oftentimes depicted as "stuck in the imitation of focal models of foreign makers" (Dongsheng and Fujimoto, 2004: 15). This lock-in is further linked to increasingly modularised product designs, which despite quasi-open architectural attributes threaten to lock Chinese assembly companies "into the existing product technologies since the incentives of making reverse engineering are impeded on the path of accumulating their product development capabilities" (Dongsheng and Fujimoto, 2004: 23). In this account of upgrading within manufacturing, "Chinese firms may be bending the metal and bolting together the parts", but is refrained from innovation in today's globalised, highly de-verticalised supply chains (Steinfeld, 2004 in Nahm and Steinfeld, 2012: 5).

In contrast, another related stream of literature takes the opposite standpoint. This literature asserts that it is "precisely because of China's position *within* manufacturing, the nation is developing proprietary know-how extending *beyond* manufacturing”, namely moving from manufacturing into ”everything from design capabilities to outright innovation, the development and commercialization of completely new products, processes, and services” (U.S.-China Economic and Security Review Commission 2011 in Nahm and Steinfeld, 2012: 4). As a ‘battle at the bottom’ is taking place, where actors are engaged in cut-throat competition for ’the middle’ (Brandt and Thun, 2010: 1560, 1566, 1569) of the market, ’there is more going on than meets the eye’ within the manufacturing sector (Brandt and Thun, 2010: 1571). These studies focus more on micro-level processes of learning and organisational structures for knowledge sharing than the depicted GVC-literature (Herrigel, 2010; Nahm and Steinfeld, 2012; Herrigel et al., 2013). Relating to the technological capabilities approach in the GVC literature, the account offered by the literature on ‘innovative manufacturing’ goes more into the actual manufacturing and learning processes at the micro-level than the GVC-literature conventionally does. Placing the notion of ‘innovative manufacturing’ at the core of the argument (Nahm and Steinfeld, 2012; 2013/forthcoming), China’s rapid development is here seen as a matter of ‘manufacturing prowess’ and not just cheap labor, as proprietary know-how and specialisation can be embedded in the fabrication and assembly process itself (Nahm and Steinfeld, 2012: 3, 5).

The notion of innovative manufacturing is amongst other industries also predicated on China’s wind turbine industry due to detected processes of multidirectional learning across a variety of national contexts (Nahm and Steinfeld, 2013/forthcoming). That is, whilst the Chinese wind power market is engaging in cut-throat competition, Chinese manufacturers are simultaneously building up competencies and gradually focusing on producing quality turbines, as depicted in the thesis. Hereby, central to the Chinese growth story, i.e. its status as a “*scale-up nation”* (Nahm and Steinfeld, 2013/forthcoming), is the “specialisation and multidirectional inter-firm learning” (Nahm and Steinfeld, 2012: 7) as well as the unique simultaneous management of tempo, volume, and cost (Nahm and Steinfeld, 2012; 2013/forthcoming). Along the same lines, Herrigel et al. (2013) argue that manufacturing upgrading is actively taking place in China (Herrigel et al., 2013). As Chinese manufacturers squeeze out costs of high volume operations, redefining existing industrial experience curves as they are specialising (Nahm and Steinfeld, 2012: 7, 17), they have engaged in relations “with other enterprises that can ‘complete the package’, so to speak” (Nahm and Steinfeld, 2012: 25). To account for this upgrading process from manufacturing, Nahm and Steinfeld (2012) develop a ”taxonomy for classifying different variants of knowledge-intensive scale up” (Nahm and Steinfeld, 2012: 7). This includes (1) backward design and the reengineering of someone else’s existing product (e.g. detected in the wind turbine industry by the authors), (2) making someone else's (new-to-the-world) product design come true (seen e.g. in the wind turbine industry), (3) rapidly-scaled new-to-the-world product innovation, and (4) a product platform for technology co-development and absorption (Nahm and Steinfeld, 2012). Indeed, the thesis has illustrated the first two variants of knowledge-intensive scale-up around software and wind power, while it is still limited how much new-to-the-world product innovation and co-development is taking place, although there are increasing signs of it. However, while this at first sight might give a pessimistic account, Breznitz and Murphree (2011; 2013) argue that it is precisely the ability to follow behind technology leaders and innovators, themselves thriving "in second-generation, production, and process innovation" (Breznitz and Murphree, 2011: 2), which has resulted in China's powerful position in the global economy:

"China's accomplishment has been to master the art of thriving in second-generation innovation – including the mixing of established technologies and products in order to come up with new solutions – and the science of organizational, incremental, and process innovation" (Breznitz and Murphree, 2011: 4).

Pursuing this strategy of thriving in second-generation innovation has been enabled by the general trend towards global decomposition of not only production, but also of innovation (Breznitz and Murphree, 2011: 13). According to Breznitz and Murhphree,

"it is much more important to realize that within the new, fragmented international economic system, China has developed a remarkably profitable and sustainable model of innovation. This model makes China into a critical part of the world innovation system, but it does not rely on China excelling in cutting-edge novel-product R&D" (Breznitz and Murphree, 2011: 19).

This course of development is coined China's "run of the Red Queen," by making a reference to the world of Lewis Carroll's 'Red Queen' in *Through the Looking-Glass and What Alice Found There,* who, in order even to stay in the same place, had to run as fast as she could (Carroll, 2001 in Breznitz and Murphree, 2011: 2-3). Through this lens,

"China shines by keeping its industrial-production and service industries in perfect tandem with the technological frontier. Like the Red Queen, it runs as fast as possible in order to remain at the cusp of the global technology frontier without actually advancing the frontier itself" (Breznitz and Murphree, 2011: 3).

The latter literatures on 'innovative manufacturing' and the notion of China's strategy of the 'Run of the Red Queen' emphasise the potentiality of Chinese firms to break free of constraining value chains and their binding structures. Instead, manufacturing and second-generation innovation can serve as a potential locus for upgrading, and thus constituting a "sustainable strategic goal for national economic growth" (Breznitz and Murphree, 2011: 3).

Governance and upgrading as associational moves

The more optimistic accounts outlined above seem to break with the more hierarchical, functionalistic, and structural accounts of the traditional GVC and VoC literatures. That is, whereas the VoC and GVC literatures tend to offer somewhat rigid accounts of hierarchically binding, reproductive, and complementary structures, the accounts of Nahm and Steinfeld (2012; 2013/forthcoming), Herrigel (2010), Herrigel et al. (2013), and Breznitz and Murphree (2011; 2013) are partly opening up some of these binding structures. That is, they open up a space for potential upgrading and breaking free of captive governance relations or institutions, through manufacturing. For instance, as expressed by Nahm and Steinfeld (2012), the story of China's scale-up in manufacturing is

"not simply the story of globalized – and often quite hierarchical – supply chains. Nor is it the story of manufacturers purchasing and rapidly integrating mature technologies through one-way learning. Rather, it is a story of multiple players sharing knowledge and risk in order to commercialize emergent technology. Moreover, it is a story of multiple players participating in a movement down – or even outright redefinition of – an industrial learning curve, one not so long ago thought to have been quite flat" (Nahm and Steinfeld, 2012: 28).

Also providing an open-ended account in terms of opportunities for upgrading, e.g. by pointing to the myriads of controversies, overflows, ability to make associations, and pragmatic, experimental marketisation, the thesis aligns itself with the optimistic account. Yet, at the same time, the thesis goes further, as it 'breaks down' structural, path-dependent, and deterministic accounts more than seen before in the extant literature. Through its lens of heterogeneous, distributed agency, the constructivist account of the thesis allows for a more agentic account, pointing to the disruptive moves of Chinese actors, as they construct relations with foreign actors and construe associations of strategic importance to software programmes, in this way mobilising a host of actors into the emerging GIN. The thesis displays how Chinese actors, by continuously transforming their role and position through negotiation and construction of associations, at times succeed in upgrading and breaking free from value chain governance relations in experimentalist, guanxi-like moves. This is e.g. done by finding creative ways of framing themselves as sustainable, redefining the identity, role, position, and relative power of Chinese actors. This disruptive governance results – in addition to overflowing – at times also in (disruptive) path creation, which makes it possible to disembed from existing relevance structures (Garud and Karnøe, 2003). This aligns somewhat with what Herrigel (2010) earlier termed 'creative action', and which the thesis coined a matter of bricolage and creative experimentation. The case study on GIN construction around software in Chinese wind power has depicted a path-creating Chinese mode of constructing new markets. The depicted '(dis)associational moves' have made it possible to learn through experimental trial and error, and to gardually develop competencies. The thesis contributes to the VoC, value chain, governance and upgrading literatures by displaying the inherent instability and negotiated nature of hierarchical roles and structures. Rather than relying on a stable account of complementary structures and institutions, the thesis hereby conveys an account of highly disruptive, yet creative and experimental dynamics.

Perspectives for industrial policy in a ’transformed era’

Having provided a discussion on how the findings of the thesis link up to wider discussions within China studies, the VoC literature, and to governance and upgrading discussions, it becomes relevant briefly to consider how the thesis contributes to perspectives on industrial policy in a developmental context. As a ‘latecomer’ country, China faces fierce competition and paradoxical pressures to upgrade by linking up to GINs (and moving beyond them) and attracting foreign actors, whilst also wanting to protect its national industries. This has created a market characterised by a somewhat schizophrenic dialectics between competition and collaboration.

According to various scholars on China’s development, China’s current situation is indeed different and more challenging than what faced the developmental and/or predatory state of the ’East Asian Tigers’ (e.g. Evans, 1995; Wade, 2004; Amsden, 2004; Johnson, 1995), which was marked by an era of vertical integration of companies (Nahm and Steinfeld, 2012: 24). In contrast, China is facing an era of vertical disintegration of activities due to increased modularity of technologies (Nahm and Steinfeld, 2012), simultaneously with opening its markets following the WTO accession. In this ’transformed era’ (Steinfeld, 2004: 1983), Chinese companies are facing new, more complex competitive pressures than ever seen before (Nolan, 2001; Steinfeld, 2004). For instance, this implies that firms must learn to operate ”in a much more networked form of production, one in which production architectures are more modular, inter-firm production relationships are more extensive, and firm-level specialization in particular production activities is much more pronounced” (Nahm and Steinfeld, 2012: 25).

Consequently, with these new conditions, blindly copying from the strategy of developmental states of the East Asian Tigers becomes unviable. That is, the successful industrialisation of the East Asian Tigers during the 1970s and 1980s was largely a result of strategic, longer-term focus, rule-setting, regulation, and strategic intervention, e.g. as reflected in the ’archetypical developmental state’ South Korea (Amsden, 2004; Nahm and

Steinfeld, 2012: 30). In contrast, in the new era of rapid change and modularity, Chinese companies are claimed to be constrained in terms of their room for maneuvre, when it comes to traditional developmental, interventionist industrial policy (Nahm and Steinfeld, 2012). This makes it more important to succeed in specialisation within production stages rather than developing large National Champion conglomerates (Breznitz and Murphree, 2011: 5), as this minimises the risk of forcing through integration of activities which are not ’integral’ (Steinfeld, 2004: 1984). Indeed, basing their argument on the notion of China’s pragmatic mode of ‘structured uncertainty’ as illustrated above, Breznitz and Murphree (2011; 2013) note how China’s model of the ‘run of the Red Queen’ does, indeed, not resemble the former Asian newly industrialised economies fast-follower model (Breznitz and Murphree, 2011: 4). While these have had

“specific policies with clearly defined goals and the pathways to get there, China developed its Red Queen run by accident, partly as a result of local experimentation, and the outcome looks quite different from the declared goals of the central government” (Breznitz and Murphree, 2011: 4-5).

As China’s Red Queen strategy has largely come about ‘by accident’ (Breznitz and Murphree, 2011), China instead, officially, pursues an industrial policy of picking strategic ”pillar industries” (Steinfeld, 2004: 1984), of selecting ‘National Champions’ (Nolan, 2001; Brødsgaard, 2012a) by building a strong, independent innovative capacity (Breznitz and Murphree, 2011: 6), and of establishing a Harmonious Socialist Society through Scientific Development (Christensen, 2013). Indeed, within wind power, China has pursued a “national push to develop a competitive wind industry” (Nahm and Steinfeld, 2012: 29), which risks not only costly investments in manufacturing capacity and rapid manufacturing expansion, but also overcapacity and potential financial losses to investors in the process of industry consolidation (Nahm and Steinfeld, 2012: 33).

Overall, China does not fit neatly into any one specific category within the developmental state literature. While China is ”neither devoid of state involvement, nor disconnected from state developmental policy” (Nahm and Steinfeld, 2012: 29), policies often seem haphazard, indiscriminately managed (Nahm and Steinfeld, 2012: 24), or ‘improvisational’. This “experimental, almost mercurial fashion” (Nahm and Steinfeld, 2012: 30-31) of intervention makes it difficult to discern any particular strategy on the part of the state (Nahm and Steinfeld, 2012: 24), which is conventionally one of the most recognisable marks of the ‘developmental state’ (Evans, 1995). That is, developmental states are normally characterised by the dual needs of an ”independent sense of purpose” (Carney and Witt, 2013: 6) and the need for access to and information from the economic actors it seeks to influence (Carney and Witt, 2013: 6). The thesis has illustrated some of the ‘developmental state' characteristics of China in regard to wind power, e.g. through the narrative of China's catch-up and 'renaissance', which construes a long-term purpose and strategy of the state, at the same time as pursuing a strategy of 'picking the winners' and intervening in industries[97]. However, China's structured uncertainty, where targets and goals are pragmatic and ambiguous in an experimental trial and error approach (Breznitz and Murphree, 2011: 20) – largely a result of China's complex bureaucracy structures (Breznitz and Murphree, 2011: 44-48) and dynamism at the local level with control by the conservative centre (Breznitz and Murphree, 2011: 22, 40) – is according to Breznitz and Murphree (2011) exactly what allows for China's unique advantage and national innovation system (Breznitz and Murphree, 2011: 8). By being open to flexible and agile containment of overflowing, and changing the goal of reforms, Chinese "[p]olitics and its unintended consequences are the root cause of the particular form and trajectory of China's economic miracle" (Breznitz and Murphree, 2011: 20). Finding it wiser to pursue second-generation rather than first-generation innovation, Breznitz and Murphree (2011; 2013) find that it is exactly China's creative pragmatism that allows China not to become trapped in its own overall strategy of indigenous innovation. That is, while maintaining an official overarching goal of indigenous innovation,

"the Chinese high-technology development path has been drastically different from the one planned and hoped for by the Chinese central government. The idealized research paradigm set out by the Chinese Communist Party (CCP) and government ministries has been to build a strong, independent innovative capacity" (Breznitz and Murphree, 2011: 6).

Rather than fearing this 'Run of the Red Queen', the largest peril and threat to China's sustainable economic growth is according to Breznitz and Murphree (2011) the very insistence on indigenous innovation by the Chinese Government, which still emphasises "independent mastery of novel product innovation and new-technology creation as necessary for national wealth and economic security" (Breznitz and Murphree, 2011: 7).

Indeed, the thesis confirms that a Run of the Red Queen strategy has been largely successful in Chinese wind power, as it has resulted in rapid construction of a new market for wind power. Further, the thesis also illustrates that a dogmatic insistence on indigenous innovation creates controversies, which threaten to destabilise structures and relations. That is, the thesis confirms that it may indeed be China's structured uncertainty that makes it possible to establish new markets, and to perform figurational change when needed. Pointing to a gradual, yet agile, figurational change from *Figuration I* towards *Figuration II*,

[97] Meanwhile, with extensive guanxi-relations, China at other times also has the characteristics of a *predatory state* (Evans, 1995 in Carney and Witt, 2013: 12; Cai, 2004; Yu and Shi, 2010).

i.e. as China’s wind power market undergoes a potential turn to quality, the thesis illustrates the socio-material work of framing that industrial policy and catch-up demands in a developmental context, the overflowing it may produce in today’s globally interdependent markets, and the disruptive governance and upgrading from pragmatic experimentalism that it performs.

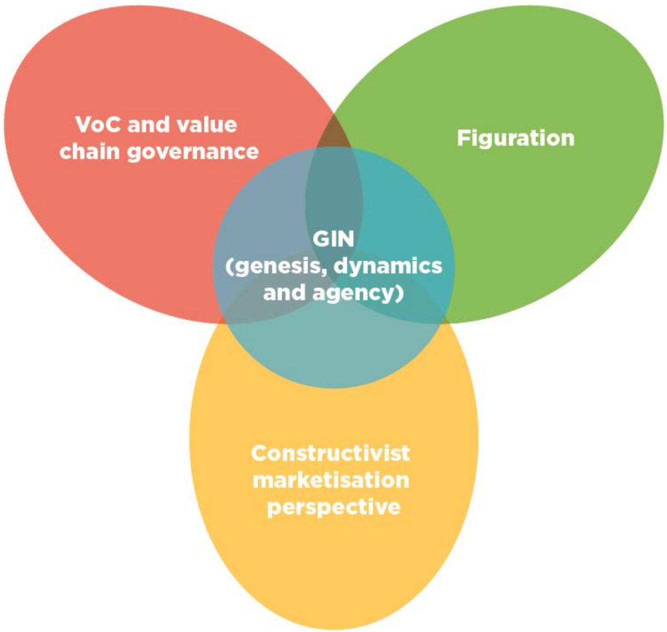
Future research – on cross-fertilising structural and processual accounts

Having explored how the findings of the thesis augment and/or correspond to other literatures than the GIN literature, in the following, the thesis outlines a tentative new research agenda for studying GIN *genesis, dynamics, and agency* in a developmental context. This new research agenda is based on the potential cross-fertilisation of perspectives. Rather than having an aim of demonstrating the primacy of the constructivist perspective over the GIN literature, the thesis seeks to point to areas of fruitful cross-fertilisation between the literatures, acknowledging the coexistence of genesis and structure as well as disorder and order. Indeed, structures are never non-existent. Thus, there ”is no need to abandon studies of formal organizations, so dominant in contemporary life” (Czarniawska, 2013: 10). Indeed, the thesis does point to how figurations are emerging into temporarily stabilised entities. Apart from letting the constructivist and figurational perspectives inform each other, the thesis suggests a further expansion of these processual and relational perspectives with a more structural perspective, in order to account for how entities are mounted into emerging figurations, which lead to (temporary and ambiguous) order and unity. By letting the conceptualisation of GINs include both a structural and a processual lens, the stark (and false and overflowing) dichotomy between structure and genesis (and structure and agency) (e.g. Derrida, 1978 [1967]; Stark, 2009) can hopefully be overthrown. Indeed, “[d]ifferent approaches and ways of conceptualizing organizing have their advantages and shortcomings, but the fact is that formal organizations, networks of actors and actor-networks, action nets and spontaneous organizing coexist – at the same time and in the same territory” (Czarniawska, 2013: 13).

A new research agenda for development studies within New Economic Sociology?

The thesis seeks to bridge and cross-fertilise the seemingly contradictory constructivist and structuralist perspectives, by inquiring into potential synergies between figurational sociology, ANT, and the more structural accounts of VoC and global value chains to account for GIN construction (*genesis, dynamics, and agency)*. Making such cross-fertilisation possible is largely enabled by the use of pragmatist tunnels and bridges (and metaphors) (*Chapter 2, Chapter 13)*, which may be considered one of the major contributions of the thesis. This pragmatist bridging has enabled cross-fertilisation between perspectives and the seemingly ontologically improbable move from the GIN approach towards the constructivist ANT lens. Below, the ’triangular relationship’ between these literatures is depicted in *figure 24*.

Figure 24: Potential cross-fertilisation of perspectives to account for GIN genesis, agency, and dynamics



Source: Own design

Such cross-fertilisation goes well beyond the cross-fertilisation suggested by Parrilli et al. (2013) of combining insights of the GVC, GPN, and GIN frameworks in order to inquire into the implications of integration into GVCs, GPNs, and/or GINs for local and regional development (LoRD) (Parrilli et al., 2013). That is, Parrilli et al. (2013) stick to a spatial and structural imagery of economic geography, and stay at a relatively high level of aggregation (Parrilli et al., 2013; Dicken et al., 2001), rather than offering a lens for inquiring into processes of building relations in the first place. Instead, the thesis argues that in order to adopt GINs as “a strategic framework for the analysis of current and future trends and leaderships in the globalized economy” (Parrilli et al., 2013: 974), the black box of the GIN metaphor must be opened up, loosening its ontology. With an interest in the negotiated roles and identities of heterogeneous actors in the constitution of new 'global' markets in a developmental context, the thesis argues that it is necessary to move beyond strictly structural chain and network constructs within economic geography, and adopting an integral processual and relational lens of networks. As outlined earlier (*Chapter 2*), the need to adopt a more relational lens has already been recognised within parts of economic geography (Dicken et al., 2001: 92), namely, by looking at networks as simultaneously relational processes *and* structures in which power is exercised (Dicken et al., 2001: 92) in distinct time- and space-specific contexts, and thereby producing observable patterns in the global economy (Dicken et al., 2001: 91).

Thus, the thesis reiterates the argument outlined in *Chapter 2* that the 'relational gap' in the existing literature must be filled by 'looking away' from the 'GIN'. Further, the thesis argues that technology matters, i.a. by underlining its social-material agency, and that lateral, symmetrical perspectives must be adopted, to allow for a more fine-grained understanding of the dynamic de- and reconfiguration of relations in the global economy, e.g. as particular technologies can be disruptive to relations and the networks they may co-constitute. Having already displayed and discussed extensively what it may imply to adopt a relational, endogenous, and processual micro-lens of relations, this leads to a further point, namely that the framework sketched above may serve as a very first rough outline of an emerging new research agenda for development studies within New Economic Sociology (NES). Whether China's mercurial, experimental way of constructing markets and learning from practice, engaging in cross-border collaborations and gradually moving from *figuration I* to *figuration II*, upon having learned from the resulting overflowing of the previous low-cost strategy, will turn out successful in the long-term is a question still blowing in the wind - and a promising fertile ground for future research.

Lastly, the research agenda indicated above may further contribute to the – still emerging marketisation account – of the constructivist perspective, namely, offering an account of how to understand the "potential diversity of markets" (Callon and Çalişkan, 2010b: 24). In particular, studies are missing out on how 'newly industrialised economies' manage unprecedented challenges, as they are entering globalising world markets (Callon and Çalişkan, 2010b), because they feel contradictory pressures for national protectionism while also being forced to engage in international networks and collectives. Combined with Elias's (1978) notion of figuration, it becomes possible to study GINs in a developmental context of globalisation as constantly de- and reconfiguring figurative games. Here, it becomes the task of the researcher to identify and trace the changing quality and types of these games and the relations they configure.

Striking a chord with a constructivist modest method – and limits to generalisability

Indicating that the findings of the thesis may be extended to a broader framework for understanding developments in the 'global economy' within NES, the thesis has simultaneously extended the ramifications of the constructivist framework. That is, to some extent the thesis strikes a chord with the 'modest method' (Law, 1994) of ANT, which was laid out in *Part II* of the thesis. That is, the thesis is positioned in the ambiguous space between the *specific* account of a constructivist perspective (e.g. Law, 1994; van Heur et al., 2013) and the demand for larger generalising claims of the GIN literature. With the constructivist demand for specificity and a practice-based approach (e.g. Gad et al., 2014; Stengers, 2005a), there has, however, been an increased debate within the constructivist literature as to how to make the constructivist more relevant, e.g. by making generalisations and comparisons and offering potentially critical accounts (e.g. Stengers, 2011; Woolgar and Lezaun, 2013; Latour, 1997: 69 in van Heur et al., 2013; Jensen, 2010). For instance, Stengers (2011) addresses the issue of comparison as a 'matter of concern', and Law (1994; 2004) features a discussion of the limits of generalisation from modest method about the extent to which ANT can and cannot be used to study large-scale phenomena spread over multiple sites. Following this gradual opening up towards broader, larger claims, the thesis has inquired into how and whether the potentially emerging 'figurations' in the wind power market may tell something more *general* about China as a particularly 'complex' market (or 'variety of capitalism').

By making wider claims, while still being reflexively attentive to the potentially performative power of such claims (e.g. Jensen, 2010; Gad et al., 2014; Barry, 2001; Woolgar and Lezaun, 2013), the thesis has not only contributed to the GIN literature and related literatures, but also to the constructivist account. In particular, apart from conducting an empirical study within a context of a newly industrialised economy, contributing to the still nascent *performativity programme* (Callon and Çalişkan, 2009: 393) in order to explore market construction of wind power in China, the thesis has extended ANT's notion of TENs. That is, a *political pole* has been added to the *market, scientific, and technical poles* of TENs. This has been necessary to account for the key role of the Chinese political leadership in the mobilisation of a network around wind power and software programmes in China. Hereby, the thesis simultaneously makes an effort to meet the critique that ANT has received for not considering politics, and for not being 'critical' or 'political' enough (e.g.

Whittle and Spicer, 2008). Unravelling how the construction of GINs in the Chinese wind power market constitutes a 'negotiated space' (Murdoch, 1998) as well as a 'contested' (or 'competitive') space' (a further notion added to the framework) rather than a spatial space, a highly politicised picture of GIN genesis and of the Chinese wind power market emerges. At the same time, it is the contention of the thesis that the constructivist perspective, although it advices that scholars stay 'sober with power' (Latour, 2005a: 260), is inherently political. The main point for a politics of ANT is, however, that hierarchical structures, e.g. the local-global dualism, which is conventionally seen as constituted by "one scale (the global) dominating the other (the local)" (Dicken et al., 2001: 103, referring to Latour, 1997: 5), should not be assumed but rather that relations of domination must be traced and treated as relational effects of translation (Law, 2009: 147; Law, 1995). Combining ANT with the notion of figuration and games may have further accentuated the centrality of power. Although power in this account is distributed, uncertain, ambiguous, and disputable in nature (Whittle and Spicer, 2008: 612), the thesis contributes to and outlines areas for future constructivist studies within a developmental context, tracing the entangled politics of marketisation and reflecting the "power struggles at the heart of any market" (Callon and Çalişkan, 2010b: 12). Indeed, having indicated a potentially particular Chinese experimental pragmatics of green marketisation, it can be relevant to look into this in other 'green' sectors in China.

Ontological politics – and the multiple worths of wind power

In addition, the findings of the thesis contribute to an emerging so-called ontological turn within STS (e.g. Alcadipani and Hassard, 2010; Barry, 2001; Woolgar and Lezaun, 2013; van Heur et al., 2013; Mol, 1999; Mol, 1999; Jensen, 2010; Gad et al., 2014; Blaser, 2009: 18; Blok, 2013). This stream within STS extends the interest in 'the becoming' and variable ontology (Callon, 1991: 140; Latour, 2005a: 39; Law, 2004) of things, as it seeks to open up towards the potential *multiple* ontologies of things (Mol, 1999). The thesis can be claimed to illustrate aspects of the multiplicity of ontologies of actors and entities in the Chinese wind power market. For instance, it illustrates how algorithms are not just mundane, technical, or scientific artifacts, but also become political as they perform multiple controversies of a scientific, technical, economical, and political character. As algorithms emerge as political/politicising entities, having 'become objects of contestation' (Barry, 2001), the emerging 'political and technological ontology' of algorithms is displayed. Hereby, the analysis may be claimed to shed light on how multiple 'worths' of wind power have been enacted, as associations of e.g. scientific, technical, economic, financial, and environmental sustainability have been ascribed to wind power. Or, in the terminology of the ontological turn, what we may see could indeed be the enactment of multiple wind power(s). In this perspective, each enactment of different qualities, construing different worths of wind power, is not only an epistemological matter, but rather an ontological matter. That is, multiple wind power(s) may actually be emerging. Mimicking Blok's (2013) notion of "many worths of nature(s)" (Blok, 2013: 3, 16), the project may be said to demonstrate (some of the) 'many worths of wind power(s)' in the specific site of China. In this site, wind power has in many instances been qualified through algorithms, that is, what we may term *'quality (and sustainability) by algorithm'*, yet, at least as many times, algorithms have objected to this qualification. Opening up the ontology of algorithms and mapping the controversies that algorithms can perform, the project has engaged ethnographically in tracing what the algorithms *do*, i.e. inquiring into how such material actors co-perform and enact markets.

The mutable ontology (or ontologies) of things is in turn related to the streams of the *sociology of associations* (Latour, 2005a) and the *pragmatics of valuation* (Callon and Çalişkan, 2009, 2010b, 2010b), on which the thesis is based, and which has its roots in the early American pragmatist Dewey's "Theory of Valuation" (Dewey in Stark, 2009). Opening up the multiple worths of wind power, the thesis also has implications for the more sociologically and institutionally oriented sociology of worth of French convention theory (e.g. Stark, 2009; Boltanski and Thévenot, 2006), which is concerned with how actions are justified and valued through different sociologically and institutionally constructed *economies of worth* (Boltanski and Thévenot, 2006 (1991); Thévenot, 2009). However, convention theory is founded on a social constructivist perspective on the role of economies of worth, which seems to pre-exist and be relatively stable, and as such to some extent bears resemblance to the notion of institutional logics (Friedland and Alford, 1991). Thus, although convention theory does acknowledge that potentially contradictory economies of worth may overlap (Stark, 2009; Thévenot, 2009), the thesis instead demonstrates the dynamically contested nature of ontologies, worth, and qualities, and how they must be myopically followed as they differ across sites, and how they are being socio-materially constituted.

Method critique

Finally, before completing the 'journey' of the thesis, and after having discussed some of the potential implications and areas for future research, as well as making a partial break with modest method to suggest a tentative framework for a future research framework for NES, the chapter concludes by venturing into a section of reflexive critique to contemplate the limits of the account and the (ontological) performative ‘politics’ of the thesis itself.

On the limits of the particular and the general

At the same time as the thesis to some extent breaks with the premises of modest method, i.e., reflexively seeking avenues for modifying the demand of modest method, it recognises that there are limits to generalisations of the highly specific site of marketisation of Chinese wind power. In this way, adhering to the premise of situated ways of knowing (Jensen, 2010), it should be acknowledged that when reaching the conclusion of the scientific journey, the researcher ”*is still somewhere* particular (albeit somewhere *new*) and for that reason *not everywhere else*” (Jensen, 2010: 12). And, yet again, the thesis positions itself in the ambiguous, and awkward stretch between the general and specific. Thus, claiming that wider lessons can be drawn from the case, as indicated in the above sections, the thesis argues that some of the findings of the thesis can be extended and somewhat generalised. Overall, the thesis argues that some of the same types of controversies, as traced in the thesis, may also occur in other (green), state-controlled, and -subsidised ‘strategic pillar’ industries, which constitute part of China’s catch-up strategy of indigenous innovation. There is no doubt, that the story provided in the thesis could have taken many other shapes or turns, than the one offered in the thesis. Indeed, the story provided is one of many stories emplotted within one, which together point in various directions instead of having just one beginning or one ending. Not aligning with any essentialist notion of the world, but opening up to the potentiality of multiple worlds and realities being enacted simultaneously, sometimes clashing and sometimes not, the ANT-based story is thus one that

”tends to tell stories, stories that have to do with the processes of ordering that generate effects such as technologies, stories about how actor-networks elaborate themselves, and stories which erode the distinction between the macro- and micro-social” (Law, 1994: 17).

Indeed, there seem to be multiple potential endings and beginnings in the account provided, and which could consequently also have been emplotted otherwise.

Traps of language and moving beyond structure-genesis dualisms via metaphors

Having pointed to the potentiality of other plots and stories, it is worthwhile to make a brief note on the way in which language and the structures it creates, by itself may work against the attempted processual account of the thesis. That is, ‘false dualisms’ (Stark, 2009; Elias 1978 in Layder, 1986; Derrida, 1978 [1967]; Latour, 2004; 2005a; 2005b) almost inevitably emerge, as researchers strive towards sensemaking (Weick, 2003). This was e.g. seen in the emerging dualism of overflowing and framing. In addition, it is also reflected in the very meta-narrative of the thesis, i.e. the "theorized storyline" (Golden-Biddle and Locke, 2007) (see *Chapter 4*), where a gap, i.e. the genesis, dynamics, and agency, and the need for a relational lens to account for the 'first act' of market construction, has been construed, creating a dualistic categorisation of structural versus processual accounts (*Chapter 2*). To counter the emergence of unintended dualisms, in an acknowledgement that there "is no genesis without structure, and no structure without genesis" (Derrida, 1978 [1967]), the thesis has used metaphors, which at times can create new (non-dualistic) imageries. For instance, the adoption of the notion of the *magmatic* (Venturini, 2009) space of lability, i.e. the ambivalent space of controversy between order and disorder, constituted by *both* genesis *and* structure was proving useful as inspiration, illustrating how new knowledge products in organisation theory are often a result of bricolage, in which metaphors play a central role (Boxenbaum and Rouleau: 2011). Likewise, metaphors of the rhizome (Deleuze and Guattari, 2011 [1980]) and meshwork (Czarniawska, 2013) have proved helpful to capture the both structure- and process-like nature of networks, which lie at the heart of the proposed research agenda for NES. In particular, through the metaphor of the dense mesh of the meshwork, which also bears resemblance to the metaphor of *figuration*, an imaginary emerges of "self-organizing and planned organizing, formal organizations and informal networks" (Czarniawska, 2013: 16). In this thick mesh, networks

"are connected and disconnected, stabilized and destabilized; actants busy themselves trying to become actors; and trajectories of people and things crisscross. The type of activity may differ from place to place, but then, in time, another type may replace it" (Czarniawska, 2013: 16).

This breaks up the more structural imaginary of networks, with its "notions of levels, layers, territories, spheres, categories, structure, systems'" (Latour 1997: 3 in Dicken et al., 2001: 104).

Critical reflexivity and the (ethical) space of potentiality

Lastly, the power of plots, language, and metaphors implies that the stories and the language and metaphors we use have performative power. Indeed, by going 'GIN hunting', while acknowledging the performative, discursive politics that the GIN metaphor constitutes, by mapping controversies, the study itself may have 'performed' a particular story of the Chinese wind power market. Such intra-reflexivity (e.g. Latour 1988 in Jensen, 2010; Jensen, 2010) is an integral part of a constructivist case study, as performativity also relates to how researchers are co-performing the object of our inquiry. Indeed, time and again, the myriads of plots, potential narratives, and stories emerging from the data have had to be cross-checked and triangulated, as far as possible, ensuring not to become ‘seduced’ by certain accounts, as the researcher was slowly submerged into the field. Avoiding too early emplotment has been an ongoing concern, since the researcher strived not only to see and listen to “those who are strong enough and shaped in such a fashion as to impact”, and listen only to those who have the power to raise their voice, and who have succeeded in mobilising a network of allies around them (Bowker and Star, 1999: 49). Yet, as ”we *do not know* how the landscape we encounter at the end of our journeys will look”, this poses to scientists the important challenge of learning how to become “responsible for all the entities of our making”, a landscape, however, which ”we are not mastering”’ (Stengers cited in Jensen, 2010: 12; Jensen 2010: 12). Always open to how the world could *be otherwise* (asking *‘what if’)*, resonating with a space of ’potentiality’ (e.g. Whitehead, 1989; Woolgar and Lezaun, 2013; Jensen, 2010; van Heur et al., 2013), a constructivist perspective implies a certain (moral and ethical) responsibility to think about what kind of world it is that the researcher wants to construct (e.g. Gad et al., 2014; Stengers, 2008; Barry, 2001; Woolgar and Lezaun, 2013). Indeed, having set out to explore the emergence of GINs in Chinese wind power, in a developmental context of global disintegration of production and innovation, the thesis has shed light on the ‘first act’ (Powell et al. 2012: 434), of GIN construction rather than offering “a play that begins with the second act, taking both plot and narrative as an accomplished fact” (Powell et al. 2012: 434). While some of the findings have been surprising and paradoxical, they do tell a story of China’s negotiated role in the world economy, where networks of simultaneous collaboration and competition take shape.

Bibliography

Articles and books

Akrich, M., Callon, M. and Latour, B. (2002): ‘The key to success in innovation, part I: The art of interessement’. *International Journal of Innovation Management,* 6(2): 187-206.

Alcadipani, R. and Hassard, J. (2010): ‘Actor-Network Theory, organisations and critique: towards a politics of organizing’. *Organization,* 17(4): 419-435.

Altenburg, T., Schmitz, H. and Stamm, A. (2008): ‘Breakthrough? China’s and India’s Transition from Production to Innovation’. *World Development,* 36(2): 325–344.

Amsden, A. H. (2004 (2001)): *The Rise of “the Rest”: Challenges to the West from Late-Industrializing Economies.* New York: Oxford University Press.

Andersen, P. H. and Drejer, I. (2006): *Danmark som Wind Power Hub – mellem virkelighed og mulighed*. Vindmølleindustrien.

Archibugi, D. and Iammarino, S. (2003): ‘The policy implications of the globalization of innovation’. Ch. 12 in Archibiugi, D., Howells, J. and Michie, J. (eds.) (2003): *Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press.

Arthur, W. B. (1989): ‘Competing Technologies, Increasing Returns, and Lock-In by Historical Events’. *The Economic Journal,* 99: 116-131.

Arthur, W. B. (1996): ‘Increasing Returns and the New World of Business’. *Harvard Business Review*: 101-109.

Bair, J. (2005): ‘Global Capitalism and Commodity Chains: Looking Back, Going Forward’. *Competition & Change*, 9(2): 153-180.

Bair, J. (2008a): ‘Analysing economic organization: embedded networks and global chains compared’. *Economy and Society,* 37(3): 339-364, Special Issue: Governing Global Value Chains.

Bair, J. (2008b): ‘Global Commodity Chains – Genealogy and Review’. Ch. 1 in Bair, J. (ed.) (2008): *Frontiers of commodity chain research*. Palo Alto, CA: Stanford University Press.

Bair, J. and Gereffi, G. (2007): *Filling the Global Gap in Economic Sociology*. Conference Papers, American Sociological Association; Annual Meeting 2007: 1-20.

Bair, J. and Peters, E. D. (2006): ‘Global Commodity Chains and Endogenous Growth: Export Dynamics and Development in Mexico and Honduras’. *World Development*, 34(2): 203-221.

Barley, S.R. (2006): ‘When I Write My Masterpiece: Thoughts on What Makes a Paper Interesting’. *Academy of Management Journal*, 49(1): 16-20.

Barnard, H. and Chaminade, C. (2012): ‘Global Innovation Networks: towards a taxonomy’. CIRCLE, Lund University (Paper no. 2011/4).

Barnard, H. and Chaminade, C. (2011): ‘Global Innovation Networks: what are they and where can we find them? (Conceptual and Empirical issues)’. Pre-print version; submitted for journal. INGINEUS Paper submitted for Globelics, Buenos Aires, Nov. 2011.

Barney, J. (1991): ‘Firm Resources and Sustained Competitive Advantage’. *Journal of Management*, 17(1): 99-120.

Barry, A. (2001): *Political Machines – Governing a Technological Society*. New York: The Athlone Press.

Basit, A., Hansen, A. D., and Margaris, I. D. (2013): *A Review of Grid Requirements for Wind Farm in Denmark and China*. Technical University of Denmark.

Beckert, J. and Zafirovski, M. (2011): *International encyclopedia of economic sociology.* London: Taylor and Francis/Routledge.

Blaikie, N. (2007): *Approaches to Social Enquiry: Advancing Knowledge.* Cambridge: Polity Press, 2nd ed.

Blok, A. (2013): ‘Pragmatic sociology as political ecology: On the many worths of nature(s)’. *European Journal of Social Theory*.

Boltanski, L. and Thévenot, L. (2006): *On justification: Economies of worth*. (Trans.: C. Porter). Princeton: Princeton University Press.

Bosworth, D. and Yang, D. (2000): ‘Intellectual property law, technology flow and licensing opportunities in the People’s Republic of China’. *International Business Review*, 9: 453–477.

Bowker, G. C. and Star, S. L. (1999): ‘Some of the Trade in Analyzing Classification’. Ch. 1 in Bowker, G. C. and Star, S. L., *Sorting Things Out*. Cambridge, MA: MIT Press.

Boxenbaum, E. and Rouleau, L. (2011): ‘New knowledge products as bricolage: Metaphors and scripts in organizational theory’. *Academy of Management Review*, 36(2): 272-296.

Brandt, L. and Thun, E. (2010): ‘The Fight for the Middle: Upgrading, Competition, and Industrial Development in China’. *World Development*, 38(11): 1555–1574.

Brandtstädter, S. (2003): ‘With Elias in China. Civilizing process, local restorations and power in contemporary rural China’. *Anthropological Theory*, 3(1): 87-105.

Breznitz, D. and Murphree, M. (2011): *Run of the Red Queen: Government, Innovation, Globalization, and Economic Growth in China*. New Haven: Yale University Press.

Breznitz, D., and Murphree, M. (n.d.): ‘China’s Run of the Red Queen: Government, Innovation, Globalization and Economic Growth’. Forthcoming as Ch. 1 in D. Breznitz and J. Zysman (Eds.): *The Third Globalization: Can Wealthy Nations Stay Rich in the Twenty-First Century?*. Oxford University Press, http://fiid.org/wp-content/uploads/2012/11/China%E2%80%99s-Run-of-the-Red-Queen-%E2%80%93-Government-Innovation-Globalization-and-Economic-Growth.pdf

Breznitz, D. and Murphree, M. (2013): ‘China’s Run: Economic Growth, Policy, Interdependences, and Implications for Diverse Innovation Policies in a World of Fragmented Production’. Ch. 1 in Breznitz, D., Zysman, J. (eds.) (2013): *The Third*

Globalization: Can Wealthy Nations Stay Rich in the Twenty-First Century?. New York: Oxford University Press.

Brown, J. S. and Duguid, P. (1991): 'Organizational learning and communities of practice: Toward a unified view of working, learning, and Innovation'. *Organization Science*, 2(1): 40-57.

Brunsson, N., Rasche, A., and Seidl, D. (2012): 'The Dynamics of Standardisation: Three Perspectives on Standards in Organisation Studies'. Downloaded from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2089976. Published version, refer to *Organization Studies*, 33(5-6), June 2012: 613-632.

Brødsgaard, K.-E. (2002): 'Institutional Reform and the *Bianzhi* System in China'. *The China Quarterly*. 170: 361-386.

Brødsgaard, K.-E. (2012a): 'Politics and Business Group Formation in China: The Party in Control?' *The China Quarterly*, 211: 624-648.

Brødsgaard, K.-E. (2012b): *Murder, Sex, Corruption: Will China Continue to Hold Together?* Copenhagen Discussion Papers, Asia Research Centre, Copenhagen Business School.

Cai, Y. (2004): 'Irresponsible State: Local Cadres and Image-Building in China'. *Journal of Communist Studies and Transition Politics*, 20(4): 20-41.

Callon, M. (1986a): 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay'. In Law, J. (ed.): *Power Action and Belief: A New Sociology of Knowledge?*. London: Routledge & Kegan Paul: 196-233.

Callon, M. (1986b): 'The Sociology of an Actor-Network: The case of the Electric Vehicle'. In Law, J. et al.: *Mapping the Dynamics of Science and Technology*. London: Routledge: 19-34.

Callon, M. (1991): 'Techno-economic networks and irreversibility'. In Law, J. (ed.): *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge: 132-161.

Callon, M. (ed.) (1998): 'The Laws of the Markets'. Oxford: Blackwell Publishers/*The Sociological Review*. Pp- 1-32: 'Introduction: The embeddedness of economic markets in economics'. Pp. 244-269: 'An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology'. Oxford: Blackwell Publishers/ The Sociological Review.

Callon, M. (2007): 'An Essay on the Growing Contribution of Economic Markets to the Proliferation of the Social'. *Theory, Culture & Society*, 24(7-8): 139-163.

Callon, M. (2009): 'Civilizing markets: Carbon trading between in vitro and in vivo experiments'. *Accounting, Organizations and Society*, 34: 535-548.

Callon, M. and Çalişkan, K. (2009): 'Economization, part 1: shifting attention from the economy towards processes of economization'. *Economy and Society*, 38(3): 369-398.

Callon, M. and Çalişkan, K. (2010a): *Economization: New Directions in the Social Studies of the Market*. Draft paper: 1-59.

Callon, M. and Çalişkan, K. (2010b): 'Economization, part 2: a research programme for the study of markets'. *Economy and Society*, 39(1): 1-32.

Callon, M., Méadel, C., and Rabeharisoa, V. (2002): 'The economy of qualities'. *Economy and Society*, 31(2): 194-217.

Cantwell, J. and Piscitello, L. (2005): 'Recent Location of Foreign-owned Research and Development Activities by Large Multinational Corporations in the European Regions: The Role of Spillovers and Externalities'. *Regional Studies*, 39(1). Special Issue.

Carney, R. W. and Witt, M. A. (2013): 'The Role of the State in Asian Business Systems'. INSEAD working paper. In M.A. Witt and G. Redding (eds.): *The Oxford Handbook of Asian Business Systems*. Oxford: Oxford University Press.

Cervantes, M. de (1705/1615): *Don Quixote*. (Trans.: Smollett, T.). New York: Barnes and Noble Classics.

Chaminade, C. and Vang, J. (2008): ‘Globalisation of knowledge production and regional innovation policy: Supporting specialized hubs in the Bangalore software industry’. *Research Policy,* 37: 1684-96.

Chang, Ha-Joon (2003): ‘Kicking Away the Ladder: Development Strategy in Historical Perspective’. London: Anthem Press.

Chang, K.-C. (2011): ‘A Path to Understanding Guanxi in China’s Transitional Economy: Variations on Network Behavior’. *Sociological Theory*, 29(4): 315-339.

Chen, Y.-C. (2007): ‘The Upgrading of Multinational Regional Innovation Networks in China’. *Asia Pacific Business Review*, 13(3): 373-403.

Chen, Y.-C. and Vang, J. (2008): ‘MNCs, Global Innovation Networks and Developing Countries: Insights from Motorola in China’. *International Journal of Business and Management Science*, 1(1): 11-30.

Chen, S.-H. (2004): ‘Taiwanese IT firms’ offshore R&D in China and the connection with the global innovation network’. *Research Policy,* 33(2): 337-349.

Chen, Y., Rong, K., Xue, L., and Luo, L. (2014*):* ‘Evolution of collaborative innovation network in China’s wind turbine manufacturing industry’. *International Journal of Technology Management*, 65(1/2/3/4): 262-299.

Chen, S.-H. and Wen, P.-C. (2011): *Industrial upgrading and global innovation networks: Taiwan case.* Paper to Conference on The Economic Geography of ICT in Asia Pacific, University of Queensland, Brisbane, Apr. 28-30.

Chen, S.-H. and Wen, P.-C. (2013): *A Longitudinal View on Global Production Network, Trade and Economic Integration.* Paper prepared for conference on Trade and Development Symposium at the Ninth WTO Ministerial Conference, Bali, Indonesia, 2013. Working Paper Series No. 2014-2. Downloaded from http://www.cier.edu.tw/public/Data/2014-2.pdf.

Cherni, J. A. and Kentish, J. (2007): ‘Renewable energy policy and electricity market reforms in China’. *Energy Policy,* 35: 3616-3629.

Chesbrough, H., Vanhaverbeke, W., and West, J. (eds.) (2008): *Open Innovation: Researching a New Paradigm.* New York: Oxford University Press.

Chow, Gregory C. (2002): *China's Economic Transformation.* Oxford: Blackwell Publishers Inc.

Christensen, N. H.(2013*): Shaping Markets: A Neoinstitutional Analysis of the Emerging Organizational Field of Renewable Energy in China.* Frederiksberg: Copenhagen Business School [Phd]

Coase, R. H., (1960): 'The Problem of Social Cost'. Journal of Law and Economics, 3: 1-44.

Coase, R. H. (1988): *The Firm, the Market and the Law*. Chicago: University of Chicago Press.

Coe, N. M, Dicken, P., and Hess, M. (2008a): 'Global production networks: realizing the potential'. *Journal of Economic Geography*, 8(3): 271-295.

Coe, N. M., Dicken, P., and Hess, M. (2008b): 'Introduction: global production networks – debates and challenges'. *Journal of Economic Geography*, 8: 267–269.

Cooke, P. (2013): 'Global Production Networks and Global Innovation Networks: Stability Versus Growth'. *European Planning Studies*, 21(7): 1081-1094.

Cornelissen, J.P. (2006): 'Making Sense of Theory Construction: Metaphor and Disciplined Imagination'. *Organization Studies*, 27(11): 1579-1597.

Czarniawska, B. (2008): *Narratives in Social Science Research*. Great Britain: SAGE Publications.

Czarniawska, B. (2013): *On meshworks and other complications of portraying contemporary organizing*. *Managing Overflow*. GRI-rapport 2013:3. Gothenburg Research Institute.

Davis, M. S. (1971): 'That's Interesting! Towards a Phenomenology of Sociology and Sociology of Phenomenology'. *Philosophy of the Social Sciences*, 1(4): 309-344.

Delman, J. (2005): ‘China's party-state and the private business sector: ‘Dog wags tail’ or ‘tail wags dog’?’. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 59(3): 207-216.

Derrida, J. (1978 [1967]): ‘Genesis and Structure' and Phenomenology’. In Derrida, J. (ed.): *Writing and Difference*, Chicago: Chicago University Press: 154-68.

Deleuze, G. and Guattari, F. (2011 [1980]): ‘Introduction: Rhizome’. Ch. 1 in Deleuze, G. and Guattari, F.: *A Thousand Plateaus. Capitalism and Schizophrenia*. London: Continuum International Publishing Group: 3-28.

Dewey, J. (1927): *The Public and its Problems*. Oxford: Holt.

Dicken, P. (2007): *Global Shift: Mapping the changing contours of the world economy*. 5th ed., London: Sage.

Dicken, P., Kelly, P. F., Olds, K., and Yeung, H. W.-C. (2001): ‘Chains and networks, territories and scales: Towards a relational framework for analysing the global economy’. *Global Networks*, 1(2): 89–112.

Dobbin, F. (ed.) (2004): *The New Economic Sociology – A Reader*. Princeton, New Jersey: Princeton University Press.

Doganova, L. (2009): *Entrepreneurship as a Process of Collective Exploration.* Centre de Sociologie de l’Innovation, MINES ParisTech. Working paper.

Doganova, L. and Karnøe, P. (2014, forthcoming): ‘Controversial valuations: Assembling environmental concerns and economic worth in clean-tech markets’. *Journal of International Marketing Management*, accepted. (Draft version: http://marketstudi.es/wp-content/uploads/2012/06/Doganova_Karnoe_Valuations.pdf)

Doganova, L. and Eyquem-Renault, M. (2009): ‘What do business models do? Innovation devices in technology entrepreneurship’. *Research Policy*, 38: 1559-1570.

Dongsheng, G. and Fujimoto, T. (2004): 'Quasi-open Product Architecture and Technological Lock-in: An Exploratory Study on the Chinese Motorcycle Industry'. *Annals of Business Administrative Science*, 3(2).

Dunning, J. H. (1980): 'Toward an eclectic theory of international production. Some empirical tests'. *Journal of International Business Studies*, 3: 9-31.

du Gay, P. (2010): 'Performativities: Butler, Callon and the 'moment of theory'. *Journal of Cultural Economy*, 3: 171-179.

Eco, U. (1983 (1980)): *Rosens navn.* København: Forum.

Elias, N. (2006 (1969)): *The Court Society*. Dublin: University College Dublin Press.

Elias, N. (1978): *What Is Sociology?* New York: Columbia University Press.

Ernst, D. (2002): 'Global production networks and the changing geography of innovation systems: Implications for developing countries'. *Economics of Innovation and New Technology*, 11(6): 497-523.

Ernst, D. (2006): *Innovation Offshoring: Asias's Emerging Role in Global Innovation Networks.* East-West Center Special Reports: 10.

Ernst, D. (2008): 'Asia's "upgrading through innovation" strategies and global innovation networks: an extension of Sanjaya Lall's research agenda'. In United Nations: *Transnational Corporations* 17(3): 31-57.

Ernst, D. (2011a): *Toward Greater Pragmatism? China's Approach to Innovation and Standardization.* Policy Brief, 18. SITC (Study of Innovation and Technology in China).

Ernst, D. (2011b): *Indigenous Innovation and Globalization. The Challenge for China's Standardization Strategy.* A joint publication of the UC Institute on Global Conflict and Cooperation and the East-West Center.: 1-136. Downloaded from: https://www.eastwestcenter.org/sites/default/files/private/ernstindigenousinnovation.pdf

Ernst, D. (2012): *America's Voluntary Standards System: A "Best Practice" Model for Innovation Policy?* Economics Series, 128. East-West Center Working Papers.

Ernst, D. (2013): *Standards, Innovation, and Latecomer Economic Development: A Conceptual Framework*. East-West Center Working Papers. Economics Series, No. 134.

Ernst, D. and Kim, L. (2002): 'Global production networks, knowledge diffusion, and local capability formation'. *Research Policy*, 31: 1417–1429.

Ernst, D. and Naughton, B. (2012): *Global Technology Sourcing in China's Integrated Circuit Design Industry: A Conceptual Framework and Preliminary Findings*. East-West Center Working Papers. Economics Series, 131.

Erzberger, C. and Prein, G. (1997): 'Triangulation: validity and empirically based hypothesis construction'. *Quality & Quantity*, 31(2): 141-154.

Evans, P. (1995): *Embedded Autonomy: States and Industrial Transformation*. Princeton: Princeton University Press.

Fagerberg, J., Mowery, D. C., and Nelson, R. R. (2005): *The Oxford Handbook of Innovation.* Oxford: Oxford University Press.

Fan, C. C. (2006): 'China's Eleventh Five-Year Plan (2006-2010): From "Getting Rich First" to "Common Prosperity"'. *Eurasian Geography and Economics*, 47(6): 708-723.

Fang, T. (1999): 西方谈判者:我会说，他利用面子;中国人说《在谈判之前，我们内部已作好分工了》，例摘自 (Tony Fang's 'Chinese Business Negotiating Styles, Business cases Western Negotiator'). In Fang's *Chinese Business Negotiating Style*, International Business Series, SAGE.

Fang, Y., Li, J., and Wang, M. (2012): 'Development policy for non-grid-connected wind power in China: An analysis based on institutional change'. *Energy Policy*, 45: 350-358.

Figueiredo, P. N. (2002): 'Does technological learning pay off? Inter-firm differences in technological capability-accumulation paths and operational performance improvement'. *Research policy*, 31(1): 73-94.

Fligstein N. (2001): *The architecture of markets: an economic sociology of twenty-first century capitalist societies*. Princeton: Princeton University Press.

Fligstein, N. and Zhang, J. (2010): 'A New Agenda for Research on the Trajectory of Chinese Capitalism'. *Management and Organization Review*, 7(1): 39–62.

Foucault, M. (1991): 'Governmentality' (Trans.: R. Braidotti) in Burchell, G., Gordon, C., and Miller, P. (eds.): *The Foucault Effect: Studies in Governmentality*: 87–104. Chicago: University of Chicago Press.

Fraser, M. (2010): 'Facts, Ethics and Event' in Jensen, C. B. and Rödje, K. (eds.): *Deleuzian Intersections in Science, Technology and Anthropology*: 57-82. New York: Berghahn Press.

Fu, X., Pietrobelli, C., and Soete, L. (2011): 'The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-Up'. *World Development*, 39(7): 1204–1212.

Gad et al. (2014): *Practical Ontology: Worlds in STS and Anthropology*. Frederiksberg: Roskilde Universitetsforlag.

García, C. (2013): 'Policies and Institutions for Grid-Connected Renewable Energy: "Best Practice" and the Case of China'. *Governance: An International Journal of Policy, Administration, and Institutions*, 26(1): 119-146.

Garsten, C. (2010): 'Ethnography at the interface: 'corporate social responsibility' as an anthropological field of inquiry'. Ch. 4 in Melhuss, M., Mitchel, J. P., and Wulff, H. (eds.): *Ethnographic Practice in the Present*: 56-68. European Association of Social-Anthropologists/EASA Series: 11. New York: Berghahn.

Garud, R. B. and Karnøe, P. (2001): 'Path Creation as a process of Mindful Deviation'. In Garud, R. and Karnøe, P.: *Path dependence and creation*. Mahwah, NJ: Lawrence Earlbaum Associates.

Garud, R. B. and Karnøe, P. (2003): 'Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship'. *Research Policy*, 32: 277-300.

Garud, R. and Gehman, J. (2012): ‘Metatheoretical perspectives on sustainability journeys: Evolutionary, relational and durational’. *Research Policy,* 41: 980-995.

Garud, R., Gehman, J., and Karnøe, P. (2010a): ‘Categorization by association: Nuclear Technology and Emission Free Electricity’. *Research in the Sociology of Work*, Forthcoming. Available at SSRN: http://ssrn.com/abstract=1615436

Garud, R., Kumaraswamy, A., and Karnøe, P. (2010b): ‘Path Dependence or Path Creation?’ *Journal of Management Studies*, 47(4): 760-774.

Geertz, C. (1973): ‘Thick Description: Toward an Interpretative Theory of Culture’. In Geertz, C.: *The Interpretation of Cultures*. New York: Basic Books.

Gereffi, G. (1994a): ‘The organization of buyer-driven global commodity chains: how US retailers shape overseas production networks’. Ch. 5 in Gereffi, G. and Korzeniewicz, M. (eds.): *Commodity Chains and Global Capitalism*. Westport, CT: Greenwood Press: 95–122.

Gereffi, G. (1994b): ‘*Capitalism, development and global commodity chains’,* in Capitalism and Development, edited by Leslie Sklair (1994), pp. 211-231, London: Routledge.

Gereffi, G. (1999): ‘International trade and industrial upgrading in the apparel commodity chain’. *Journal of international economics*, 48(1): 37-70.

Gereffi, G. (2005): ‘The Global Economy: Organization, Governance, and Development’. Ch. 8 in Smelser, N. and Swedberg, R. (eds.) (2005): *The Handbook of Economic Sociology*. Princeton: Princeton University Press.

Gereffi, G. and Fernandez-Stark, K. (2011): *Global Value Chain Analysis: A Primer*. Center on Globalization, Governance & Competitiveness (CGGC), Duke University.

Gereffi, G., Humphrey, J., and Sturgeon, T. (2005): ‘The governance of global value chains’. *Review of International Political Economy*, 12(1): 78–104.

Gertler, M. S. (2003): ‘Tacit knowledge and the economic geography of context, or The undefinable tacitness of being (there)’. *Journal of Economic Geography,* 3: 75-99.

Gertler, M. S and Levitte, Y. M. (2007): 'Local Nodes in Global Networks: The Geography of Knowledge Flows in Biotechnology Innovation'. *Industry & Innovation*, 12(4): 487-507. Special Issue: Knowledge Geographies.

Gibbon, P. and Ponte, S. (2008): 'Global value chains: from governance to governmentality?' *Economy & Society*, 37(3): 365-392.

Gibbon, P., Bair, J., and Ponte, S. (2008): 'Governing global value chains: an introduction'. *Economy and Society*, 37(3): 315-338.

Gilpin, Robert (2000): 'National Systems of Political Economy'. Chapter 7 in Gilpin, R.: *Global Political Economy*. Princeton: Princeton University Press.

Giuliani, E. and Bell, M. (2005): 'The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster'. *Research Policy*, 34(1): 47–68.

Giuliani, E. (2013): *Network Dynamics in Regional Clusters: The Perspective of an Emerging Economy*. Papers in Evolutionary Economic Geography, 10.14. Utrecht: Utrecht University, Urban & Regional Research Centre.

Glaser, B. G. and Strauss, A. L. (1967): *The discovery of grounded theory: strategies for qualitative research*. Chicago: Aldine.

Goldstein, S. M. (1996): 'The Political Foundations of Incremental Reform', in Walder, A. (ed.): *China's Transitional Economy.* Oxford: Oxford University Press: 143-169.

Gosens, J. and Lu, Y. (2014): 'Prospects for global market expansion of China's wind turbine manufacturing industry'. *Energy Policy*, 67: 301-318.

Grabher, G. (2005): Trading routes, bypasses, and risky intersections: Mapping the travels of 'networks' between economic sociology and economic geography. Working Papers Series, Center on Organizational Innovation, Columbia University. (Also available in, 'Progress in Human Geography', 2006, Vol. 30(1).) (Referenced paper is the 2005 version available online at http://www.coi.columbia.edu/pdf/grabher_trbri.pdf.)

Granovetter, M. S., (1985): ‘Economic Action and Social Structure: The Problem of Embeddedness’. *American Journal of Sociology*, 91(3): 481-510.

Hall, P. A. and Soskice, D. (2001): ‘An Introduction to Varieties of Capitalism’. Ch. 1 in Hall, P.A. and Soskice, D.: *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage.* Oxford: Oxford University Press.

Hall, P. A. and Gingerich, D. W. (2009): ‘Varieties of Capitalism and Institutional Complementarities in the Political Economy: An Empirical Analysis’. *British Journal of Political Science,* 39(3): 449-482.

Hall, P. A. and Thelen, K. (2009): ‘Institutional change in varieties of capitalism’. *Socio-Economic Review*, 7: 7–34.

Heilmann, S. (2005): ‘Regulatory Innovation by Leninist Means: Communist Party Supervision in China’s Financial Industry’. *The China Quarterly*, 181: 1-21.

Heilmann, S. (2008): ‘From Local Experiments to National Policy: The Origins of China’s Distinctive Policy Process’. *The China Journal*, 59, January.

Heilmann, S. (2009): ‘Maximum Tinkering under Uncertainty: Unorthodox Lessons from China’. *Modern China*, 35(4): 450-462.

Heilmann, S. (2011): ‘Policy Making through Experimentation: The Foundation of a Distinctive Policy Process’, in Heilmann, S. and Perry, E. J. (2011): *Mao's Invisible Hand: The Political Foundations of Adaptive Governance in China* (Harvard Contemporary China Series).

Heilmann, S. and Perry, E. J. (2011): *Mao's Invisible Hand: The Political Foundations of Adaptive Governance in China*. Harvard Contemporary China Series.

Heimer, M. and Thøgersen, S. (eds.) (2006): *Doing fieldwork in China*. Copenhagen: NIAS Press.

Henderson, Rebecca M., and Clark, Kim B. (1990): ‘Architectural Innovation: The Reconfiguration Of Existing’. *Administrative Science Quarterly,* 35(1): 9-30.

Henderson, J., Dicken, P., Hess, M., Coe, N., and Yeung, H. W.-C. (2002): ‘Global production networks and the analysis of economic development’. *Review of International Political Economy*, 9(3): 436-464.

Herrigel, Gary; Volker Wittke and Ulrich Voskamp (2013): ‘The Process of Chinese Manufacturing Upgrading: Transforming from Unilateral to Recursive Mutual Learning Relations’, Global Strategy Journal 3: 109-125.

Herrigel, G. (2010): *Manufacturing Possibilities: Creative Action and Industrial Recomposition in the United States, Germany, and Japan*. Oxford: Oxford University Press.

Herstad, S. J., Aslesen, H. W., and Ebersberger, B. (2014): ‘On industrial knowledge bases, commercial opportunities and global innovation network linkages’. *Research Policy*, 43: 495-504.

Herstad, S. J., Ebersberger, B., and Asheim, B. (2013): ‘MNC affiliation, knowledge bases and involvement in global innovation networks’. CIRCLE, Lund University, Paper no. 2013/12. Authors’ original manuscript of article submitted for *Economics of Innovation and New technology*; available online at http://www.tandfonline.com

Hess, M. and Yeung, W.-C. (2006): ‘Guest Editorial’. *Environment & Planning A*, 38(7): 1193-1204.

Hopkins, T. and Wallerstein, I. (1977): ‘Patterns of development of the modern world-system’. *Review*, 1(2): 11–145.

Humphrey, J. and Schmitz, H. (2002): ‘How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters?’. *Regional Studies,* 36(9): 1017-1027.

Haakonsson, S. J., and Slepniov, D. (forthcoming): *Industrial dynamics beyond the lead firms; internalization of turn-key SMEs: Evidence from the wind energy industry in China.* Working paper for ’Green Asia’-conference, Copenhagen Business School, Asia Research Centre, May 2014.

INGINEUS (Deliverable 2.2) (2011): *Complete standardized data set containing all the information collected in all countries: Executive Summary*. Impacts of Networks, Globalisation and their Interaction with EU Strategies. http://www.feemdeveloper.net/UserFiles/INGINEUS_D2.2_MethodologyReport(2).pdf

INGINEUS (Deliverable 4.1) (2011): *The patterns of knowledge accumulation, institutional frameworks and insertion in global innovation networks in successful sub-national regions*. Impact of Networks, Globalisation and their Interaction with EU Strategies. http://www.feemdeveloper.net/UserFiles/INGINEUS_D4.1.pdf

INGINEUS (Deliverable 5.1) (2011): *Understanding strategies of R&D offshoring by Northern and Southern firms*. Impact of Networks, Globalisation and their Interaction with EU Strategies. http://www.ingineus.eu/UserFiles/INGINEUS_D5.1._3_pdf

INGINEUS (2011): *Project Final Report*. http://www.feemdeveloper.net/ingineus/userfiles/attach/20123131122294INGINEUS_finalreport.pdf

Jensen, C. B. (2007): 'Infrastructural fractals: revisiting the micro-macro distinction in social theory'. *Environment and Planning D: Society and Space*, 25: 832-850.

Jensen, C. B. (2010): 'An Amodern Disposition – On Performativity, Practical Ontology, and Intervention'. Ch. 1 in Jensen, C. B. (2010): *Ontologies for Developing Things: Making Health Care Futures Through Technology*. Transdisciplinary Studies, 3. Rotterdam: Sense Publishers.

Jessop, B. (2011): 'Rethinking the diversity of capitalism: varieties of capitalism, variegated capitalism, and the world market'. In Wood, G. and Lane, C. (eds.), *Capitalist Diversity and Diversity within Capitalism*, London: Routledge: 209-237.

Johnson, C. A. (1995): 'Comparative capitalism: the Japanese difference', in Johnson, C. A.: *Japan: Who Governs? The Rise of the Developmental State*. New York: Norton & Co, 51-68.

Karnøe, P. and Garud, R. B. (2012): ‘Path Creation: Co-creation of Heterogeneous Resources in the Emergence of the Danish Wind Turbine Cluster’. *European Planning Studies,* 20(5): 733-752.

Kaya, T. A (2007): ‘Comparative Analysis Of The Patentability Of Computer Software Under The Trips Agreement: The U.S., The E.U., and Turkey’. *Ankara Law Review,* 4(1): 43-81.

Keister, L. A. (1998): ‘Engineering Growth: Business Group Structure and Firm Performance in China’s Transition Economy’. Vol. 104, No. 2: 404-440, University of North Chicago.

Keister, L. A (2000): ‘Chinese Business Groups: The structure and Impact of Interfirm relation during economic development’. Hong Kong: Oxford University Press.

Keyuan, Z. (2006): ‘Administrative Reform and Rule of Law in China’. *The Copenhagen Journal of Asian Studies*, North America, 24, Apr. 2006.

Kirkegaard, P. (2013): ’Blues for Folkhemmet. Næranalyse af Arne Dahls Europa Blues’. Aalborg: Aalborg Universitetsforlag.

Kirkegaard, P. (2014): ’OPCOP – eller EUROPA BLUES 2.0 – om Arne Dahls nye Eurokrimi-kvartet’. *Standart* 3, Sep. 2014.

Klagge, B, Liu, Z., and Silva, P. C. (2012): ‘Constructing China’s wind energy innovation system’. *Energy Policy,* 50: 370–382.

Korsnes, M. (2014): ‘Fragmentation, Centralisation and Policy Learning: An Example from China’s Wind Industry’. *Journal of Current Chinese Affairs,* 43(3): 175–205.

Koza, P. M. and Lewin, A. Y. (1998): ‘The Co-Evolution of Strategic Alliances’. *Organization Science*. Special Issue: Managing Partnerships and Strategic Alliances, 9(3): 255-264.

Kristinsson, K. and Rao, R. (2008): ‘Interactive Learning or Technology Transfer as a Way to Catch-Up? Analysing the Wind Energy Industry in Denmark and India’. *Industry & Innovation*, 15(3): 297-320.

Krugman, P. (1991): ‘Increasing Returns and Economic Geography’. *The Journal of Political Economy*, 99(3): 483-499.

Lam, J.C.K., Woo, C.K., Yu, and W.K. (2013): ‘What moves wind energy development in China? Show me the money!’. *Applied Energy*, 105: 423-429.

Latour, B. (1983): ‘Give me a laboratory and I will move the world’. Ch. 6 in Knorr, K. et Mulkay, M. (eds.): *Science Observed. Perspectives on the Social Study of Science*. Beverly Hills, California, Sage: 141-170. http://www.bruno-latour.fr/sites/default/files/12-GIVE-ME-A-LAB-GB.pdf

Latour, B. (1987): *Science in Action. How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

Latour, B. (1992): ‘Where are the missing masses: Sociology of a few mundane artefacts’. In Bijker, W. and Law, J. (eds.): *Shaping Technology-Building Society*. Cambridge, MA: MIT Press: 225-259.

Latour, B. (2004): ‘Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern’. *Critical Inquiry*, 30: 225-248.

Latour, B. (2005a): *Reassembling the Social: An Introduction to Actor-Network-Theory*. New York, NY: Oxford University Press.

Latour, B. (2005b): ‘From Realpolitik to Dingpolitik or How to Make Things Public’. In Latour, B. and Wiebel, P. (eds.): *Making Things Public: Atmospheres of Democracy*. Cambridge, MA: MIT Press.

Layder, D. (1986): ‘Social Reality as Figuration. A Critique of Elias’s Conception of Sociological Analysis’. *Sociology*, 20: 367.

Lave, J. (2009): ‘The practice of learning’. In Illeris, K. (ed.): *Contemporary theories of learning: Learning theorists...in their own words*. Milton Park: Routledge: 200-208.

Law, J. (1994): *Organizing Modernity: Social Ordering and Social Theory*. Oxford: Blackwell.

Law, J. (2004): *After Method. Mess in social science research*. New York: Routledge.

Law, J. (2003): *Ordering and Obduracy*. Centre for Science Studies, Lancaster University. Accessed 29.11.2014: http://www.lancaster.ac.uk/fass/sociology/research/publications/papers/law-ordering-and-obduracy.pdf

Law, J. (2009): ‘Actor Network Theory and Material Semiotics’. Ch. 7 in Turner, B. S. (ed.): *The New Blackwell Companion to Social Theory*. Oxford: Blackwell Publishing: 141-158.

Lawrence, S. V. and Martin, M. E. (2013): ‘Understanding China’s Political System’. *Congressional Research Service*. CRS Report for Congress.

Lee, T.-L. and von Tunzelmann, N. (2005): ‘A dynamic analytic approach to national innovation systems: The IC industry in Taiwan’. *Research Policy*, 34(4): 425–440.

Lema, R., Berger, A., and Schmitz, H. (2013): ‘China’s Impact on the Global Wind Power Industry’. *Journal of Current Chinese Affairs*, 42(1): 37–69.

Lema, A. and Ruby, K. (2007): ‘Between fragmented authoritarianism and policy coordination: Creating a Chinese market for wind energy’. *Energy Policy,* 35: 3879-3890.

Lewis, J. I. (2007): ‘Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India’. *St. Comp. Int. Dev*., 42: 208–232.

Lewis, J. I. (2011): ‘Building a national wind turbine industry: experiences from China, India and South Korea’. *International Journal of Technology and Globalisation,* 5(3/4): 281-305.

Lewis, J. I. (2013): *Green innovation in China. China's Wind Power Industry and the Global Transition to a Low-Carbon Economy.* New York: Columbia University Press.

Lewis, J. I. and Wiser, R. H. (2007): 'Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms'. *Energy Policy*, 35: 1844-1857.

Li, J. (2010): 'Decarbonising power generation in China – Is the answer blowing in the wind?' *Renewable and Sustainable Energy Reviews*, 14: 1154-1171.

Li, C.B., Li, P., and Feng, X. (2014): 'Analysis of wind power generation operation management risk in China'. *Renewable Energy*, 64: 26-275.

Liao, C., Jochem, E., Zhang, Y., and Farid, N. R. (2010): 'Wind power development and policies in China'. *Renewable Energy*, 35: 1879-1886.

Lieberthal, K. (2004 (1995)): 'The organization of political power and its consequences: The view from the outside'. Ch. 6 in Lieberthal, K.: *Governing China: From Revolution Through Reform.* 2nd ed. New York: W.W.: Norton & Co: 171-205.

Lin, L.-W. and Milhaupt, C. J. (2013): 'We Are the (National) Champions: Understanding the Mechanisms of State Capitalism in China'. *Stanford Law Review*, 65: 697-760.

Linden, G., Kraemer, K. L., and Dedrick, J. (2009): 'Who Captures Value in a Global Innovation Network? The Case of Apple's iPod'. *Communications of the ACM*, 52(3): 140-144.

Liu, W. (2005): 'Intellectual property protection related to technology in China'. *Technological Forecasting & Social Change*, 72: 339–348.

Liu, Y. and Kokko, A. (2010): 'Wind power in China: Policy and development challenges'. *Energy Policy*, 38: 5520-5529.

Liu, J., Chaminade, C., and Asheim, B. (2013): 'The Geography and Structure of Global Innovation Networks: A Knowledge Base Perspective'. *European Planning Studies*, 21(9): 1456-1473.

Lohmann, L. (2009): ‘Toward a different debate in environmental accounting: The cases of carbon and cost–benefit’. *Accounting, Organizations and Society*, 34: 499–534.

Lundvall, B.-Å. (ed.) (2010): *National Systems of Innovation. Toward a Theory of Innovation and Interactive Learning*. New York: Anthem Press.

MacKenzie, D. (2003): ‘An Equation and its Worlds: Bricolage, Exemplars, Disunity and Performativity in Financial Economics’. *Social Studies of Science*, 33(6), 831–868.

March, J. G. (1991): ‘Exploration and Exploitation in Organizational Learning’. *Organization Science*, 2 (1): 71–87.

Marcus, G. E. (1995): ‘Ethnography in/of the world system. The Emergence of Multi-Sited Ethnography’. *Annual Review of Anthropology*, 24: 95-117.

Marcus, G. E. (2005): *Multi-sited Ethnography: Five or Six Things I Know About It Now*. In Problems and Possibilities in Multi-sited Ethnography Workshop, University of Sussex. (Unpublished paper). http://eprints.ncrm.ac.uk/64/

Malmberg, A. and Maskell, P. (2006): ‘Localized Learning Revisited’. *Growth and Change*, 37(1).

Martin, R. (2010): ‘Rethinking Regional Path Dependence: Beyond Lock-in to Evolution’. The 2009 Roepke Lecture in *Economic Geography*, 86(1): 1-27.

Maskus, K. E. (2002): ‘Regulatory standards in the WTO: Comparing intellectual property rights with competition policy, environmental protection, and core labor standards’. *World Trade Review*, 1(2): 135–152.

Mathews, J. A. (2002): ‘Competitive Advantages of the Latecomer Firm: A Resource-Based Account of Industrial Catch-Up Strategies’. *Asia Pacific Journal of Management*, 19: 467-488.

Mathews, J. A. (2006): ‘Dragon Multinationals: New Players in 21st century globalization’. *Asia Pacific Journal of Management*, 23(1): 5-27.

Mathews, J. A. (2008): ‘Energizing industrial development’. In United Nations: *Transnational Corporations*, 17(3): 59-73.

Mathews, J. A. (2009): ‘China, India and Brazil: Tiger technologies, dragon multinationals and the building of national systems of economic learning’. *Asian Business & Management*, 8(1): 5–32.

McGregor, J. / APCO Worldwide / US Chamber of Commerce (2009): *China’s Drive for ‘Indigenous Innovation’. A Web of Industrial Policies.* Global Intellectual Property Centre, Global Regulatory Cooperation Project; Accessed on 29.11.2014: https://www.uschamber.com/sites/default/files/documents/files/100728chinareport_0_0.pdf

McNally, C. A. (2006): *Insinuations on China’s Emergent Capitalism*. East-West Center Working Paper. Politics, Governance, and Security Series, 15.

McNally, C. A. (2007): ‘China’s capitalist transition: The making of a new variety of capitalism’. *Comparative Social Research*, 24: 177-203.

McNally, C. A., Guo, H., and Hu, G. (2007): *Entrepreneurship and Political* Guanxi *Networks in China’s Private Sector*. East-West Working Papers, 19.

Mead, G. H. (1934): ‘Mind, Self and Society’. Chicago: Chicago University Press.

Meidan, M., Andrews-Speed, P., and Xin, M. (2009): ‘Shaping China’s Energy Policy: actors and processes’. *Journal of Contemporary China*, 18(61): 591-616.

Mertha, A. (2009): ‘Fragmented Authoritarianism 2.0: Political Pluralization in the Chinese Policy Process’. *The China Quarterly*, 200 (December): 995-1012.

Meyer, K. E. (2004): ‘Perspectives on Multinational Enterprises in Emerging Economies’. *Journal of International Business Studies*, 35(4): 259-276.

Meyer, M. and Lu, X. (2005): ‘Managing indefinite boundaries: The strategy and structure of a Chinese business firm’. *Management and Organization Review*, 1 (1): 57-86.

Mol, A. (1999): ‘Ontological politics. A word and some questions’. In Law, J. and Hassard, J. (ed.): *Actor Network Theory and after*: 74-88. Oxford: Blackwell.

Morrison, J. (2001): ‘Corporate Governance: Global Issues and Japanese Perspectives’. In Thorpe, R. and Little, S.: *Global Change: The Impact of Asia in the 21st Century*. Houndmills, Basingstoke: Palgrave: 85-106.

Morrison, A., Pietrobelli, C., and Rabellotti, R. (2008): ‘Global Value Chains and Technological Capabilities: A Framework to Study Learning and Innovation in Developing Countries’. *Oxford Development Studies*, 36(1): 39-58.

Muniesa, F. (Forthcoming): ‘Actor-Network Theory’. *International Encyclopedia of the Social and Behavioral Sciences*, Elsevier: 2nd ed.

Murdoch, J. (1998): ‘The Spaces of Actor-Network Theory’. *Geoforum*, 29(4): 357-374.

Nahm, J. and Steinfeld, E. S. (2012): ‘Scale-Up Nation: The Political Economy of China’s Ascendance in Global Manufacturing’. Presented at the INCODE-Conference, Sep. 24-25, 2012.

Nahm, J. and Steinfeld, E. S. (2013/forthcoming): *Scale-Up Nation: China’s Specialization in Innovative Manufacturing*. Brown University. (Currently under review at World Development). http://www.hbs.edu/faculty/conferences/2013-bgie/Documents/SteinfeldNahm.pdf (Accessed 29.11.2014).

Naughton, B. (2011): ‘What Price Continuity?’ *China Leadership Monitor*, 34.

Nelson, R. R. and Winter, S. G. (2002): ‘Evolutionary Theorizing in Economics’. *The Journal of Economic Perspectives*, 16(2): 23-46.

Nolan, P. (2001): *China and the Global Economy: National Champions, Industrial Policy and the Big Business Revolution.* New York: Palgrave.

OECD (2008): *Policy Brief – Open Innovation in Global Networks*: 1-8.

Oi, J. C. (2005): 'Patterns of Corporate Restructuring in China: Political Constraints on Privatisation'. *The China Journal*, 53: 115-136.

Owen-Smith, J. and Powell, W. W. (2004): 'Knowledge Networks as Channels and Conduits: The Effects of spillovers in Boston Biotech Community'. *Organization Science,* 15(1): 5-21.

Padgett, J. F., and Powell, W. W. (edt.) (2012): *The Emergence of Organizations and Markets.* Princeton: Princeton University Press.

Parrilli, M. D., Nadvi, J.; and Yeung, H. W.-C. (2013): 'Local and Regional Development in Global Value Chains, Production Networks and Innovation Networks: A Comparative Review and the Challenges for Future Research'. *European Planning Studies,* 21(7): 967-988.

Pavitt, K. and Patel, P. (2003): 'Global corporations and national systems of innovation: who dominates whom?'. Ch. 6 in Archibiugi, D., Howells, J., and Michie, J. (eds.) (2003): *Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press.

Peck, J. and Theodore, N. (2007): 'Variegated capitalism'. *Progress in Human Geography*, 31(6): 731–772.

Peck, J. and Zhang, J. (2013): 'A variety of capitalism…with Chinese characteristics?'. *Journal of Economic Geography*, 13: 357-396.

Peng, M. W. (2002): 'Towards an institution-based view of business strategy'. *Asia Pacific Journal of Management*, 19(2/3): 251-267.

Penrose, E. (1959): *The Theory of the Growth of the Firm*. New York, John Wiley and Sons.

Peteraf, M.A. (1993): 'The Cornerstones of Competitive Advantage: A Resource-Based View'. *Strategic Management Journal*, 14(3): 179-191.

Phillips, N., Lawrence, T. B. and Hardy, C. (2004): 'Discourse and Institutions'. *Academy of Management Review*, 29(4): 635-652.

Pietrobello, C. and Rabellotti, R. (eds.) (2007): *Upgrading and Governance in Clusters and Value Chains in Latin America*. Cambridge, MA: Harvard University Press.

Ponte, S. (2007): *Governance in the Value Chain for South African Wine*. Tralac Working Paper, 9.

Ponte, S. (2009): 'Governing through Quality: Conventions and Supply Relations in the Value Chain for South African Wine'. *European Society for Rural Sociology,* Sociologia Ruralis, Vol. 49(3).

Ponte, S. and Cheyns, E. (2013): 'Voluntary standards, expert knowledge and the governance of sustainability networks'. *Global Networks*, 13(4): 459–477.

Powell, W. W. (1990): 'Neither Market nor Hierarchy'. *Research in Organizational Behavior*, 12: 295-336.

Powell, W. W. (1998): 'Learning From Collaboration: Knowledge and Networks in the Biotechnology and Pharmaceutical Industries'. *California Management Review*, 40(3): 228-240.

Powell, W.W., Koput K. W., and Smith-Doerr, L. (1996): 'Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology'. *Administrative Science Quarterly* (ASQ), 41: 116-145.

Powell, W. W. and Grodal, S. (2005): 'Networks of Innovators'. *The Oxford Handbook of Innovation,* 56-85. Online: http://web.stanford.edu/group/song/papers/powellgrodal.pdf (Accessed 29.11.2014)

Powell, W. W., Packalen K. E., and Whittington, K. B. (2012): 'Organizational and Institutional Genesis: The Emergence of High-Tech Clusters in the Life Sciences'. Ch. 14 in Padgett, J. and Powell, W. W. (eds.) (2012): *The Emergence of Organizations and Markets*: 434-465. Princeton: Princeton University Press.

Powell, W. W. and Padgett, J. F. (2012): 'Coda. Reflections on the Study of Multiple Networks'. Ch. 'Coda': 566-570 in Padgett, J. and Powell, W. W. (eds.): *The Emergence of Organizations and Markets*. Princeton: Princeton University Press.

Prior, L. (2004): ‘Doing Things with Documents’. In Silverman, D. (ed.): *Qualitative Research. Theory, Method and Practice*: 76-94. Los Angeles: Sage.

Quintaneiro, T. (2006): ‘The concept of figuration or configuration in Norbert Elias’ sociological theory’. *Teoria & Sociedade*, 2.

Redding, G. and Witt, M. A. (2006): ‘The ‘Tray of Loose Sand’: A Thick Description of the State-Owned Enterprise Sector of China Seen as a Business System’. *Asian Business & Management*, 5: 87–112.

Redding, G. and Witt, M. A. (2008): *China’s Business System and Comparative Advantage*. Faculty & Research Working Paper, INSEAD.

Redding, G. and Witt, M. A. (2009): ‘China’s business system and its future trajectory’. *Asia Pac. J. Manag.*, 2: 381–399, Springer.

Redding, G. and Witt, M. A. (2010): *Post-Transition China*. Working Paper Series, INSEAD.

Ru, P., Zhi, Q., Zhang, F., Zhong, X., Li, J., and Su, J. (2012): ‘Behind the development of technology: The transition of innovation modes in China’s wind turbine manufacturing industry’. *Energy Policy*, 32: 58-69.

Saunders, M., Lewis, P., and Thornhill, A. (2003): *Research Methods for Business Students*, 3rd ed. Madrid: Prentice Hall, Financial Times.

Saxenian, A.L. (2006): *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, MA: Harvard University Press.

Smith, A. (1776): *The Wealth of Nations*. London: Strahan and Cadell.

Schmitz, H. (2004): *Local upgrading in global chains: Recent findings*. DRUID Summer Conference 2004, Denmark.

Schumpeter, J. A. (1934): *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Serger, S. S. and Breidne, M. (2007): ‘China's Fifteen-Year Plan for Science and Technology: An Assessment’. *Asia Policy,* 4: 135-164.

Serres, M. (1995): *Genesis.* Ann Arbor: University of Michigan Press.

Shi, Y. (2012): *China’s Power Sector Reform: Efforts, Dilemmas, and Prospect*. Department of Industrial Economic Research, The Development Research Center of the State Council of P.R. China, Harvard Electricity Policy Group. Power point presentation, March 8-9, 2012.

Silva, P. C. and Klagge, B. (2013): ‘The Evolution of the Wind Industry and the Rise of Chinese Firms: From Industrial Policies to Global Innovation Networks’. *European Planning Studies,* 21(9): 1341-1356.

Stacey, R. D. (2003): *Strategic management and organisational dynamics. The challenge of complexity*. London: Pearson Higher Education, Ed. 4.

Spencer, J. W. (2003): ‘Firms’ knowledge-sharing strategies in the global innovation system: Empirical evidence from the flat panel display industry’. *Strategic Management Journal*, Vol. 24: 217–233.

Stark, D. (2009): *The Sense of Dissonance. Accounts of Worth in Economic Life*. Princeton: Princeton University Press.

Steinfeld, E. S. (2004): ‘China’s Shallow Integration: Networked Production and the New Challenges for Late Industrialization’. *World Development,* 32(11): 1971–1987.

Stengers, I. (2005a): ‘Introductory notes on an ecology of practices’. *Cultural Studies Review 11(1):184-196.*

Stengers, I. (2005b): ‘The Cosmopolitical Proposal’. In Latour, B. and Webel, P. (eds.), *Making Things Public*. Cambridge, MA: MIT Press: 994-1003.

Stengers, I. (2011): ‘Comparison as a matter of concern’. *Common Knowledge,* 17:1. Symposium: Comparative Relativism.

Strauss, A. and Corbin, J. (1998): ‘Grounded Theory Methodology: An Overview’. In Denzin, N. K. and Lincoln, Y. S. (eds.): *Strategies of Qualitative Inquiry*, Thousand Oaks, CA: Sage: 158-183.

Sturgeon, T. J. (2002): ‘Modular Production Networks: A new American Model of Industrial Organization’. *Industrial and Corporate Change*, 11(3): 451-496.

Sturgeon, T. J. (2004): ‘What Really Goes on in Silicon Valley? Spatial Clustering and Dispersal in Modular Production Networks’. *Journal of Economic Geography*, 3(2): 199-225.

Sturgeon, T. J. (2008): ‘From Commodity Chains to Value Chains Interdisciplinary Theory Building in an Age of Globalization’. Ch. 6 in Bair, J. (ed.) (2008): *Frontiers of Commodity Chain Research.* Palo Alto, CA: Stanford University Press.

Sturgeon, T. J., van Biesebroeck, J., and Gereffi, G. (2008): ‘Value chains, networks and clusters: reframing the global automotive industry’. *Journal of Economic Geography*, 8: 297–321.

Sturgeon, T. J. and Gereffi, G: (2009): ‘Measuring success in the global economy: international trade, industrial upgrading, and business function outsourcing in global value chains’. *Transnational Corporations*, 18(2). An essay in memory of Lall, S.

Tam, O.K, (1999): *The Development of Corporate Governance in China.* Cheltenham: Edward Elgar.

Tang, J. and Ward, A. (2003): *Inside the Enterprise. The Changing Face of Chinese Management.* London: Routledge, Ch. 3: 68-105.

Teece, D.J., Pisano, G., and Shuen, A. (1997): ‘Dynamic capabilities and Strategic Management’. *Strategic Management Journal*, 18(7): 509-533.

Thévenot, L. (2009): ‘Governing Life by Standards: A View from Engagements. Postscript to the special issue’. *Social Studies of Science*, 39(5): 793-813.

Thøgersen, S. (2006): ‘Beyond Official Chinese: Language Codes and Strategies’. Ch. 7 in Heimer, M. and Thøgersen, S. (eds.): *Doing fieldwork in China*. Copenhagen: NIAS Press.

Tödtling, F., Trippl, M., and Lengauer, L. (2008): *Towards Regional Knowledge Economies: Routes and Policy Options*. SRE-Discussion 2008/05, Wirtschafts Universität, Institute of Regional Development and Environment.

Tödtling, F. and Trippl, M. (2012): ‘Transformation of regional innovation systems: From old legacies to new development paths’. Forthcoming in *Reframing Regional Development*, ed. by Cooke, P., Routledge. To be presented at ERSA Conference, Bratislava, 2012.

van Heur, B., Leydesdorff, L., and Waytt, S. (2013). ‘Turning to ontology in STS? Turning to STS through ‘ontology’’. *Social Studies of Science*, 43: 341-362.

Venturini, T., (2009): ‘Diving in magma: How to explore controversies with actor-network theory’. *Public Understanding of Science*: 1-16. Published online May 29, 2009, doi: 10.1177/0963662509102694. (Published as Venturini, T. (2010): Diving in magma: How to explore controversies with actor-network theory. Public Understanding of Science, 19(3): 258–273.

Vernon, R. (1966): ‘International Investment and International Trade in the Product cycle’. *Quarterly Journal of Economics*, 80: 190-207.

Wang, J. C.-Z. (2007): *John Dewey in China. To Teach and To Learn*. New York: State University of New York Press.

Wade, R. (2004 (1990)): *Governing the Market. Economic Theory and the Role of Government in East Asian Industrialization*. Princeton University Press. 2nd edition with new introduction.

Wang, L. (2004): ‘Intellectual property protection in China’. *International Information, Library Review*, 36(3): 253-261.

Wang, P., Wang, Y., and Hill, J. (2010): *Standardization Strategy of China – Achievements and Challenges*. East-West Center Working Papers. Economics Series, 107.

Wang, Q. Wen, F., Yang, A., and Huang, J. (2011): ‘Cost Analysis and Pricing Policy of Wind Power in China’: *Journal of Energy Engineering*, 137: 138–150; ASCE.

Wei, Y. (2003): *Comparative Corporate Governance – A Chinese Perspective.* The Hague: Kluwer Law International.

Weick, K. E. (2003): *Making Sense of the Organization*. Oxford: Blackwell Publishing.

Wenger, E. (2009): ‘A social theory of learning’. In Illeris, K. (ed.): *Contemporary theories of learning: Learning theorists...in their own words*. Milton Park: Routledge: 209-218.

Wernerfelt, B. (1984): ‘A Resource-Based View of the Firm’. *Strategic Management Journal*, 5(2): 171-180.

Whitehead, A. N. (1989 (1978)): *Process and Reality*. New York: Free Press.

Whittle, A. and Spicer, A. (2008): ‘Is Actor Network Theory Critique?’. *Organization Studies*, 29: 611-629.

Williamson, O. E. (1981): ‘The Economics of Organization: The Transaction Cost Approach’. *The American Journal of Sociology*, 87(3): 548–577.

Williamson, O. E. (2002): ‘The Theory of the Firm as Governance Structure: From Choice to Contract’. *Journal of Economic Perspectives*, 16 (3): 171–195.

Witt, M. A. (2010): *China: What Variety of Capitalism?* Working Paper, INSEAD.

Wong, J. (1999): ‘China’s economy’. Ch. 5 in Gamer, R. E. (ed.), *Understanding Contemporary China*: 103-140. Boulder: Lynne Rienner Publishers, 1999.

Wong A., Tjoswold, D., and Fang, S. (2007): ‘Social face for innovation in strategic alliances in China: the mediating roles of resource exchange and reflexivity’. *Journal of Organizational Behavior*, 28: 961-978.

Woolgar, S. and Lezaun, J. (2013): ‘A turn to ontology in science and technology studies’. *Social Studies of Science*, 43.

Wu, Q., Xu, Z., and Østergaard, J. (2010): *Grid Integration for Large Scale Wind Power Plants (WPPs)*. Center for Electric Technology, Technical University of Denmark.

Yaneva, A. (2012): *Mapping Controversies in Architecture*. Surrey, U. K.: Ashgate.

Yang, D. (2003): 'The development of intellectual property in China'. *World Patent Information,* 25: 131–142.

Yang, D. and Clarke, P. (2005): 'Globalisation and intellectual property rights in China'. *Technovation,* 25(5): 545-55.

Yang, D., Sonmez, M., and Bosworth, D. (2004): 'Intellectual Property Abuses: How should Multinationals Respond?'. *Long Range Planning*, 37: 459–475.

Yang, M., Patino-Echeverri, D. and Yang, F. (2012): 'Wind power generation in China: Understanding the mismatch between capacity and generation'. *Renewable Energy,* 41: 145-151.

Yasuda, H. (2005): 'Formation of strategic alliances in high-technology industries: comparative study of the resourcebased theory and the transaction-cost theory'. *Technovation,* 25: 763-770.

Yeh, E. T. and Lewis, J. I. (2004): 'State Power and the Logic of Reform in China's Electricity Sector. Pacific Affairs'. *The Political Economy of Electricity Reform in Asia,* 77(3): 437-465.

Yu, J., Ji, F., Zhang, L., and Chen, Y. (2009): 'An over painted oriental arts: Evaluation of the development of the Chinese renewable energy market using the wind power market as a model'. *Energy Policy,* 37: 5221-5225.

Yu, J.-X. and Shi, D.-J. (2010): 'The Developmental State and Beyond: The Case of China'. *Fudan Journal of the Humanities & Social Sciences*, 3(4): 42-66.

Zeng, M., Zhang, K., and Dong, J. (2013): ‘Overall review of China’s wind power industry: Status quo, existing problems and perspective for future development’. *Renewable and Sustainable Energy Reviews,* 24: 379-386.

Zhang, S. (2012): ‘International competitiveness of China’s wind turbine manufacturing industry and implications for future development’. *Renewable and Sustainable Energy Reviews,* 16: 3903-3909.

Zhang, J. and Peck, J. (2014): ‘Variegated Capitalism, Chinese Style: Regional Models, Multi-scalar Constructions’. *Regional Studies,* DOI: 10.1080/00343404.2013.856514.

Zhao, Z., Ji, H., and Jian, Z. (2009): ‘Performance of Wind Power Industry Development in China: A Diamond Model Study’. *Renewable Energy,* 34(12): 2883–2891.

Zhao, X., Wang, F., and Wang, M. (2012a): ‘Large-scale utilization of wind power in China: Obstacles of conflict between market and planning’. *Energy Policy,* 48: 222-232.

Zhao, Z., Ling, W., Zillante, G., and Zuo, J. (2012b): ‘Comparative assessment of performance of foreign and local wind turbine manufacturers in China’. *Renewable Energy,* 39: 424-432.

Zimmerman, A. and Chaudhry, P. E. (2009): ‘Protecting Intellectual Property Rights: The Special Case of China’. *Journal of Asia-Pacific Business,* 10:4, 308-325, DOI: 10.1080/10599230903340262.

Reports

Bloomberg (2010): *China: a global clean energy leader?* China Market Outlook H1 2010.

Bloomberg (New Energy Finance) (2012): *Will China's new Renewable Portfolio Standard boost project development?* Renewable energy: Research note, May 11.

Caijing Cover Story 财经 (24 Mar. 2013*): *电改试金石.* Power reform in metal and stone/hard and powerful (gems of wisdom/priceless advice): 50-68.

CGC (2013): *Wind turbine certification in China.* China General Certification/鉴衡认证中心 http://events.ciemat.es:8899/documents/36718/59272/CGCC-Wind+Turbine+Certification+in+China-Leijie+Chen.pdf/d0510b44-2bd9-4a7a-a9be-e2334654653b (Accessed 20.11.2014)

CRESP (2005): *National Action Plan for China's Wind Power Industry Development*; CRESP, http://www.cresp.org.cn/uploadfiles/89/253/NationalAction_EN.pdf. (Accessed 20.11.2014)

DNV (2011): *Wind Turbines. Type Certification of Wind Turbines.* Det Norske Veritas, Danmark A/S, DNV Wind Turbine Certification – a unit in technical co-operation with RISØ. Certification Description, Jan. 2011, rev. 12.

EIA (U.S. Energy Informationa Administration, 2014, Feb. 4): *Country Report – Energy, China.* Accessed Jul. 25, 2014. http://www.eia.gov/countries/analysisbriefs/China/china.pdf (Accessed 20.11.2014)

Frankfurt School-UNEP Centre/BNEF and Bloomberg New Energy Finance (2014): *Global Trends in Renewable Energy Investment*, http://www.fs-unep-centre.org (Accessed 20.11.2014)

Germanischer Lloyd (GL) (2010a): *IEC 61400-1: 2005 ("edition 3") – Experiences.* Germanischer Lloyds Industrial Services. Kai Freudenreich, Peter Frohböse. Risø, January 2010.

Germanischer Lloyd (GL) (2010b): *The forthcoming GL-Guideline for onshore wind energy – GL 2010*. Mike Woebbeking. Germanischer Lloyd Industrial Services GmbH, Renewables Certification (GL).

GWEC (2013) (Global Wind Energy Council): *Global Wind Report – Annual Market Update 2012.*

GWEC (2014) (Global Wind Energy Council): *Global Wind Report – Annual Market Update 2013.*

IEC (2005): *International Standard. Wind turbines – Part 1: Design requirements.* IEC 61400-1, Third Edition 2005-08.

Jun He Bulleton (Jun. 6, 2013): *Administrative Law: Interpretation of "Decision of the State Council on Cancelling and Delegating the Power of Approval of a Batch of Items Requiring Administrative Approval and Other Issues".*
http://www.junhe.com/images/ourpublications_en_img/jun_he_legal_2_update/43_20136131447534694.pdf (Accessed 20.09.2014).

PEW (the PEW Charitable Trusts) (2013): *Who's Winning the Clean Energy Race?* 2012 Edition.

PWC (Price Water-House Coopers) (2013): *New Roadmap for Achieving the China Dream. Business and economic implications of the Third Plenary Session of the CPC's 18th Central Committee.*
http://www.pwc.ch/user_content/editor/files/publ_tls/pwc_new_roadmap_achieving_china_dream_e.pdf, (Accessed 20.11.2014)

REN (2013, Renewable Energy Policy Network for the 21st Century): *Renewables 2013. Global Status Report.*

Risø DTU, Technical University of Denmark (2008): *Introduction to the IEC 61400-1 standard.* Peter Hauge Madsen, Risø DTU. August 2008.

Risø DTU (National Laboratory for Sustainable Energy), Bergami, L. (2010): *RISØ HAWC2 – Models and capabilities, a quick overview.* Power point presentation at Wind turbine blade workshop. Albuquerque, NM, 2010. Aeroelastic Design Program – Wind Energy Division. http://windpower.sandia.gov/2010BladeWorkshop/PDFs/2-2-E-3-Bergami.pdf

Vestas-CWEA (China Wind Energy Association) (2011): 'Wind Industry Evaluation Criteria in China. International Experiences and Recommendations. 中国风力发电评价体系。国际经验和建议。北京:中国出版社。

Laws and Regulations

State Council Decision (2013), State Council, The Central People's Government of the People's Republic of China: *国务院关于取消和下放一批行政 审批项目等事项的决定 国发*[2013]19号, http://www.gov.cn/zwgk/2013-05/15/content_2403676.htm

REL (2005) (Renewable Energy Law): Standing Committee of the National People's Congress (NPC) (2005). http://www.ccchina.gov.cn

Amendment to REL (Renewable Energy Law) (2009): REL adopted in 2005; Amended according to the Decision of the 12th Meeting of the Standing Committee of the 11th National People's Congress of the People's Republic of China on December 26, 2009. http://english.mofcom.gov.cn/article/policyrelease/questions/201312/20131200432160.shtml

MLP RE (2007): National Development and Reform Commission (2007): *Medium and Long-Term Development Plan for Renewable Energy in China*. http://www.chinaenvironmentallaw.com/wp-content/uploads/2008/04/medium-and-long-term-development-plan-for-renewable-energy.pdf

MLP S&T (2006-2020), National Development and Reform Commission (NDRC) People's Republic of China: *The National Medium- and Long-Term Program for Science and Technology Development (2006-2020). 国家中长期科学和技术发展规划纲要.* http://www.gov.cn/jrzg/2006-02/09/content_183787.htm

5YP S&T Wind Power (2012*), State Council, The Central People's Government of the People's Republic of China: *The 12th 5-Year-Plan for the Scientific Development of Wind*

Power (2012): 关于印发风力发电科技发展“十二五”专项规划的通知,国科发计(2012) 197号. (http://www.most.gov.cn/fggw/zfwj/zfwj2012/201204/t20120424_93884.htm)

Energy Policy, China (2012): The Information Office of the State Council. First edition 2012. October 2012. On file with author.

Decision on Major Issues Concerning Comprehensively Deepening Reforms – CPC Central Committee. The Decision on Major Issues Concerning Comprehensively Deepening Reforms in brief.
http://www.china.org.cn/china/third_plenary_session/2013-11/16/content_30620736.htm

SASAC, 2003: *Interim Regulations on Supervision and Management of State-owned Assets of Enterprises, article 1*; http://www.sasac.gov.cn/n2963340/n13933222/13934025.html).

Newspaper articles

Børsen (19 Sep. 2014a): *FAKTA Kinas marked for vindenergi*. By Elers, P.: http://borsen.dk/nyheder/avisen/artikel/11/93309/artikel.html#ixzz3GrHVEMOS (Accessed on Oct. 23, 2014).

Børsen (19 Sep. 2014b): *I Kina blæser der nye vinde*. By Elers, P. http://borsen.dk/nyheder/avisen/artikel/11/93281/artikel.html#ixzz3GrFjXoDt (Accessed on Oct. 23, 2014).

Børsen (20 Oct. 2014): *Nye skrappe møllekrav guld værd for Vestas i Kina.* By Bindslev, J. C.
http://borsen.dk/nyheder/virksomheder/artikel/1/292844/nye_skrappe_moellekrav_guld_vaerd_for_vestas_i_kina.html#ixzz3GrHK1ZmV (Accessed Oct. 23, 2014)

Børsen (21 Oct. 2014): *Vestas satser på to nye 2MW-møller i Kina*. By Bindslev, J. C.
http://borsen.dk/nyheder/virksomheder/artikel/1/292925/vestas_satser_paa_to_nye_2mw-moeller_i_kina.html#ixzz3GrKPAV15 (Accessed on Oct. 23, 2014)

china.org.cn (China Daily), (16 Nov. 2013): *The Decision on Major Issues Concerning Comprehensively Deepening Reforms in brief*.
http://www.china.org.cn/china/third_plenary_session/2013-11/16/content_30620736_5.htm
(Accessed on Jan. 10, 2014).

chinaipr.gov.cn (10 Jun. 2014): *Xi urges independent innovation in science, technology*. http://www.chinaipr.gov.cn/newsarticle/news/headlines/201406/1822623_1.html (Accessed on Jun. 15, 2014).

cresp.org.cn: *China Renewable Energy Scale-up Program: Project Name: Establishment of Wind Turbine Certification Capabilities* (CRESP). http://www.cresp.org.cn/english/content.asp?id=1465 (Accessed Jul. 20, 2014).

dongfang.com.cn: http://www.dongfang.com.cn/index.php/business/ (Accessed on Aug. 20, 2014).

EcoBusiness (22 Jan. 2014): *China's wind power sector foresees a recovery in 2014.* http://www.eco-business.com/news/chinas-wind-power-sector-foresees-recovery-2014/ (Accessed on May 25, 2014).

EnergiWatch (af Christensen, T. B., Jun. 10, 2013): *Vestlige vindselskaber presses ud af Kina.* http://energiwatch.dk/Energinyt/Renewables/article5543644.ece (Accessed on Aug. 20, 2013).

Ens.dk: http://www.ens.dk/sites/ens.dk/files/politik/Kina-samarbejdet/Materialer/Faktaark/c2_projects.pdf (Accessed on Jun. 15, 2014).

Wind Energy and Electrical Vehicle Review (Apr. 22, 2012): Sinovel and Mita Teknik join forces in wind energy. http://www.evwind.es/2012/04/22/sinovel-and-mita-teknik-join-forces-in-wind-energy/18020 (Accessed on Nov., 15, 2012).

China Wind Power Conference (2013) (conference web-site): http://www.chinawind.org.cn/cwp2013/le/ (Accessed on Sep. 25, 2013).

GlobalData (10 Jun. 2014): *Global Cumulative Wind Power Capacity to More than Double by 2020, Led by China, says GlobalData*. http://energy.globaldata.com/media-center/press-releases/power-and-resources/global-cumulative-wind-power-capacity-to-more-than-double-by-2020-led-by-china-says-globaldata (Accessed on May 25, 2014).

IEA (Oct. 14, 2010): *China's power sector revolution stalled.* Probe International's Brady Yauch provides a historical look at the stalled reforms in China's electricity sector. http://journal.probeinternational.org/2010/10/14/chinas-power-sector-revolution-stalled/ (Accessed on Apr. 23, 2013.)

International Business Times (by Dettoni, J.: Feb. 14, 2014): *Wind Farms, Solar Panels And Killer Smog: Coal Still Reigns In China's Schizophrenic Energy Revolution.* http://www.ibtimes.com/wind-farms-solar-panels-killer-smog-coal-still-reigns-chinas-schizophrenic-energy-revolution-1553615 (Accessed on Jul. 20, 2014).

lexology.com (by Pereira, C. G. and Puertas, O., 31 Jul. 2013): *Decision on abolishing and delegating the power of approval of several items requiring administrative approval China*. http://www.lexology.com/library/detail.aspx?g=307b32e9-6921-41b8-8fad-94ea38125534 (Accessed on Jun. 22, 2014).

Metal-supply.dk (13 Jun. 2014): *Vestas frygter ikke længere kineserne.* http://www.metal-supply.dk/article/view/132280/vestas_frygter_ikke_laengere_kineserne?ref=newsletter#.U7O69hXU9dg (Accessed on Jun. 17, 2014.

OECD/IEA (2006): *China's Power Sector Reforms: Where to Next?* OECD/ International Energy Agency (IEA).
http://probeinternational.org/library/wp-content/uploads/2010/10/Chinas-power-sector-reforms-where-to-next.pdf (Accessed on Apr. 20, 2013).

People's Daily Online (May 11 2011): *China fine-tunes wind turbine industry with new guidelines*. http://english.peopledaily.com.cn/90001/90778/90857/7376036.html. (Accessed on Oct. 15, 2011).

People's Daily (11 May 2014): *"Chinese dream" to benefit China, world*. http://english.peopledaily.com.cn/90883/8623708.html (Accessed on Jun. 24, 2014).

Renewable Energy World (5 Jan. 2012): *China Increases Target for Wind Power Capacity to 1,000 GW by 2050.*
http://www.renewableenergyworld.com/rea/news/article/2012/01/china-increases-target-for-wind-power-capacity-to-1000-gw-by-2050 (Accessed on Jun. 15, 2013).

Renewableenergyworld.com (22 Sep. 2011): *China Releases Technical Standards for Wind Power Industry*. http://www.renewableenergyworld.com/rea/news/article/2011/09/china-releases-technical-standards-for-wind-power-industry. (Accessed on Oct. 17, 2011).

Riley, M. and Vance, A. (2012) Bloomberg/Bizweek, Mar. 15, 2012): 'Inside the Chinese Boom in Corporate Espionage'. http://www.businessweek.com/articles/2012-03-14/inside-the-chinese-boom-in-corporate-espionage (Accessed on May, 15, 2012).

rieti.go.jp (2013): *Abolition of the central government's administrative inspections and the delegation of authority to local governments*. RIETI (Research Institute of Economy, Trade & Industry, IAA. http://www.rieti.go.jp/en/columns/a01_0381.html (Accessed on Aug, 13, 2014).

Sinosphere, New York Times (10 Jun. 2014 by Buckley, C.): *Xi Urges Greater Innovation in 'Core Technologies'*. http://sinosphere.blogs.nytimes.com/2014/06/10/xi-urges-greater-innovation-in-core-technologies/?_php=true&_type=blogs&_r=0. (Accessed on Aug. 14, 2014).

The Economist (4 May 2013): *Xi Jinping and the Chinese dream. The vision of China's new president should serve his people, not a nationalist state.* http://www.economist.com/news/leaders/21577070-vision-chinas-new-president-should-serve-his-people-not-nationalist-state-xi-jinping (Accessed on Aug. 14, 2014).

Windpowermonthly.com (10 May 2011 by Wu Qi): *China's wind manufacturing industry set for high capacity boost.* Wind Power Monthly. http://www.windpowermonthly.com/article/1068997/chinas-wind-manufacturing-industry-set-high-capacity-boost (Accessed on Nov. 14, 2012).

Windpowermonthly (16 Apr. 2013 by Qi, W.): *Analysis - How debt is weighing down China's wind sector*. http://www.windpowermonthly.com/article/1178534/analysis---debt-weighing-down-chinas-wind-sector (Accessed on Apr. 29, 2013).

Xinhua (15 Nov. 2013): *Key reform decision settles market-government relationship:* Xi. http://news.xinhuanet.com/english/china/2013-11/16/c_132892309.htm (Accessed on Mar. 10, 2014).

Xinhuanet/English.news.cn (13 Mar. 2014): *Chinese premier vows "zero-tolerance" to corruption.* http://news.xinhuanet.com/english/special/2014-03/13/c_133183102.htm (Accessed on Mar. 20, 2014).

Xinhua (27 May 2014a): *Xi stresses market-gov't coordination.* http://news.xinhuanet.com/english/china/2014-05/27/c_133366072.htm (Accessed on Jul. 22, 2014).

Xinhua (27 May 2014b): *China pledges growth through innovation.* http://news.xinhuanet.com/english/china/2014-05/27/c_133366203.htm (Accessed on Jul. 22, 2014)

Xinhua (12 June 2014): *China aims to realize dream through innovation.* http://news.xinhuanet.com/english/china/2014-06/12/c_133403021.htm Accessed on Jul. 22, 2014

Homepages

aerodyn.com: http://www.aerodyn.de/kundenspezifische-projekte-en-GB/ (Accessed on Jul. 14, 2014).

amsc.com: http://www.amsc.com/windtec/software.html (Accessed on Jul. 14, 2014)

cnrec.org.cn: http://www.cnrec.org.cn/english/ (Accessed on Jul. 20, 2014).

cresp.org.cn: *China Renewable Energy Scale-up Program: Project Name: Establishment of Wind Turbine Certification Capabilities (CRESP)*; http://www.cresp.org.cn/english/content.asp?id=1465 (Accessed on Jul. 21, 2014).

dnvgl.com: http://www.dnvgl.com/ (Accessed on Jul. 14, 2014).

envision.com: http://www.envisioncn.com/index.aspx (Accessed on Oct. 21, 2014).

gl-garradhassan.com: http://www.gl-garradhassan.com/en/garrad-hassan.php (Accessed on Jul. 14, 2014). (For a description of Bladed, refer to http://www.gl-garradhassan.com/en/software/GHBladed.php). (Accessed on Jul. 14, 2014) gdupc.com.cn: http://www.gdupc.com.cn/defaultEn.aspx (English homepage): *Guodian United Power Technology Company Lmt.*) (Accessed on Aug. 23, 2014).

iec.com: http://webstore.iec.ch/Webstore/webstore.nsf/Artnum_PK/44160 (Accessed on Jul. 20, 2014).

ingineus.eu: www.ingineus.eu (Accessed on Feb. 20, 2012).

sasac.gov.cn (http://www.sasac.gov.cn/n2963340/n2971121/n4956567/4956583.html= (Accessed on Sep. 1, 2014).

sinovel.com: http://www.sinovel.com/en/newscontent.aspx?ID=418 (Accessed on Aug. 20, 2014).

Vestas job-offer website: https://www.appone.com/MainInfoReq.asp?R_ID=485538 (Accessed on Jul. 13, 2014).

vindenergi.dtu.dk: http://www.vindenergi.dtu.dk/Undervisning_tekst (Accessed on Jul. 15, 2014).

windsystemsmag.com: (http://www.windsystemsmag.com/article/detail/14/company-profile-amsc-windtec) (Accessed on Jul. 14, 2014)

Worldbank.org: http://www.worldbank.org/projects/P067625/china-renewable-energy-scale-up-program-cresp?lang=en (Accessed on Jul. 15, 2014).

wto.org: http://www.wto.org/english/thewto_e/whatis_e/tif_e/fact4_e.htm (Accessed on Sep. 28, 2014).

Blogs:

China Energy Viewpoint, Sandholt, K. (Jan. 27, 2013): *The biggest obstacle to wind power development in China.* Blog by Sandholt, K. on energy policy in China. Accessed on Jun. 2, 2014. http://www.sandholts.dk/?author=1&paged=2

China Energy Viewpoint, Sandholt, K. (Feb. 11, 2013): *Danmark 2012: 30% wind power and no curtailment at all – how is it possible?* Blog by Sandholt, K. on energy policy in China. Accessed on Jun. 2, 2014. http://www.sandholts.dk/?author=1&paged=2

China Energy Viewpoint, Sandholt, K. (Jan. 30, 2014): *Integration of RE – made simple*. Blog by Sandholt, K. on energy policy in China. (Accessed on Jul. 20, 2014). Accessed on Jun. 1, 2014). http://www.chinaenergyviewpoint.com/?p=421

China Energy Viewpoint, Sandholt. K. (Feb. 6, 2014): *China wind power development back on track, but…..* Blog by Sandholt, K. on energy policy in China. Accessed on Jun. 2, 2014. http://www.chinaenergyviewpoint.com/?p=433

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