A legal framework for a transnational offshore grid in the North Sea

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"In any moment of decision, the best thing you can do is the right thing, the next best thing is the wrong thing, and the worst thing you can do is nothing."

Theodore Roosevelt (1858-1919)

Contents

Abbreviations

AC	Alternating current
ACER	EU Agency for the Cooperation of National Energy Regulators
ACM	Autoriteit Consument en Markt (Dutch regulatory authority)
Art.	Article
BGBl.	Bundesgesetzblatt (Federal Law Gazette of Germany)
BNetzA	Bundesnetzagentur (German regulatory authority)
BRP	Balancing responsible party
BSH	Bundesamt für Seeschifffahrt und Hydrographie (German Federal Maritime and Hydrographic Agency)
BSUoS	Balancing Services Use of System
CACM	Network Code on Capacity Allocation and Congestion Management
CEER	Council of European Energy Regulators
CEF	Connecting Europe Facility
CfD	Contracts for Difference
CJEU	Court of Justice of the European Union
CO_2	Carbon dioxide
COM	European Commission
CS	Continental shelf
CUSC	Connection Use of System Code
DC	Direct current
DEA	Danish Energy Agency (Energistyrelsen)
DECC	Department of Energy and Climate Change
DERA	Danish Energy Regulatory Authority (Energitilsynet)
DSO	Distribution System Operator
DTI	Department of Trade and Industry
EC	European Community
ECLI	European Case Law Identifier
ECR	European Court Reports
EEA	European Economic Area
EEC	European Economic Community
EEG	Gesetz für den Ausbau erneuerbarer Energien: Erneuerbare Energien-Gesetz (German Act on the Promotion of RES)
EEPR	European Energy Programme for Recovery

EEZ	Exclusive economic zone
EIA	Environmental impact assessment
ENTSO-E	European Network of Transmission System Operators for Electricity
EnWG	Gesetz über die Elektrizitäts- und Gasversorgung: Energiewirtschaftsgesetz (German Energy Industries Act)
ERGEG	European Regulators' Group for Electricity and Gas
ETYS	Electricity Ten Year Statement
EU	European Union
Euratom	European Atomic Energy Community
EWEA	European Wind Energy Association
FG	Framework Guidelines
GB	Great Britain
GW	Gigawatt (1000 megawatts)
HVDC	High Voltage Direct Current
ICJ	International Court of Justice
IEA	International Energy Agency
kV	Kilovolt
kW	Kilowatt (1000 watts)
MS	Member States
MSP	Maritime Spatial Planning
MW	Megawatt (1000 kilowatts)
NDP	Network Development Policy
nm	Nautical miles
NRA	National regulatory authority
NREAP	National renewable energy action plan
NSCOGI	North Seas Countries' Offshore Grid Initiative
Ofgem	Office of the Gas and Electricity Markets (British regulatory authority)
OFTO	Offshore Transmission Owner
OJ	Official Journal of the European Union
OWF	Offshore wind farm
PCI	Project of Common Interest
PSO	Public service obligation
RE	Renewable energy
RE-Act	Danish Promotion on Renewable Energy Act (Lov om fremme af vedvarende energi)

Rec.	Recital
RES	Renewable energy sources
ROC	Renewable Obligation Certificate
SDE	Stimulering Duurzame Energie
SEA	Strategic environmental assessment
Sec.	Section
Stbl.	Staatsbald (Law gazette of the Netherlands)
Stcrt.	Staatscourant (Government gazette of the Netherlands)
TCE	The Crown Estate
TEN	Trans-European networks
TEN-E	Trans-European energy networks
TEU	Treaty on the European Union
TFEU	Treaty on the Functioning of the European Union
TNUoS	Transmission Network Use of System
TPA	Third party access
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
UK	United Kingdom
UNCLOS	1982 United Nations Convention on the Law of the Sea
VSC	Voltage Source Converter
Wbr	Wet beheer rijkswaterstaatswerken (Dutch Waterworks Management Act)

Introduction

Mitigating climate change and ensuring energy security are global concerns. In order to reduce the emission of carbon dioxide (CO_2) and the dependence on fossil fuels, many states aim at increasing the production of energy from renewable energy sources (RES).[1] The European Union has introduced the union-wide target of a 20% share of energy from renewable sources to be reached by 2020.[2] This target has been translated into binding national targets for the Member States.[3] Next to that, the EU aims at a union-wide share of a 27% renewable energy by 2030.[4] For 2050, it is even estimated that nearly 100% of the electricity mix could be generated by RES.[5]

Most North Sea states consider offshore wind energy as an important contributor towards the achievement of the renewable energy targets until 2020.[6] The potential capacity that could be reached after 2020 is even higher.[7] In comparison to wind energy produced on land, the advantages of wind energy produced at sea are, inter alia, that the wind speed is usually higher with increasing distance from shore, that offshore locations offer a higher number of full-load hours and that there are more suitable free areas and less visual impacts.[8] Since offshore wind energy production took off in the 1990s, a total of 74 wind farms have been installed in European waters, which are connected to the onshore electricity grid of the respective coastal state.[9] The majority of these turbines are located in the North Sea, which is seen as an area especially suitable for large-scale wind energy development.[10]

These offshore wind farms need to be connected to the onshore grid. To date, the standard approach is to provide each offshore wind farm with an individual park-to-shore cable that connects the offshore wind farm to the onshore connection point (radial connection). If the current plans for the expansion of offshore wind are given effect, this approach would result in a multitude of submarine cables. With the increasing number of offshore wind farms and the increasing distance from shore, the question of how to efficiently bring the electricity to shore is therefore gaining importance. Due to the costs of submarine cables, the scarceness of acceptable cable routes and the potential conflicts with other users of the sea, new concepts for the transport of the produced electricity are required. These could involve the clustering of wind farms, meaning that several wind farms are connected via one offshore platform, or the combination between an

[1] The EU and its Member States are party to the Framework Convention on Climate Change and the Kyoto Protocol. They committed to achieving the emission reduction obligations jointly, see Council Decision 2002/358/EC concerning the approval of the Kyoto Protocol and the joint fulfilment of commitments thereunder [2002] OJ L130/1.

[2] Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directive 2001/77 and 2003/30 [2009] OJ L140/16.

[3] The individual national targets are contained in Annex I of Directive 2009/28/EC.

[4] This has been agreed on by the Member States in: European Council, 'Conclusions on 2030 Climate and Energy Policy Framework' (23 and 24 October 2014) SN 79/14, 5. See also Commission, 'A policy framework for climate and energy in the period from 2020 to 2030' COM(2014) 15 final, 5.

[5] Commission, 'A Roadmap for moving to a competitive low carbon economy in 2050 (Communication)' COM(2011) 112 final, 6.

[6] This applies with the exception of Norway. For the potential contribution of offshore wind energy in 2020, see European Wind Energy Association (EWEA), 'Pure Power Wind energy targets for 2020 and 2030: A report by the European Wind Energy Association' (2009) 12, 41; The North Seas Countries' Offshore Grid Initiative (NSCOGI), 'Memorandum of Understanding' (2011) 2.

[7] It is estimated that the potential capacity of offshore wind energy in European waters amounts to 40 GW by 2020 and to up to 150 GW by 2030, EWEA, 'Deep water: The next step for offshore wind energy' (2013) 7.

[8] For the general benefits of offshore wind, see EWEA, 'Delivering Offshore Wind Power in Europe: Policy Recommendations for Large-Scale Deployment of Offshore Wind Power in Europe by 2020' (2007) 8. Also Maria Dolores Esteban et al, 'Why offshore wind energy?' (2011) 36 Renewable Energy 444-460, 448; David MacKay, *Sustainable Energy – without the hot air* (UIT Cambridge 2009) 60; NASA, 'Ocean Wind Power Maps Reveal Possible Wind Energy Sources' (9 July 2008); Windenergieagentur, 'Fragen und Antworten zur Offshore-Windenergie' (2012) 6-7.

[9] This amounts to a total installed capacity 8,045.3 MW by the end of 2014, see EWEA, 'The European offshore wind industry: key trends and statistics 2014' (January 2015) 10.

[10] Of the total offshore wind capacity installed in European waters, 63.3% were located in the North Sea, EWEA, 'The European offshore wind industry: key trends and statistics 2014' (January 2015) 11. It is expected that the Northern Seas could supply 4-12% of the EU's electricity consumption by 2030, see Commission, 'Achieving the 10% electricity interconnection target: Making Europe's electricity grid fit for 2020 (Communication)' COM(2015) 82 final, 14.

interconnector cable that connects two onshore grids and the park-to-shore cable connecting the offshore wind farms to shore. The most efficient way would be to develop a transnational offshore grid that connects the offshore wind farms to the different North Sea states while at the same time providing interconnection between the states. The development of such a 'meshed' offshore grid is under active consideration by the North Sea states.[11]

However, the current legal frameworks have been developed to facilitate the radial connection of wind farms to the national transmission system. In consequence, most wind farms are connected to the national onshore grid by radial park-to-shore cables. As it will become apparent in this PhD thesis, there are legal uncertainties and regulatory barriers that prevent the development of more coordinated projects going beyond the radial connection. In order to enable the construction of these more complex projects in the short term and to enable the development of a transnational offshore grid in the long term, an adequate legal and regulatory framework is needed.

1 Aim and contribution

The aim of this PhD thesis is to establish which legal provisions govern the development of offshore infrastructure in the North Sea and whether these are adequate to support the development of a transnational offshore grid in the long term. In analysing the legal framework, potential legal and regulatory barriers shall be identified. Next to that, I aim to develop legal solutions of how the barriers could be addressed and how the development of a transnational offshore grid could be facilitated in the North Sea. For this purpose, I will first analyse the current legal frameworks under international, EU and national law in order to determine the exact legal situation governing the development and operation of offshore infrastructure and to identify the main legal barriers. Secondly, I will identify the necessary legal changes, and the means of developing an adequate legal framework for a transnational electricity offshore grid in the North Sea.

With this PhD thesis, I wish to contribute to the reform of the current legal frameworks. Here, I strive to advance the legal discussion of how to align national interests with regional, European and global interests, and how to align the main three objectives of EU energy policy – being the aim of achieving an internal energy market, the aim of increasing the share of renewable energy sources and the aim of ensuring the security of supply.

1.1 Relevance

In 2010, ten North Sea countries have signed a Memorandum of Understanding. Within this 'North Seas Countries' Offshore Grid Initiative' (NSCOGI), they agreed to work jointly towards a transnational offshore grid.[12] In the past years, the development of a North Sea offshore grid has also been discussed in many economic, technical and political studies.[13] Although most of the studies and reports concluded that the legal and regulatory frameworks constitute an obstacle for more complex offshore infrastructure projects, none of these studies have so far conducted an exact analysis of the current legal and regulatory frameworks or have developed clear recommendations of how the legal regimes need to change. Instead, many reports suggest simplified solutions such as aligning national

[11] For an explanation of how such a transnational offshore grid could develop, see below, sec. 3.4 Option 4: connection of offshore wind farms into a meshed offshore grid.

[12] Working groups have been established on inter alia network configuration and market integration, market and regulatory aspects, and on planning and authorisation procedures. The reports of the NSCOGI working groups have been published at http://www.benelux.int/NSCOGI/.

[13] See inter alia OffshoreGrid Study, 'Offshore Electricity Infrastructure in Europe' (Final Report, October 2011); TradeWind, 'Integrating Wind: Developing Europe's power market for the large-scale integration of wind power' (2006) 57; Greenpeace, 'A North Sea Electricity Grid [R]Evolution, Electricity Output of Interconnected Offshore Wind Power: A Vision of Offshore Wind Power Integration' (2008) 20; THINK, 'Topic 5: Offshore Grids: Towards a Least Regret EU Policy' (January 2012); ForWind, 'Grid Connection of Offshore Wind Farms: A Feasibility Study on the Application of Power Transmission Pipelines' (2009) 7.

support schemes, harmonising grid rules, appointing a single TSO or establishing a single body being responsible for overall network planning.[14] I argue that these suggestions are not feasible as they do not sufficiently take into consideration the legal context of international and EU law as well as the choices made under national law.

The PhD thesis reveals that the existing legal frameworks have not been designed for complex offshore infrastructure projects. The resulting lack of certainty regarding the applicable legal framework is not only a theoretical or academic problem. Already now, it can be witnessed that cross-border projects are delayed or not implemented at all due to regulatory difficulties, legal uncertainties and the lack of incentives.[15] Although it would be more efficient to be able to allocate the generated offshore wind energy within the entire North Sea area, offshore wind farms are currently developed as national projects connected only to the respective national onshore grid.[16]

To implement the energy transition towards a more sustainable energy supply, a different approach to the development of offshore infrastructure is needed. This PhD thesis brings clarity regarding the applicable legal framework for more advanced infrastructure projects in the North Sea, the legal barriers that they face and the potential solutions. National governments have to become active and have to facilitate the development of complex (cross-border) projects. It is of considerable practical relevance that governments and policy makers are aware of the exact legal framework, of the main legal barriers and of the legal changes that are needed to enable the development of a transnational offshore grid.

1.2 Energy law and other disciplines

Before the approach and methodology of this thesis are outlined, I have to point out that there are several factors that make a thesis in energy law different from a thesis in other fields of law. First, energy law consists of several areas of law. The relevant provisions come from public law, such as permitting, environmental requirements or competition rules, and from private law, such as connection agreements or claims for damages. The legal regimes of the North Sea countries applying to offshore wind energy and offshore grid infrastructure are further impacted by international law and EU law. Together, all these different legal provisions form the basis for the development of a transnational offshore grid.

Next to that, the development of offshore infrastructure is influenced by other factors, such as technical development and economic analyses. To ensure that the analysis and solution presented in this thesis are in line with the findings of other disciplines, I have cooperated with representatives from these different fields. This has been challenging as not only the terminology but also the approaches differ substantially. Yet, my research benefitted greatly from the input of other academics and stakeholders.

First of all, this PhD project involved cooperation with the Technical University of Delft (TU Delft). Whereas I focused on the legal aspects of the development of a transnational offshore grid, the team at TU Delft worked on the technical and economic

[14] Simon Skillings and Jonathan Gaventa, ‘Securing Options Through Strategic Development of North Seas Grid Infrastructure’ (July 2014) 17; THINK, ‘Topic 5: Offshore Grids: Towards a Least Regret EU Policy’ (January 2012); Franz Jürgen Säcker et al, *Der regulierungsrechtliche Rahmen für ein Offshore-Stromnetz in der Nordsee* (Peter Lang 2014); Leonardo Meeus, ‘Offshore grids for renewables: do we need a particular regulatory framework?’ (2014) 24 EUI Working Paper RSCAS. The Friends of the Supergrid further suggested the introduction of a single grid code, a single European regulator and clear rules on financing and ownership, see Friends of the Supergrid, ‘Position paper on the EC Communication for a European Infrastructure Package’ (2010) 14.

[15] See for example the Kriegers Flak project or COBRAcable, Chapter 6, sec. 2.1 Case studies.

[16] Commission, ‘In-depth study of European Energy Security (Commission Staff Working Document)’ (2014); Simon Skillings and Jonathan Gaventa, ‘Securing Options Through Strategic Development of North Seas Grid Infrastructure’ (July 2014) 14.

aspects. This interdisciplinary cooperation resulted in several joint papers.[17] It became clear that, next to the legal challenges being subject of this thesis, there are technical and economic barriers that need to be overcome as well.[18] If wind farms are constructed far away from shore, they are connected to the onshore grid by way of high-voltage direct current (HVDC) cables. These result in fewer losses than the more common alternating current (AC) technology. The development of a transnational offshore grid would further involve a new converter technology that allows the development of multi-terminal offshore HVDC grids.[19] This means that several wind farms could be connected with each other or that the connection of offshore wind farms could be combined with interconnectors. The new technology also allows for a better control of the electricity flow and direction and is more compact than the classical technology. Although this technology has hardly been used in practice, it is increasingly considered from a technical and economic perspective as it would be more efficient to develop a transnational offshore grid. The design of such a meshed grid is not clear. In the framework of this research project, the TU Delft has therefore developed a model that shows how the offshore grid would be constructed most efficiently, but also how its development would be influenced by different legal and regulatory constraints. The cooperation with the TU Delft further ensured that the suggestions presented within this thesis are in line with the technical and economic findings.

Secondly, my research benefitted from the input of the 'Stakeholder Advisory Group'. This group consists of representatives from transmission system operators and ministries from the different North Sea states. Twice a year, I presented my research to this group and received very useful feedback and practical insights. This gave me the certainty that my analysis and recommendations were not only correct from a legal and academic perspective but also made sense in practice.

Thirdly, I was able to conduct two research stays at two transmission system operators: one at TenneT TSO GmbH in Germany and one at National Grid Plc in England. During these research stays, I could expand my knowledge about the respective legal regimes through discussions with the legal department, and was also able to have conversations and interviews with employees working on the technical, regulatory, operational and economic issues. These research stays helped me to better understand how the transmission networks are developed, operated and regulated. Based on these different experiences, I was able to further refine my analysis and argumentation.

As a last point, I would like to stress that energy law cannot be seen independent of energy policy. It will become apparent in the following that the legal frameworks developed under international law, EU law and national law are affected by policy considerations and strategic decisions. Therefore, this thesis will not only present an analysis of the current legal frameworks, but will also discuss the process of how these

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17 Hannah Katharina Müller, Martha Roggenkamp, Mart van der Meijden, Madeleine Gibescu, and Shahab Shariat Torbaghan, 'The need for a common standard for voltage levels of HVDC VSC technology' (2013) 63 Energy Policy 244-251; Shahab Shariat Torbaghan et al, 'The legal and economic impacts of implementing a joint feed-in premium support scheme on the development of an offshore grid' (2015) 45 Renewable and Sustainable Energy Reviews 263-277; Shahab Shariat Torbaghan et al, 'Investigating the Impact of Unanticipated Market and Construction Delays on the Development of a Meshed HVDC Grid using Dynamic Transmission Planning' (2015) IET Generation, Transmission & Distribution (accepted).

18 Although lawyers have an opinion on everything, I will not expand on these technical and economic challenges. For this purpose, I refer to the PhD thesis of Shahab Shariat Torbaghan, which also provides more detail over the economic development and design of the offshore grid, see Shahab Shariat Torbaghan, *Transmission Expansion planning in the North Sea Region: a Techno-Economic Approach* (working titile).

19 This is the so-called Voltage Source Converter High Voltage Direct Current (HVDC VSC) technology. So far, Germany is the only country that uses HVDC VSC technology for the connection of wind farms, as they are located far away from shore and are connected via offshore platforms. On that, see in more detail below, Chapter 4, sec. 5.3.1 Connection of offshore wind farms. For the construction of a multi-terminal offshore grid, the use of DC breakers would be required, which have not yet been tested in practice.

frameworks have been developed. Also in the argumentation for a change in the legal frameworks, it is important that the political feasibility is taken into account.[20]

1.3 Methodology and research choices

Although the cooperation with other disciplines is essential, the PhD thesis at hand is the result of extensive legal research. The focus is on the existing and former legal regimes under international law, EU law and national law. The main research method is the legal analysis of primary and secondary law, complemented by a study of academic legal literature, case law and policy documents. In addition, documents from the EU institutions, national governments, national regulatory authorities and other institutes have been analysed, as well as academic literature on offshore development from other disciplines.

I developed my argumentation on the basis of a variety of academic sources. Initially, I conducted a study of legal, technical and economic literature to establish how the offshore grid would evolve and which legal, technical and economic challenges exist. Subsequently, I examined the relevant primary and secondary legislation as well as legal literature to establish the applicable framework under international, EU and national law. In a next step, I analysed academic literature and policy reports to establish how the North Sea states have designed their energy policies, what the objectives are and how offshore wind and related infrastructure are classified. Based on this analysis, case studies, other legal literature as well as conversations with stakeholders, I identified the main legal barriers. Building on this, I finally developed the necessary legal amendments and established the possible solutions.

To define the scope of my research, I made a few research choices that need explanation. My research focuses on the development and operation of infrastructure in the North Sea, where the majority of European offshore wind energy is and will be generated.[21] Since the offshore grid will for the largest part be located outside the territory of the coastal states, the legal analysis starts with the legal basis under the international law of the sea. Next to that, all North Sea states, except for Norway, are Member States of the European Union, which is why their activities are also determined by EU law. Therefore, the scope and applicability of EU law is examined in a next step. Although international law and EU law provide the basis for offshore activities, the national law of the coastal states remains relevant. To be able to discuss the different options of connecting offshore wind energy in detail, I have decided to conduct a comparative analysis between the different legal and regulatory choices made in four North Sea states. The primary objective of this comparative research was to identify the differences between the legal regimes and to critically analyse the different choices.[22] The experiences of these states were expected to provide insights into possible solutions as well as negative developments and unintended consequences. With this, I wanted to establish whether the current legal frameworks are adequate and, if not, how the different experiences and choices made in the North Sea states could be used to establish an adequate legal framework.

For this comparative research, I chose to examine the legal regimes of the Netherlands, Denmark, Great Britain and Germany. These four North Sea countries were chosen because they are amongst the European countries with the largest amount of installed offshore wind capacity and have already gathered experience regarding offshore wind

[20] On the relationship with energy policy, see also Kim Talus, *EU Energy Law and Policy: A Critical Account* (OUP 2013) 6-7.

[21] As stated above, 63.3% of the total wind energy capacity installed in European waters is located in the North Sea. Of the total capacity under construction, 84.8% is located in the North Sea. See EWEA, 'The European offshore wind industry: key trends and statistics 2014' (January 2015) 10.

[22] On comparative law and comparative research, see Konrad Zweigert and Hein Kötz, *Introduction to Comparative Law* (Clarendon Press 1998) 15-31. Here, it is stated that "[t]he primary aim of comparative law, as of all sciences, is knowledge", at 15.

exploitation.[23] Furthermore, they rank amongst the EU countries with the highest potential for offshore wind energy.[24] Lastly, these four North Sea states have developed different approaches to the connection of offshore wind farms that are interesting to compare.

Another research choice was to focus on the regulations governing the transmission grid. An offshore grid will expectedly mainly involve large wind farms located far away from shore. These offshore wind farms are usually connected to the high-voltage or extra high-voltage transmission grids. Only small wind farms that are constructed close to shore are connected to the (low- and medium-voltage) distribution grids. Therefore, I decided to focus on the transmission grids and the operators of the transmission grids. Next to that, the TSOs are responsible for the park-to-shore cables connecting the offshore wind farms to the onshore grid in the majority of the North Sea countries. I will refer to the distribution grids and their operators where relevant.

1.4 Approach

Within this thesis, I will first provide an analysis of the legal bases for offshore grid development under international and EU law. In determining the legal framework applying to offshore infrastructure, it is important to note that the legal position at sea is different from the legal situation on land. Within its territory, a state has sovereignty and is authorised to regulate all activities taking place. At sea, the state's position is limited and mainly determined by international law. The basic provisions concerning states' rights and duties in the North Sea are contained in the 1982 United Nations Convention on the Law of the Sea (UNCLOS). I will analyse the relevant rules and examine whether they are adequate for the development of a transnational offshore grid. As all North Sea states, except for Norway, are Member States of the European Union, the legal situation is further determined by EU law. I will therefore establish to which extent EU law applies offshore and whether the EU has sufficient competence to adopt legislation governing the development of an offshore grid. Subsequently, I will discuss the relevant EU law provisions applying to offshore infrastructure. Since international and EU law need to be framed at the national level and since there are some areas of exclusively national competence, I will then analyse how the Netherlands, Denmark, Great Britain and Germany regulate the development of offshore wind energy and the related offshore infrastructure. This comparative research is not a mere description; I will first discuss the essential provisions of the different legal frameworks. Subsequently, I will use the results as a basis for a critical comparison of the different choices made.[25]

In a next step, I will apply the current legal frameworks to more advanced (cross-border) projects, identify the existing legal barriers and assess the legislative approaches chosen. In doing so, I will analyse to which extent the different legal regimes facilitate or hamper more coordinated and transnational projects. Based on the examination of international, EU and national law, I will establish which legal changes are needed to address these barriers, and on which level a solution should be developed.

[23] By the end of 2014, the UK had the largest amount of installed offshore wind capacity in Europe (4494.4 MW), amounting to 55.9% of the installed capacity in Europe. Denmark followed with 1271 MW (15.8%), after which comes Germany with 1048.9 MW (13%). Belgium has 712 MW installed (8.8%) and the Netherlands 247 MW (3.1%). Currently, there are 24 offshore wind farms installed and connected in British waters, 16 in German waters and 12 in Danish waters. The Netherlands and Belgium follow with 5 offshore wind farms each. See EWEA, 'The European offshore wind industry: key trends and statistics 2014' (January 2015) 10. Belgium was not included in the research since, at the end of 2011, the other four coastal states were leading in offshore wind installations, see EWEA, 'The European offshore wind industry key trends and statistics 2011' (January 2012) 10. These four coastal states were also chosen because they had developed different regimes for the connection of offshore wind farms.

[24] See for example European Environment Agency, 'Europe's onshore and offshore wind energy potential: An assessment of environmental and economic constraints' (Technical report No 6/2009) 21. Regarding the installed number of wind turbines, the UK is leading with 52%, followed by Denmark with 24.6%, Belgium (7%), the Netherlands (6%) and Germany (6%), see EWEA, 'The European offshore wind industry: key trends and statistics 2013' (January 2014) 11.

[25] On the approach to comparative law studies, see Konrad Zweigert and Hein Kötz, *Introduction to Comparative Law* (Clarendon Press 1998) 6.

The PhD thesis ends with recommendations of how an adequate legal framework could be developed between the North Sea states that facilitates the development of a transnational offshore grid in the long term. Here, I need to point out that there are many different possibilities to approach the question of how law can be used to facilitate the development of the offshore grid. I chose an approach that focuses on enabling a first set of more coordinated projects to be built in the near future, while keeping open the possibility of interconnecting the projects at a later stage. Although the development of a transnational offshore grid is a long-term objective, I argue that certain legal agreements need to be made now to allow for the connection of infrastructure to other countries at a later stage.[26] For this purpose, I will establish how the existing laws need to be amended to facilitate the efficient development of coordinated cross-border infrastructure in the North Sea.

2 Introduction networks

There are different sorts of networks for the transport of electricity. For this thesis, the most relevant ones are transmission networks, distribution networks, and interconnectors. Different from the oil and gas sector, there is no separate category for 'upstream' networks.[27] As the offshore grid does not form a specific category of networks, it is questionable how it would be classified and regulated under the existing legal regimes and approaches. Before entering the discussion on the legal frameworks determining the development and operation of offshore infrastructure, a few remarks concerning electricity networks need to be made. These are necessary to set the context.

2.1 Transmission networks

Unlike other goods, electricity cannot (yet) be stored cheaply.[28] That means that it always needs to be transported directly to the consumers. Its transport further requires the existence of electricity grids. Since electricity infrastructure is expensive and since parallel grids are not considered desirable, the existing electricity networks constitute a natural monopoly.[29] Onshore, the transmission grid is under the responsibility of the respective national transmission system operator (TSO). The TSO transmits power from the production facilities over the electricity transmission grid to regional or local distribution networks. The responsibility of TSOs can be broadly separated into two different tasks: first, the TSOs are required to plan, build and finance new electricity lines and to expand the existing grid, as to ensure the security of the network and the transmission of electricity to consumers.[30] Secondly, they have to operate the electricity grid and provide access to the grid for all third parties, including generators, distributors and traders.[31] Electricity transmission grids in Europe operate at a frequency of 50 Hertz. To keep this frequency, the TSOs further need to keep the electricity grid in balance.[32] That means that the amount of electricity that is fed into the grid by generation needs to be equal to the amount of

[26] Such an approach that takes the possibility of future interconnections into account is referred to as a 'least regret' approach. The economic benefits of such an approach have been shown inter alia in Simon Skillings and Jonathan Gaventa, 'Securing Options Through Strategic Development of North Seas Grid Infrastructure' (July 2014).

[27] This term refers to any pipeline or network of pipelines that is used to transport gas or oil from a production facility to a landing terminal.

[28] Inter alia Andra Lakatos, 'Overview of Regulatory Environment for Trade in Electricity' in Janusz Bielecki and Melaku Geboye Desta, *Electricity Trade in Europe: Review of the Economic and Regulatory Challenges* (Kluwer 2004) 123.

[29] In the economic literature, a natural monopoly is often defined as a situation where the market can be served most cheaply by a single firm, rather than different competing firms, Robert Baldwin, Martin Cave, and Martin Lodge, *Understanding Regulation: Theory, Strategy, and Practice* (2nd edn, OUP 2012) 443-444.

[30] Art. 12 of Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, L211/55. On the regulation of TSOs, see Georg Zachmann, 'Electricity without borders: a plan to make the internal market work' (2013) Bruegel Blueprint Series 60.

[31] This requirement is referred to as 'third party access' (TPA), art. 32 of Directive 2009/72/EC. It will be discussed below, Chapter 3, sec. 2.2.4 Connection and access to the grid.

[32] There are always some frequency shifts. However, the better the balance between generation and consumption is, the smaller is the frequency variation, which increases the quality of electricity.

electricity taken out by demand.[33] The TSOs are responsible for the secure operation of the electricity grid at all times.

EU legislation as well as national legislation treat TSOs as natural monopolists that need to be regulated.[34] To prevent the abuse of this monopoly by the transmission system operators, the construction, operation and tarification of infrastructure is regulated by independent national regulatory authorities (NRAs).

Next to these general principles, there are two developments that increasingly impact the development and operation of transmission infrastructure: the growing need for cross-border infrastructure to achieve the internal energy market, and the growing need to integrate energy from renewable energy sources. While the national transmission grids were mainly developed to fulfil national needs, they are increasingly seen in a European context.[35] The growing share of (intermittent) renewable energy also requires a more regional approach. In this context, Member States have to facilitate the construction of cross-border connections,[36] the cross-border access for new electricity suppliers[37] as well as the cooperation of TSOs at the regional level.[38] This results in an increasing interconnection of the existing onshore grids and an increasing harmonisation of their operation.

For the offshore grid, I suggest that, instead of repeating this development, it would be more efficient to develop the needed infrastructure with a cross-border perspective from the very beginning to enable the efficient allocation of renewable energy sources. The legal frameworks for offshore infrastructure are currently still evolving and not all North Sea states have extended their electricity legislation and the responsibility of the onshore TSO to the North Sea. That means that, although the North Sea countries are considering more coordinated, transnational projects, it is not clear to which extent the existing frameworks apply and whether the current legal frameworks would provide adequate support. Clear political decisions are required to establish an adequate legal framework that would facilitate the development of a transnational offshore grid. In doing so, regional aspects should be taken into consideration from the outset.

2.2 Offshore wind and the offshore grid

The majority of offshore wind farms built in the North Sea is connected radially to the national onshore grid. If the current plans of the North Sea are given effect, there will be a large amount of wind farms built in the North Sea in the coming years. As coastal waters are already heavily used and often consist of ecologically sensible areas, future wind energy projects are increasingly built far from shore. This means that long submarine cables are needed. Since the laying of cables is expensive and may have impacts on the natural environment, a prospective approach is to cluster wind farms, which allows for the sharing of offshore infrastructure, or to connect them to more countries. This could eventually lead to the construction of a transnational offshore grid.

[33] To decide which generators can meet the demand most economically, the capacity is allocated through bidding systems. Some generators or consumers are further contracted that can adapt their production or consumption quickly in order to deal with unexpected situations.

[34] Konstantin Staschus, 'The active role of TSOs and their association ENTSO-E to ensure, today and tomorrow, the security of electricity supply of 532 million citizens' in Jean-Arnold Vinois (eds), *EU Energy Law: The Security of Supply in the European Union*, vol 6 (Clays & Casteels 2012) 143.

[35] As Hellner puts it, every TSO has to move "towards unknown territory in terms of planning, development and operation of its network", see Cecilia Hellner, 'Re-engineering the European Transmission Grid' in Christopher Jones (ed), *EU Energy Law: The European Renewable Energy Yearbook*, vol 3 (Claeys & Casteels 2010) 159.

[36] Art. 3(10) of Directive 2009/72/EC.

[37] Rec. 8 of Directive 2009/72/EC.

[38] Art. 6(1) of Directive 2009/72/EC.

New concepts for the connection of wind farms thus involve for example the connection of neighbouring offshore wind farms not only to the shore but also with each other, with hubs and with interconnectors.[39] Connecting wind farms in such a more coordinated way would have several benefits.[40] Wind energy is an intermittent source of energy, which means that it is not continuously available and that yields depend on the amount of wind. Using a larger area to produce and to supply offshore wind energy could help to decrease the intermittent effects of wind energy as the energy can be better allocated in times of much wind and since other sources of energy can be used as back-up in times of little or no wind.[41] An offshore grid that links wind farms across borders therefore mitigates the volatility of the wind energy and, at the same time, increases effectiveness, efficiency and security of supply.[42]

In comparison to the radial connection of wind farms, a coordinated (inter)connection could also be more cost-efficient and have less detrimental effects on the marine environment.[43] The clustering of wind farms reduces the number of cables crossing coastal areas.[44] As the construction periods are more concise, this approach could also reduce the conflicts with other uses of the sea, in particular with fishing.[45] In addition, the development of a North Sea electricity grid that connects offshore wind farms while also interconnecting onshore transmission systems would provide new opportunities for trade of electricity between the North Sea states. This increase in trade between different energy price areas would enhance competition and increase the security of supply, as more renewable energy generators would be connected.[46] Such a regional approach to the production and supply of offshore wind energy would also be in line with the EU 2030-target, which aims at a union-wide target of 27% renewable energy by 2030 instead of individual national targets.[47] Lastly, several studies have shown that a more coordinated, regional approach to connecting offshore wind farms would be beneficial in comparison to the radial connection.[48]

Due to these expected benefits, the construction of such a transnational offshore electricity grid is under active consideration by the North Sea states, which have concluded a Memorandum of Understanding on this subject in 2010.[49] The involved states agreed to work together to identify the obstacles for grid development and find optimal solutions.

[39] These concepts will be explained below, at sec. 3 Different options for the connection of offshore wind farms. For a summary of ideas and proposals for a possible offshore grid, see Jan de Decker and Achim Woyte, 'Review of the various proposals for the European offshore grid' (2013) 49 Renewable Energy 58-62; OffshoreGrid, 'Offshore Electricity Infrastructure in Europe' (Final Report, October 2011) 8.

[40] For a recent study on the benefits, see also Commission, 'Study of the benefits of a meshed offshore grid in the Northern Seas region' (July 2014). The study classifies the benefits as environmental benefits such as the reduction of CO_2 emissions and of the curtailment of RES-plants, techno-economic benefits such as increased efficiency, and socio-economic welfare benefits. Further, the strategic benefits are stressed since a meshed grid would increase security of supply and competition. In this study, the Commission comes to the conclusion that a more coordinated approach has many more benefits than the 'business-as-usual approach', ibid, 72-91.

[41] Andrea Herscuth, 'Grid Issues' in Christopher Jones et al (eds), *EU Energy Law: Renewable Energy Law and Policy in the European Union,* vol 3 (Claeys & Casteels 2010) 148; Mott McDonald, 'Impact Assessment on European Electricity Balancing Market Final Report' (March 2013) 16.

[42] Volker Roeben, 'Governing shared offshore electricity infrastructure in the Northern Seas' (2013) International & Comparative Law Quarterly 839-864, 841.

[43] ForWind, 'Grid Connection of Offshore Wind Farms: A Feasibility Study on the Application of Power Transmission Pipelines' (2009) 7.

[44] Achim Woyte at al, 'European Concerted Action on Offshore Wind Energy Deployment' (2007) Wind Energy 357-378, 367.

[45] Seanergy 2020, 'Cross-Border MSP Case Study' (February, 2012) 4; ENTSO-E, 'ENTSO-E response to the CEER public consultation on the "Regulatory aspects of the integration of wind generation in European electricity markets"' (February 2010) 8.

[46] TradeWind, 'Integrating Wind: Developing Europe's power market for the large-scale integration of wind power' (2006) 57; Greenpeace, 'A North Sea Electricity Grid [R]Evolution, Electricity Output of Interconnected Offshore Wind Power: A Vision of Offshore Wind Power Integration' (2008) 20.

[47] European Council, 'Conclusions on 2030 Climate and Energy Policy Framework' (23 and 24 October 2014) SN 79/14, 5.

[48] For an overview of the various studies, see European Parliamentary Research Service, 'Mapping the Cost of Non-Europe, 2014-19' (March 2014) 26.

[49] The North Seas Countries' Offshore Grid Initiative, 'Memorandum of Understanding' (2010).

TSOs have started to look at more complex solutions as well.[50] Developing such a more efficient way of transmitting the produced offshore wind energy will be a key factor in the transition to a more sustainable and independent energy supply. Therefore, the European Commission has also included the 'Northern Seas Offshore Grid' as a priority electricity corridor in its Regulation on Trans-European Energy Networks.[51]

The increase of offshore wind capacity and the increasing focus on cross-border trade require a more comprehensive approach to the connection of offshore wind farms. Although the exact design as well as the related benefits of a transnational offshore grid are still uncertain, it is expected that the transition towards more complex cross-border projects entails several advantages compared to a purely national approach.[52] Due to the potential benefits and since infrastructure projects take several years to be developed, I argue that a legal framework needs to be developed that facilitates these projects in the near future.

3 Different options for the connection of offshore wind farms

In order to analyse the adequacy of the current legal framework, I will apply the legal regimes to different options of offshore infrastructure development. It is assumed that the offshore grid will not be built at once, but will rather evolve gradually.[53] Therefore, it is important to facilitate more complex projects, that serve as 'stepping-stones' towards the development of an offshore grid in the long term.

Note that each wind turbine in these pictures stands for an entire wind farm.

3.1 Option 1: radial connection of offshore wind farms

Historically, transmission lines were laid for two purposes: either to connect generation plants to the transmission grid or to enable cross-border transport through interconnectors. Also for offshore wind farms, the standard approach is the connection of offshore wind farms to the national onshore grid (option 1a). The cable between the offshore wind farm and the onshore grid will be referred to as park-to-shore cable. Next to this 'radial connection' of offshore wind farms, another standard approach is to connect two countries by means of an interconnector (option 1b). As more complex projects build on these point-to-point projects, the legal framework governing these two options will be discussed under international, EU and national law.

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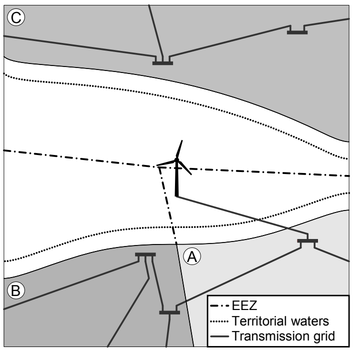
[50] "The development of an efficient off-shore grid in the North Sea is fully consistent with ENTSO-E's fundamental objectives to increase reliability of supply, to facilitate sustainable developments and to support the integration of energy markets by greater interconnection", see ENTSO-E, 'Ten-Year Network Development Plan 2010-2020' (2010) 157.

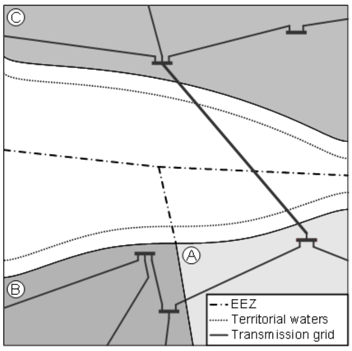
[51] Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009, Annex 1. On this, see below. Chapter 3, sec. 2.3.2 The Northern Seas offshore grid as a priority corridor.

[52] Even the 'worst case' was restricted to stranded assets of around 1 billion if significant volumes of offshore wind fail to materialize, see Simon Skillings and Jonathan Gaventa, 'Securing Options Through Strategic Development of North Seas Grid Infrastructure' (July 2014) 4.

[53] Inter alia NSCOGI, 'The North Seas Countries' Offshore Grid Initiative: Initial Findings' (November 2012) 61; OffshoreGrid, 'Offshore Electricity Grid Infrastructure in Europe' (October 2011) 14; EWEA, 'Oceans of Opportunity Harnessing Europe's largest domestic energy resource' (2009) 8, 34; EWEA, 'Powering Europe: wind energy and the electricity grid' (2010) 118; Dirk van Hertem and Mehrdad Ghandhari, 'Multi-terminal VSC HVfDC for the European supergrid: obstacles' (2010) 14 Renewable and Sustainable Energy Reviews, 3156–3163, 3163.



1a

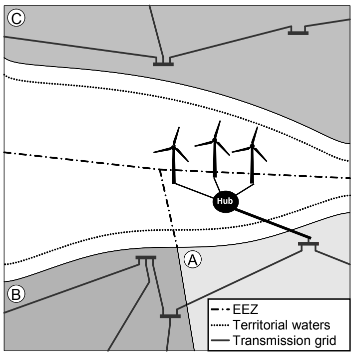


1b

As it will become apparent in this thesis, the current national legal frameworks have mainly been developed for the regulation of option 1a and option 1b. To allow for the development of a transnational offshore grid, however, the states have to go beyond this radial approach.

3.2 Option 2: clustering of offshore wind farms via offshore hubs

A first step towards a more efficient approach concerning offshore infrastructure is to cluster wind farms on the national level. This means that two or more offshore wind farms are connected via an 'offshore hub', meaning an offshore platform where the electricity of the wind farms is collected and converted to HVDC. Subsequently, the electricity can be transmitted via a shared cable to the onshore grid.



2

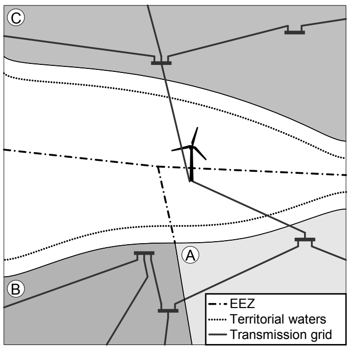
These clustered projects would thus allow for the sharing of infrastructure between several wind farms in the same area whereby using 'offshore hubs'. This would not only reduce the connection costs as fewer cables are needed but would also reduce the environmental impacts and allow for a better use of economies of scale.[54] In addition to these benefits, I argue that such coordinated projects at the national level are a crucial prerequisite for the development of an offshore grid in the long term. The main reason is that offshore hubs can be built with a larger capacity than initially needed, which would allow for additional interconnection with other countries or wind farms at a later stage. The extra space is needed since the connection to an interconnector or a wind farm would usually require another converter station. Such clustered projects involving offshore hubs are thus considered as stepping-stones for the offshore grid. There is not yet a legal definition of offshore hubs. For the purpose of this thesis, an offshore hub will be defined as an offshore platform that connects more than one wind farm offshore and allows that a single cable is used to connect the hub to the onshore grid, and to transmit the produced electricity to shore.[55]

[54] For a more detailed discussion of the benefits, see Chapter 5, sec. 1.1 Benefits of offshore hubs and the clustering of wind farms.

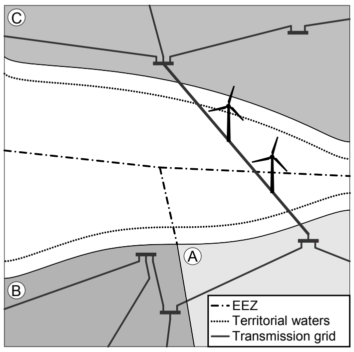
[55] A possible technical definition may be that a hub is an offshore substation (DC collector), in which AC/DC converters and other facilities are placed with more than one HVDC connection. On this, see in more detail below. Chapter 5, under sec. 1.2.3 Applicable definition for this thesis. Note that DC cables are usually laid with two cables. When I refer to 'a single cable', I want to demarcate this approach from the radial connection of wind farms, where each wind farms is connected with an individual park-to-shore cable.

3.3 Option 3: connection of offshore wind farms with two or more countries

A third option would be to connect one wind farm to two countries. Here, different variations exist. Such a cross-border connection could be reached by connecting one wind farm (option 3a) or more wind farms (option 3b) directly to two countries. Alternatively, one (option 3c) or more wind farms (option 3d) could be connected to an interconnecting cable by way of ‘teeing-in’.



3a



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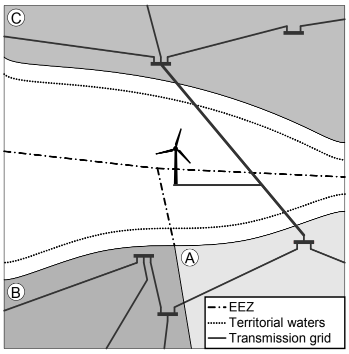
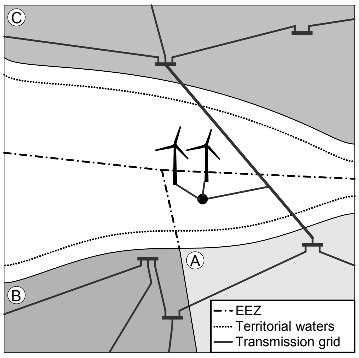


3c



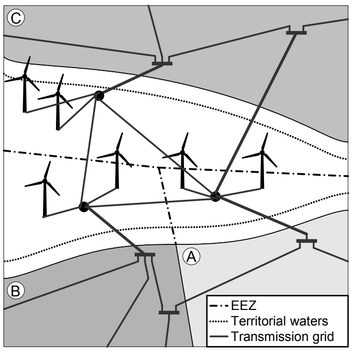
3d

For option 3c and 3d, two different scenarios are possible. Either the wind farm could be connected to an existing interconnector or the project could be constructed as a combined solution from the very beginning. This might have implications for the regulatory treatment and will be discussed in more detail. Similar to the clustering of wind farms, such a combination of offshore wind farms and interconnectors is considered as a crucial stepping-stone for the development of a transnational offshore grid. These projects are also referred to as ‘hybrid projects’.

3.4 Option 4: connection of offshore wind farms into a meshed offshore grid

The last option would be the ‘meshed grid’, being the final stage of the offshore grid. Here, wind farms would be connected via offshore hubs with each other and with all North Sea countries. For this offshore grid, the possible options vary from a meshed grid like this, consisting of combined connections of offshore wind farms and interconnecting cables to other designs that involve the construction of a ‘loop’ connecting the different offshore wind farms.

4



Within this PhD thesis, I argue that this offshore grid will not be built as such but will rather evolve from the options 2 and 3. Eventually, these projects would lead to an interconnected, meshed HVDC offshore grid with several landing points to the onshore grids as shown in the picture.

4 Structure

This PhD thesis consists of four main parts. In Part I, the legal bases under international law and EU law will be analysed, including their implications for all four options. In Part II, I will examine the applicable legal framework under EU and national law. I will discuss the relevant secondary EU legislation and the national legal frameworks that have been developed so far. As it will become apparent in this thesis, the current legal frameworks have mainly been developed to regulate option 1. In Part III, I will apply these legal frameworks to options 2 (clustering) and 3 (hybrid projects) to establish whether legal shortcomings would arise. The thesis will end with recommendations on how the current legal frameworks need to change to facilitate the more structured connection of wind farms, potentially across borders. To this end, I will identify in Part IV the necessary legal amendments that need to be implemented to enable the development of projects involving the clustering of wind farms as well as hybrid projects. Next to that, I will establish how these amendments can be agreed on between the North Sea states. The establishment of such a coherent and supportive legal framework for these projects is a prerequisite for the development of a transnational offshore grid.

The law is stated at February 2015. Wherever possible, subsequent developments have been taken into account.

PART I: Legal basis under international and EU law