Environment and Planning C: Government and Policy 2016, volume 34, pages 340 – 355

doi: 10.1177/0263774X15614660

The challenges of greening energy: policy/industry dissonance at the Mongstad refinery, Norway

Håvard Haarstad and Grete Rusten
Department of Geography, University of Bergen, Bergen, Norway;
e-mail: havard.haarstad@uib.no
Received 16 July 2014; in revised from 15 October 2014; published online 26 November 2015

Abstract. The interaction between policy making and industry is a key to understanding the conditions for 'greening' contemporary energy systems. This article uses efforts toward greening the Mongstad oil refinery in Norway as a case to analyse the challenges involved in politically stimulated shifts towards increased sustainability in the energy sector. A technology test centre and a full-scale carbon capture and storage (CCS) project at Mongstad were the centrepiece of the Stoltenberg government's (2005–2013) climate strategy. However, the project suffered delays and cost overruns until the full-scale carbon capture and storage project was eventually stopped. It is argued that interactions between the policy-making and industrial innovation arenas involved in this case are challenging because they operate according to different internal logics. We conceptualize this divergence as 'policy/industry dissonance' and suggest that this concept is a useful complement to literatures on regional innovation systems (RIS) and the multilevel perspective on sustainability transitions (MLP).

Keywords: energy, policy, innovation, carbon capture and storage, dissonance

Introduction

Interactions between the public sector and the industry innovation arena provide a key to understanding the current conditions for 'greening' contemporary energy systems. As institutional perspectives recognize, the state is shaping the foundations for energy production and energy markets by governing resources; among other issues, this involves establishing legal frameworks, initiating infrastructure development and controlling land use (Martin and Sunley, 1997; Norberg-Bohm, 1999). Persistent and stable public policy regimes are critical to driving changes in energy production and consumption (Grubler, 2012). Given concerns over the environment, climate change and energy security, it is of significant public and commercial interest that industries shift towards greener forms of energy production and that industrial stakeholders take part in stimulating such a shift through prioritizing innovation and investment for that purpose (Head, 2011; Porter and Kramer, 2011).

However, the transition to more sustainable energy systems presents significant challenges for policy makers and governments. For industry, the key driving force behind eco-innovations is generating business opportunities and reducing costs, and public sector institutions have a wide range of tools available to stimulate innovation and drive technological change. It is unclear which tools are appropriate and effective in different contexts. The broad question posed in this article is: how can we understand and conceptualize the constraints on policy-efforts of greening large-scale energy production?

Our contention is that interactions between the policy-making arena and industrial sector innovation is challenging because these arenas operate according to different logics, and that understanding this 'policy/industry dissonance' is important in explaining the failure of public sector institutions in driving technological change. We identify three aspects of policy/industry dissonance: rationality, spatiality and temporality. Rationality dissonance is linked to notions of bounded rationality (Simon, 1957) and refers to the divergent objectives and interests through which policy makers and industry actors approach a project. Spatial dissonance, understood through geographical concepts of site, scale, distance and context (Haarstad, 2014; Peck, 2011), refers to a mismatch between the territorial assumptions of the policy and the spatial composition and dynamics of the industrial project. Temporal dissonance, understood with reference to the timescales of energy transitions and industrial ecology (Desrochers, 2002; Grubler, 2012), points to the diverging time frames between policy and industrial innovation processes.

This contribution is intended to complement the literature on regional innovation systems (RISs) and the multilevel perspective on sustainability transitions (MLP), two perspectives that attempt to conceptualize the interaction between government and policy on the one hand, and industry and innovation on the other. In both these fields of research, public sector institutions are seen as elements in a broader system of actors, institutions and technologies that shape the conditions for innovation and change in industry practices (Asheim and Isaksen, 2002; Cooke et al., 1997; Geels, 2011; Kemp, 1994; Verbong and Loorbach, 2012). There has been a tendency, particularly within RIS, to operationalize public sector institutions simply as 'supporting' organizations that facilitate innovation and learning (see Asheim and Isaksen, 2002: 83). However, in certain geographical contexts and sectors the state plays a far more active role, as has been the case in the Norwegian petroleum sector and the present case study (Hull Kristensen and Lilja, 2011). Similarly, several recent contributions have suggested that appraising the specific agency of governmental institutions is difficult within the MLP, and so it is the role of spatiality (Coenen et al., 2012; Greenwood, 2012; Smith et al., 2010; Späth and Rohracher, 2012). Conceptualizing policy/industry dissonance can help refine understandings of relations between governmental institutions and industrial actors.

Examining policy/industry dissonance is particularly relevant for large-scale energy projects, since they typically require significant public backing as well as technological innovation in order to succeed. We use as our case study a project aimed at greening an oil refinery at Mongstad, Norway. The Norwegian energy sector has been described as exhibiting systemic interdependencies that create lock-in patterns around petroleum and hydropower, constraining innovation and implementation of new renewable energies (Christiansen, 2002). Converting Mongstad – Norway's single highest point source polluter – into an international showcase for innovation in carbon capture and storage (CCS) was the main environmental and climate-related project of the government of Jens Stoltenberg. It was launched in 2006 as Norway's 'moon landing' because of its ambition to develop ground-breaking CCS technology. To this end, Statoil and other companies received ample institutional support, not least of which included public funding. Yet the project ended, at least symbolically, with the appearance of now-former Prime Minister Jens Stoltenberg in front of the Norwegian parliament's standing committee on scrutiny and constitutional affairs, in February 2014. Shortly after losing the 2013 election, the Stoltenberg government had pulled the plug on the full-scale carbon capture project. There was widespread criticism of misappropriations of public funds, and both the State Auditor and a parliamentary scrutiny committee concluded that the Stoltenberg government had mismanaged the project.[1]

From this case study, we argue that the project failure cannot simply be explained by weak implementation or mismanagement, but rather by some crucial process differences between the policy-making and industrial sectors. We identify and explain rationality dissonance, spatial dissonance and temporal dissonance as they appear in this case. In the next section, we will briefly discuss theoretical perspectives on public and private sector interactions,

(1) Whether or not the project was a failure is of course subject to debate. Stoltenberg and industrial participants in the project defended it, saying that important technological advances had been made and that these will benefit CCS projects elsewhere. The fact remains that significant resources went into planning for full-scale implementation of CCS at the site, and this did not materialize.

explain our concept of policy/industry dissonance and outline our methodology. In section 'the challenges of greening an oil refinery', we provide a contextual background for the case study. The core of the empirical analysis is presented in section 'identifying policy/industry dissonances in the greening of the Mongstad refinery', where we discuss the case through our policy/industry dissonance perspective. Finally, in section 'conclusion', we provide some general observations.

Theoretical background and framework

Policy making and industry in greening energy; or, why is configuring the right policy so difficult?

The role of the state in the economy has been one of the central issues in social science and politics for decades (Block, 1994). Most recent perspectives now recognize that the state plays a fundamental role in shaping the functioning and organization of economic markets (Martin and Sunley, 1997; Peck and Tickell, 2002), and that economic action is socially embedded (Granovetter, 1985). Public policy is an essential element in shaping the rate and direction of technological innovation in the private sector (Norberg-Bohm, 1999).

The relationships between government and industry have been conceptualized in different ways in the various subdisciplines of human geography. In the field of economic geography dealing with clusters and RISs, government is typically understood as supporting institutions, and charged with creating an enabling environment for inter-firm learning and co-operation. RISs are described as 'regional clusters surrounded by "supporting" organisations' (Asheim and Isaksen, 2002: 83). They emerge under conditions that facilitate a culture of co-operation, involve research and education institutions and provide appropriate means of finance (Cooke et al., 1997). Governmental institutions are seen as key to providing or facilitating some of these functions, but the primary determinants of innovation and economic growth are processes occurring within and between the firms themselves. The 'success' of governmental innovation policy is then conditional upon how this policy is fine-tuned to local and regional conditions. Tödtling and Trippl (2005) argue that innovation policy must be differentiated on the basis of the region type (central, peripheral, old industrial) it is targeting. Research experience from the Hordaland region (where Mongstad is located) and other regions in Norway also point to the need to better adjust policy instruments to industry type and to firms' structural composition and innovation capacity (Rusten and Overå, 2014). Finally, the RIS literature tends to focus on knowledge and technology intensive industries, whose inertia and path dependencies are primarily related to human resources, competence and market positions (Malerba, 2010). For our case study, and for large-scale energy projects in general, inertia is significantly related to physical artefacts such as pipelines and huge mountain oil storage caverns.

The fundamental assumption in RIS, namely that innovations are conditioned by a broader system of relations in which government policy is one element, is shared by the MLP framework. The MLP attempts to explain the socio-technological contexts in which green technologies develop. From this perspective, radical innovations occur within 'niches', but their introduction and usage are conditioned by the way they become integrated into socio-technical 'regimes' and socio-technical 'landscapes' (Geels, 2011). A socio-technical regime is understood as the coherent complex of scientific knowledge, production practices, user preferences, regulatory requirements, institutions and infrastructure (Rip and Kemp, 1998). Technological transitions occur as multifaceted processes in which industrial innovation plays a key role, but these always co-evolve within a selection environment in which government is one actor (Kemp, 1994). In line with the RIS and production system perspective, the MLP stresses how government and policy shape and are being affected by the institutional and regulatory context in which innovations emerge. But government is typically conceived as only one element in the complex of relations, rules and motivations that actually trigger and govern technological change. Critics have recently suggested that this makes it difficult to appraise the governability of and the agency involved in socio-technical transitions, as well as the way spatial dimensions influence conditions for transitions (Coenen et al., 2012; Greenwood, 2012; Smith et al., 2010; Späth and Rohracher, 2012). Although there is a growing literature on the spatiality of sustainability transitions, empirical contributions have focused on local, regional and urban niches, rather than national levels and regimes (Hansen and Coenen, 2013).

Much of the RIS and MLP literature has been focused on assessing the effectiveness of various types of public sector support for stimulating innovation and technological change. In broad terms, we share this systems-oriented approach to understanding innovation and technological change. However, following on from the critics cited above, we contend that there is a need to further refine the way public–private interrelations are dealt with and analysed in these perspectives. Seeing the state as a facilitative, enabling or supporting institution – as RIS in particular tends to do – is related to a particular understanding of the public/private relationship, which may not be accurate for all geographical and temporal contexts (Martin and Sunley, 1997). In certain contexts, such as the Norwegian oil sector, the state has historically had a far more active role as planner and operator (Hull Kristensen and Lilja, 2011). While both RIS and MLP allow for mismatches between elements of the system, there is little focus on how these emerge historically or geographically, and how they can be conceptualized. Governmental policy and industry sectors may interact (or fail to do so) in very different ways from one project to another. The challenge for systems approaches such as RIS and MLP is to more accurately account for the diversity of relations between specific actors in the system, particularly relations between government and industry. Contributing to this enhanced understanding of relations between policy-making and industrial arenas is, theoretically speaking, the purpose of this article.

Conceptualizing policy/industry dissonance in the energy sector

In a general sense, our concept of policy/industry dissonance can be understood as a divergence between the internal dynamics within the arena of political decision-making on the one hand and the arena of industrial innovation on the other. In political science and public policy studies, there are long-running traditions that point to institutional inertia, risk minimization, resource constraints and elements of non-rationality in policy design (Head, 2008; Rittel and Webber, 1973). While institutional inertia and non-rationality can probably explain many cases of weak policy design, our perspective is rather that actors in different arenas expectedly develop divergent practices, discourses and interests. An important part of the failure of governments to generate the intended industrial responses can be attributed to a divergence between these intra-sectorial logics, rather than to irrationality or inertia per se.

This concept of policy/industry dissonance can be disaggregated further and, on the basis of our case study below, we identify three aspects of dissonance: rationality, spatiality and temporality. These are not necessarily mutually exclusive categories but rather different aspects of policy/industry dissonance.

Rationality dissonance. It is a widely accepted notion in social science that people make decisions within particular frames that shape perceptions, limit information and condition choices, and these frames are often called bounded rationalities (March, 1988; Simon, 1957) This is not the same as suggesting that actors are irrational, but rather that the rationality and information actors employ in making decisions are not comprehensive and universal. Professional communities share particular frames of meaning (Grin and van de Graaf, 1996). Policy makers, technological entrepreneurs and firm managers are likely to draw on very different types of expertise and frame problems differently, which means that they are likely to come to different conclusions about solutions and courses of action. Policy makers can be expected to design green policy packages on the basis of their own rationality and incentives, and work their own values and regional-political interests into them (Lipp, 2007). They are, of course, highly motivated by prospects of re-election. This means that implemented policies are rarely direct formulations of abstract political goals; they are rather results of complex negotiations between different interests.

For companies it is generally the profit motive that shapes their rationality (although some recent research (Bergek et al., 2013) complicates this picture in the renewable energy sector). This does not necessarily mean that their investments are not aligned with environmental concerns. Companies that anticipate future regulations by undertaking eco-innovations or implementation of technology that represents an environmental improvement can acquire competitive market positions (Porter and Kramer, 2011). Furthermore, reducing production costs through more efficient use of materials, manpower or energy, or reducing costs spent on pollution reduction or finding markets for byproducts, may be effective strategies in a business sense. The industrial ecology literature illustrates this well (Desrochers, 2002; Hews and Lyons, 2008). Rationalities may be compatible across policy and business arenas, but they may also diverge significantly and create mismatches in project expectations, strategies and goals.

Spatial dissonance. Geography adds complexity to the relationships between public policy and industrial innovation processes in several different ways. Distance (both in relational and absolute terms) can stretch and dilute social relations, and the contextual specificities of place can create and maintain cultural barriers between policy makers and actors involved in innovation processes. Differences in the scale of policy-making, governance and innovation processes can uphold differences in knowledge regimes and bounded rationalities (Haarstad, 2014; Jordan, 2008; Lindseth, 2006), and in turn fragment decision-making and make implementation difficult (Duit and Galaz, 2008). While policies appear increasingly 'mobile' and 'mutable' across different geographical contexts, they always involve certain territorial assumptions and conditions that complicate implementation in particular places (Peck, 2011).

Likewise, innovations and investment decisions have their own geographical dynamics (Rusten and Overå, 2014). Site characteristics such as energy infrastructures are embedded in space for long periods of time and tend to lock socio-technical systems into particular patterns of energy production and consumption (Unruh, 2000). These infrastructures are increasingly interconnected, and they are often stretched out across large distances and often across the jurisdictional boundaries of polities (Bridge et al., 2013). Therefore, policies typically only reach or cover parts of the interconnected systems, and the industrial dynamics of other parts of the system may work against the intentions of the policy. For example, a policy package may be targeting a particular region, while the regional industries are embedded in and shaped by geographical relationships that stretch much further. In other words, a dissonance can occur when there is mismatch between the territorial assumptions of the policy and the spatial dynamics of an industrial project.

Temporal dissonance. Processes in different sectors and niches of society work on different timescales, corresponding to the particular cycles in which tasks and reporting are completed. For example, politics are significantly shaped by election cycles as well as the time frames involved in political decision-making, while business sectors are shaped by the cycles of annual and quarterly reporting. For energy projects, the time cycles of political decision-making and elections often correspond poorly with the longer time frames of constructing energy infrastructure, and the long-term horizons for upscaling new energy innovations (Grubler, 2012). Politically, projects are often processed within an electoral cycle, while energy infrastructure takes years to build and operate at a cost that can defend the large investment, and therefore it takes several decades to render them obsolete. Actors within the different arenas have incentives to evaluate and plan activities and projects on very different timescales.

The difficulty of reconciling the respective timescales between political and industrial sectors is illustrated in the literature on regional development and industrial ecology. Environmental industrial projects, such as industrial symbiosis and eco-industrial parks, typically evolve dynamically over the long term, and are difficult for planners to organize in a top-down fashion (Desrochers, 2002; Deutz and Gibbs, 2008; Hews and Lyons, 2008). These projects illustrate how the development of complex energy projects involves timescales that are significantly different from those within politics. These timescale differences between political and industry arenas may generate temporal dissonance.

Methodology

The data for this study of the Mongstad refinery and the CCS technology project have been compiled from a detailed project history using a mixed methods approach. Sources include the academic literature, open or grey documents, the media, secondary data and personal interviews covering various aspects of regional and industrial development in the Nordhordland region since 2007. During this period, the authors have conducted personal, semi-structured interviews with the management of 34 local and national companies including Statoil and Statoil Mongstad, eight interviews with informants representing the industrial park, incubator, Chamber of Commerce, the education system and the municipality. Several of these have served as key informants. In addition, six interviews relating to national CCS politics were conducted in 2013 with representatives from public institutions and environmental NGOs. This includes the Ministry of Petroleum and Energy, the Bellona Foundation and Zero (the latter two NGOs have been central in public debate on the issue). We have also reviewed minutes and documents from the parliamentary hearing in 2013. Our analytical assessments below draw on the interview material in particular.

The challenges of greening an oil refinery

In 2005, the Norwegian government announced plans to use the Mongstad refinery, Norway's single highest point source emitter of CO_2, as a site to test and develop technology for CCS.[2] CCS is a strategy of capturing CO_2 before it is emitted into the atmosphere, and storing it through subsurface injections in geological formations underwater or on shore. There are also industrial applications for the captured CO_2, most prominently its injection into oil and gas reservoirs to achieve enhanced oil recovery. Since 1996, Statoil has annually stored about 1 million tons of CO_2 from the Sleipner gas field in the Norwegian North Sea, where CO_2 from the liquefied natural gas (LNG) plant at Melkøya at HAmmerfest is injected into geological structures in the gas field. It is widely believed that CCS technology is still immature for large-scale application as a cost effective climate mitigation option. It is also debatable whether this type of technology is actually a wise climate mitigation strategy, given the high cost and that it is predicated on the continued extraction of fossil fuels. Captured CO_2 can be used for the production of various chemical products, but this requires industrial symbiosis and the co-location of chemical industries on the CO_2 capture sites. An additional alternative for the captured CO_2 would be to use this resource to produce oil-rich microalgae, which can be utilized as biofuel or as a nutrient in food products for humans or as a fodder ingredient for fish farming. As such, the greening of the Mongstad plant potentially involves a series of industrial projects that extend beyond the energy sector.

(2) The Statoil Mongstad refinery emitted 2.3 million tons of CO_2 in 2012, which corresponds to 5.2% of Norway's total CO_2 emissions for 2012 (44 million tons). Source: Norwegian Environment Agency, see www.norskeutslipp.no.

The Mongstad refinery was developed as part of national and regional industrialization strategies long before the greening of energy emerged as a serious concern. The initiative and planning for the Mongstad refinery in the late 1960s was developed by Norsk Hydro (at that time Norway's largest processing company) with active engagement and support of the state, local and county authorities. The industrial commercial basis for Mongstad was that this industrial development could solve challenges Hydro had with providing sufficient access to material input needed for certain parts of their production (Kolstad, 1999).

Initial construction of the Mongstad refinery started in 1972, the same year as Statoil was established by the Norwegian government to ensure national and public control of the emerging oil industry (Nebben, 2009). The Mongstad refinery started production in 1975, but was soon seriously affected by non-competitive operational costs and market uncertainties with low prices. Many of the market difficulties came as a result of the OPEC oil crisis in 1973 (Bjørnevoll, 2004). Statoil gradually increased its ownership share at Mongstad, and in the 1980s eventually became majority owner and plant operator. This ownership change meant a business strategy shift, since Statoil was almost entirely focused on oil production. A merger between Statoil and Hydro's oil division, and Statoil's purchase of Shell's holdings in the refinery, gave Statoil full ownership control.

The Mongstad refinery was originally planned for and based on imported crude oil but with exploration and production in the Norwegian sector of the North Sea, rich petroleum resources were suddenly found to be much closer. Mongstad is now a medium-sized, relatively modern refinery, directly linked to offshore fields through two crude oil pipelines, a natural gas liquids/condensate pipeline to the crude oil terminal at Sture, and the gas processing plant and gas pipeline from the nearby township of Kollsnes. The refinery has gradually expanded and consists of a crude oil terminal and an LNG processing unit and terminal. The facilities also include three mountain caverns totalling 1.5 million m^3 of crude oil, which is received by ship as well as through pipelines from the major offshore oilfields (NPD, 2012).

The part-privatization of Statoil in 2001 and the gradual process of internationalizing their operations had several implications for Mongstad. Organizational changes within Statoil meant that management responsibilities were relocated from local units (such as Mongstad) to the operation headquarters in Bergen and corporate headquarters in Stavanger. Statoil is no longer considered a political instrument for regional and national development, but rather as a multinational corporation with an overall strategy to create profit to satisfy its shareholders (Rusten et al., 2005; Ryggvik, 2009).[3] Another problem over the years is that the refinery has faced economic difficulties due to an overcapacity of these facilities in Europe. An additional market challenge is the U.S. government's ban on the export of crude oil from its territory, which has put their refineries in a favourable market position.

The Mongstad refinery became central to Norwegian political debate in the mid-2000s, when Statoil applied for a licence to build an on-site gas-fired power generator. For years, gas-fired power has been at the centre of an ongoing political controversy over how climate and energy policy should be weighed and prioritized (Tjernshaugen and Langhelle, 2009). This controversy embodies Norway's troubled position as both a leading country in climate and environmental protection and one of the world's largest exporters of oil and gas. For much of the environmental movement and the left, gas-fired power plants became the

(3) That Statoil initially was initially conceived as a political instrument is illustrated by the fact that three of its first CEOs had political backgrounds in the Labour Party (Nebben, 2009). The CEO who served during the Mongstad process, Helge Lund, had a business school and corporate background.

(4) It did, however, receive the NOK 6 million (EUR 800,000) needed to launch after negotiation between the two ruling right-wing parties in the Solberg government and their supporting parties in parliament in June 2014.

key symbolic issue for mobilization of a generation of young environmental activists. In 2000, the government resigned rather than granting licences to build gas-fired power plants without CCS.

When the liberal environmentalist party (SV) and the labour party (AP) formed a government in 2005 (in a coalition that also included the rurally based Centre Party, SP), the climate/energy dilemma – and the issue of gas-fired power plants in particular – came to the fore: should the governing coalition prioritize energy security and regional industrial development or climate responsibilities? The issue of gas-fired power plants had the potential to break the governing coalition. An agreement was finally reached that gas-fired power plants could be built, provided they were 'based on CCS', as the governmental platform statement read. As Tjernshaugen and Langhelle (2009) put it, CCS became the 'political glue' in the governing coalition.

When Statoil shortly thereafter applied for a licence to build the gas-fired power plant at Mongstad, this 'political glue' was tested. Statoil's plans included upgrading the Mongstad refinery with a co-generation facility that would deliver heat to the refinery as well as power to the electrical grid (Osland and Rusten, 2005). The use of the gas-fired power plant represented a major new and additional source of CO_2 emissions. After tense negotiations, Statoil was allowed to build the facility on the condition of abiding by a two-step process towards carbon capture. First, the Norwegian government, Statoil and a consortium of international companies would build a CCS test centre at Mongstad. Second, the state would fund a full-scale application for CO_2 capture, to be operative from 2014. Prime Minister Jens Stoltenberg characterized this solution as 'Norway's moon landing', arguing that technological development of CCS at Mongstad would be internationally ground breaking.

The characterization of the CCS project at Mongstad as a 'moon landing' came to haunt the Stoltenberg government (Røyrvik et al., 2012). The programme quickly ran into overrunning costs and repeated delays. Critics in both the environmental movement and the right-wing opposition pointed to an unclear agreement between the state and Statoil that set few incentives for the oil company to promote the project. It became clear that installing the capture technology while the plant was in operation would be more challenging and expensive than foreseen. In addition, discussion emerged around the potential detrimental health effects from the amino solution used in the capturing process. The CCS test centre (Technology Center Mongstad, TCM) was opened in 2012, a year and a half behind schedule. At the same time, local industrial actors developed plans for using the captured CO_2 in industrial processes, most particularly in an algae project in connection with the Mongstad refinery. The algae project CO2BIO is planned as a non-profit infrastructure laboratory, based on payment for using these facilities.

Shortly after the 2013 elections in which the Stoltenberg government lost power, but before the new government had formally taken power, the Stoltenberg government announced that the full-scale application of CCS technology at the Mongstad refinery had been terminated. As the 'moon landing' project was a major part of the government's climate agenda, this was a significant blemish on the government's legacy. As the new Solberg government took office in the autumn of 2013, the record of the greening of the Mongstad refinery was as follows (see Figure 1 for a timeline of the central events):

- The gas-fired power generator was in operation without CCS, contributing to Mongstad's status as Norway's largest point source polluter.
- More than NOK 7 billion (about EUR 900 million) was spent on the planning of CCS at Mongstad, although no CO_2 was captured.
- The implementation of full-scale CCS on the plant was called off and no plans for other implementation sites in Norway existed.

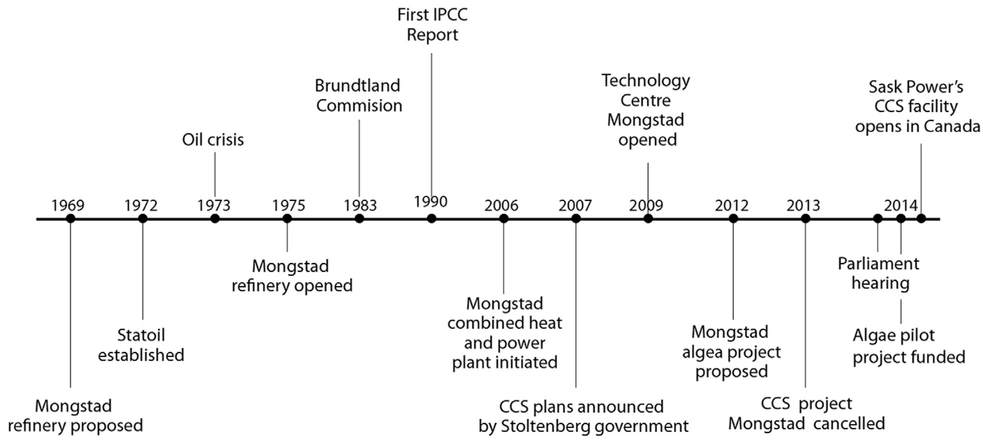

Figure 1. Timeline of significant events relating to Mongstad development.
CCS: carbon capture and storage.

- The CCS technology test centre had been built and technology options continued to be tested there. But it is disputed whether any applicable technologies had been developed by the end of 2013.
- The office of the auditor general had delivered a highly critical report on the organizational and financial management of the project.
- The spin-off projects, such as algae production, had suffered from a lack of funds.[4]

Identifying policy/industry dissonances in the greening of the Mongstad refinery

As a large-scale industrial project with clear political motivations, the greening of the Mongstad refinery was predicated on a relationship between the policy-making and industrial arenas. Reports by the State Auditor and the standing committee on scrutiny and constitutional affairs (Riksrevisjonen, 2013; Stortingets kontroll og kons.komité, 2014) revealed a series of weaknesses in the project's logistical management, including insufficient cost control and a lack of clear project goals. One of the main conclusions of the State Auditor was that the complexity of the development of CCS at Mongstad had been underestimated when the original agreement with Statoil was made, and that this later limited the state's opportunities for managing the project. What we are trying to show is that underlying these financial and organizational problems there are more fundamental disconnections between policy-making arenas and industrial actors. Analysing these disconnections can help explain why managerial problems occurred. Drawing on the terminology developed above, we will now explain the failure of the efforts of greening Mongstad through our notions of rationality dissonance, spatial dissonance and temporal dissonance.

Rationality dissonance: Actors are driven by different objectives and rationalities

The technological solution of retrofitting the gas-fired power generator with CCS technology was, contrary to the suggestions of the 'moon landing' rhetoric, a compromise between the parties involved. Actors in the policy-making and industrial sectors had different objectives and rationalities for accepting this compromise. By assessing the internal dynamics in each of these sectors, it becomes clear that their objectives and rationalities clearly diverged.

In the political realm, the central actors related to Mongstad by defending their ideological positions. The three political parties of the governing coalition: the AP, the Socialist Left Party (SV) and the SP had divergent agendas in relation to the gas-fired power generator.

It was particularly the SV party's need to exhibit a strong pro-environmental stance that clashed with the AP's pro-industry and Statoil-friendly position. When Statoil applied for the gas-fired power generator permit, these party differences came close to bringing down the government. The CCS project at Mongstad came about as a solution to bridge these divergent positions. Allowing the project to go forward with the CCS project, and labelling this as a ground-breaking environmental project (akin to the moon landing), catered to the interests of both the SV and AP parties. It was a way for SV to stand behind an ambitious climate-related project at the same time as the AP could grant Statoil the licence needed to build the gas-fired power plant.

Looking at the dynamics internal to the political sphere, it can be suggested that the main motivation behind the project was not to lower CO_2 emissions, but to bridge particular political and strategic positions. It is perhaps telling that the 'moon landing' project was cancelled just a few weeks after this governing coalition lost the 2013 general election. It was conceived by, and lived within, the Stoltenberg government. Opposition politicians have called the EUR 900 million price tag of the CCS project 'the price to keep SV in government' (Dagens Næringsliv, 21 September 2013). In short, the political motive behind the project was, to a significant extent, driven by party politics.

The industrial actors related to the project on the basis of quite different objectives and rationalities. The overarching logic of the industrial sector is, of course, economic profitability and it should also be expected that Statoil applied this rationality in dealing with the greening of Mongstad. In the case of the 'moon landing' project, Statoil's objective was to get a licence to build the gas-fired power generator – in a sense, the CCS project was the price Statoil had to pay to get this licence. Several interviewees, for example, the CEO of a large Norwegian company co-operating with Statoil on CCS-related technology development, held that many Statoil employees were personally dedicated to realizing the project, but that top management had little motivation to develop and implement the CCS technology. Once the gas-fired power generator was built, Statoil had few profit-related incentives to prioritize it. The agreement between Statoil and the state, according to which the state covers the project costs and Statoil is the operator, gives Statoil a clear incentive to inflate the project budget. That is precisely what happened – the initial budget of NOK 5.9 billion in 2006 increased to NOK 20–25 billion in 2012 (Riksrevisjonen, 2013). The high-budget estimate gave the state good reason to cancel the project, which left Statoil with the licence it wanted but without having to 'pay the price' of building the full-scale CCS facility.

Whether or not this was Statoil's strategy, the point here is to note that there was a significant dissonance between policy makers and industrialists in terms of the rationalities and objectives for pursuing the project. Policy makers were to a significant extent driven by the need to bridge divergent ideological positions within the governing coalition, while Statoil wanted the licence for the gas-fired power plant. Arguably, the development of the CCS project was in itself not the primary objective for any of the key actors. The rationales that the different actors brought into the project did not converge into effective planning and execution. To the contrary, the key actors each met their divergent primary objectives without actually achieving full-scale CCS at Mongstad.

Spatial dissonance: Mismatch between the territorial assumptions of the policy and the spatial dynamics of the industrial project

The political process behind the CCS project meant that no geographical locations other than Mongstad were considered for the CCS technology development. In a way, the plant being Norway's largest point source polluter appears to be a good reason. Yet, as became apparent throughout the project's life cycle, this location presented constraints and complexities that were not envisioned beforehand.

The location and regional embeddedness of the existing refinery at Mongstad has influenced the types of activities that have been developed there. The increasing oil activities on the Norwegian continental shelf made Mongstad a favoured site for the expansion of oil-related activities and generated the growth of a significant oil services industry immediately surrounding the refinery. These oil-related activities crowded out strategic plans for symbiotic industrial activities that could have generated other types of local and regional development. Besides, after Statoil took over ownership, the refinery no longer had an owner with competence and ambitions to invest in a broader range of petrochemical and raw material processing. Statoil's focus was purely on oil and Mongstad developed into a medium-sized, relatively modern refinery close to the oil resources but far from major markets outside Norway. These oil-related technical service activities have occupied the physical space around the Mongstad refinery, making it difficult to fit symbiotic production activities that could have environmental effects onto the site itself. Researchers have developed a technological model for an eco-industrial park at Mongstad, but they emphasized the difficulty of adding on new production activities to an already cramped industrial site (Zhang et al., 2008). Also, it was discussed whether the innovation project geographically far from the most prominent technical research community at Norwegian University of Science and Technology (Trondheim) which also is the location for the R&D headquarters at Statoil was the most favourable. And regional industrial developers started to look for alternative CCS sites. In short, Mongstad has developed historically in response to corporate strategies and changing market conditions, which have favoured the oil side of the business rather than opening up for symbiotic industrial activities such as CCS.

For the CCS project, the fact that the gas-fired power plant was built adjacent to an oil refinery presented a series of technical difficulties. The operation of a refinery, a gas-fired power generator and a test centre for CCS technology led to increased demands on accessible electricity, steam and cooling water. It also led to the need for heightened security measures. Almost half of the costs of building the technology test centre went to building and upgrading infrastructure, a point of criticism noted in the State Auditor's report (Riksrevisjonen, 2013).

Oil-related activity has also consumed the available labour capacity, making it difficult to find qualified personnel for non-oil-related activity in the region. The refinery is located in a semi-rural region with a local unemployment rate for some years of roughly 2% (NAV, 2014). Local crowding out of non-oil-related activities is also characteristic of Hordaland and western Norway, a region with high levels of oil-related activities that attract most of the available qualified personnel into this high-wage sector and draw much of the capital investments. This has made it difficult to recruit qualified labour into more economically risky greening and renewable energy projects. In addition, Statoil's concentration of management responsibilities and new practices of global sourcing have likely turned the attention of Statoil's top management away from local cluster development. In an interview, a local industrial development officer portrayed Statoil as growing increasingly indifferent to local and regional development concerns (interview, 2013).

Apparently, there was little consideration of the spatiality of the industrial dynamics at Mongstad before it was decided upon politically. But the geographical conditions at the site and distances to key competence milieus presented significant complexities. In turn, there was a significant mismatch between the territorial assumptions of the policy and the spatial dynamics of the industrial project.

Temporal dissonance: Diverging timescales between policy processes and industry processes

The CCS project at Mongstad also suffered from divergence between political process timescales and the industry actors. For the political actors, the timing of the decision and announcement of the project corresponded to political strategizing – the infamous 'moon landing' rhetoric was initially in the Prime Minister's 2007 New Year speech – akin to a Norwegian State of the Union watched by the public at large. The political process set the time-related parameters for project planning. For the SV party, it was critical to set particular parameters on the building of the gas-fired power plant, in particular to be able to say that some carbon capture (capturing at least 100,000 tons of CO_2) would be in place from day one, simultaneous with the start-up of the gas-fired generator. Further, it was established that full-scale carbon capture would be in place by 2014. Originally, the SV party argued for full-scale capture from day one, but had to settle for a somewhat less ambitious plan after negotiations with the AP. Nevertheless, the project development plan was significantly shaped by party politics. For the SV party, with its environmentalist, climate-focused base and tradition of opposing gas-fired power plants, it was out of the question to accept granting a licence to Statoil without strong, climate-related requirements. This translated into a specific progress plan for the construction of the gas-fired power generator and the CCS technology.

The fact that the decision-making process progressed according to a 'political timescale' put the state at a significant disadvantage in negotiations with the main industry actor – Statoil – and introduced certain irrationalities into the process. (This is not to suggest that the project should not have been subject to a political process where both parties' opinions are represented.) Since the project outlines had been decided politically and were committed to by the government, Statoil was in a comfortable bargaining position vis-à-vis the state. Publicly, the governing parties' positions and the party leaders' priorities were well known. It was already a given that the state-backed effort to promote the CCS would take place at Mongstad, Statoil's plant, and in turn it was a given that Statoil would be the main partner. An arguably more rational process would have been that the government first decided what type of project it wanted and then negotiated with several different companies to get the best possible terms, as the UK government has done with its CCS commercialization programme competition. In the Mongstad case, such a solution was precluded by the chronology of the political process. Statoil accepted the basic requirements negotiated between the SV and AP parties (some carbon capture from day one, full-scale capture from 2014), but as stated by many critics, including the State Auditor, the contract between Statoil and the state was highly beneficial for Statoil because it contained virtually no enforcement mechanisms for the state and few incentives for Statoil to achieve the stipulated intentions.

The dissonance between the political and industrial timescales introduced other irrationalities and complexities into the project. For instance, the politically decided timeline included technological advances that had yet to be made. Basically, the government legislated that innovations should take place according to a set schedule. Despite the information about budget overruns and delays that had been available to the government for several months, the project went ahead until after the 2013 elections – most likely because cancelling the project would impact the election result. Cancelling the plans for full-scale carbon capture at Mongstad was in a sense symbolic – the life cycle of this industrial project roughly corresponded with the life cycle of the Stoltenberg government.

Conclusion

Our purpose in this paper has not been to list the managerial errors that caused the failure of the CCS project at Mongstad. Instead, we are suggesting that underlying the project management failures (such as cost overruns and lack of clear project goals), there are disconnections between policy-making arena and the policy process on the one hand, and the industrial sector and actors within it, on the other. Conceptualizing and analysing these disconnections can help explain why managerial problems occurred, and make it easier to understand why similar problems occur elsewhere. We hold that the Mongstad case exhibits a set of mismatches and divergences between the internal logics of the policy-making arena and the industrial sector that have broader relevance. In particular, the case can help to understand and conceptualize the constraints on policy-efforts of greening large-scale energy production.

We have here termed this phenomenon policy/industry dissonance, and analysed our case by looking at three aspects of such dissonance – rationality, spatiality and temporality. Rationality dissonance between the policy-making arena (essentially political parties) and the industry arena (Statoil) generated different objectives for the key actors involved and created a situation wherein the key actors each met their interests without actually executing the project. Spatial dissonance denotes the mismatch between the territorial assumptions of the policy and the spatial dynamics of the industrial project. The project was necessarily at a site where industrial functions had developed historically in response to corporate strategy and market conditions, and retrofitting the refinery with CCS technology presented significant problems and resulted in delays and cost overruns. Temporal dissonance denotes the different timescales of policy making on the one hand and industry and innovation on the other. For political reasons, it was necessary to set specific time frames for CO_2 capture and for technological innovations in CCS technology, which corresponded poorly to the industrial processes of innovation and development.

The case study, and the conceptual framework we develop around it, can help nuance understandings of interactions between policy-making arenas on the one hand and industrial dynamics on the other. Both the RIS and MLP literatures are concerned with this interaction, but critics have suggested that there is a need to advance understandings of how government actions shape innovations and sustainability transitions in specific contexts. (Coenen et al., 2012; Greenwood, 2012; Smith et al., 2010; Tödtling and Trippl, 2005). There has been a tendency, particularly within RIS, that the agency of governments is reduced to being supporting organization for innovation processes. Empirically, our case brings nuance to these frameworks. Here the government plays an initiating role in a large-scale industrial project, which enables the case to illustrate more clearly the longer term dynamics of policy/industry interactions. When analysing these dynamics, it becomes clear that they are not just occurring in the interface between two coherent arenas – the policy-making arena and the industrial arena have their own internal logics, contradictions and path dependencies. At its worst, government policy-making is more shaped by its own internal logics rather than by considerations for what policy mechanisms would be appropriate or effective. The view to these processes internal to specific arenas tend to be lost in when we take a systems perspective. As other geographers have emphasized, systems perspectives must strive to bring spatial complexities, including regional specialization, into account in understanding sustainability transitions, or lack of such (Hansen and Coenen, 2013). Our study has demonstrated how regional specialization (here through an embeddedness of oil-related industries) can have a conserving effect on the industrial structure and constrain transitions.

Our main concern here has been to understand and conceptualize the constraints on policy-efforts of greening large-scale energy production. There is clearly a role for the state in pushing for a greening of energy systems, even though dissonance can hinder the implementation and effectiveness of government-initiated projects. Therefore, the observation from this case is not necessarily that '"big push' policies in the energy sector are doomed to failure, but rather that they must be designed with the particularities of industrial dynamics and regional conditions in mind. Conceptualizing various aspects of policy/industry dissonance may be helpful here as a heuristic for thinking about potential problems and how they may be resolved.

Acknowledgements. An earlier version of this paper was presented at the session 'Entrepreneurship, innovation and sustainability' at the 2014 Association of American Geographers conference in Tampa, Florida. The study forms part of an ongoing project titled 'Small municipalities and large companies – the roles of local governments for regional economic resilience' (Vetenskapsrådet, Sweden 2013–2016, Linköping University), as well as the World Universities Network-funded project 'Developing Compatible Energy and Climate Strategies'. The authors would like to thank the two reviewers for helpful comments. Also thanks to policy makers, industry planners and companies for participating in our interviews relating to this research topic.

Declaration of conflicting interest. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding. See acknowledgements section above.

References

Asheim B, Isaksen A, 2002, "Regional innovation systems: the integration of local 'Sticky' and global 'Ubiquitous' knowledge" *Journal of Technology Transfer* **27** 77–86

Bergek A, Mignon I, Sundberg G, 2013, "Who invests in renewable electricity production? Empirical evidence and suggestions for further research" *Energy Policy* **56** 568–581

Bjørnevoll O, 2004, "*Historien om Mongstadbasen*" (Mongstad administrasjon, Lindås)

Block F, 1994, "The roles of the state in the economy", in *The Handbook of Economic Sociology* Eds N J Smelser, R Swedberg (Princeton University Press, Princeton) pp 691–710

Bridge G, Bouzarovski S, Bradshaw M, Eyre N, 2013, "Geographies of energy transition: space, place and the low-carbon economy" *Energy Policy* **53** 331–340

Christiansen A C, 2002, "New renewable energy developments and the climate change issue: a case study of Norwegian politics" *Energy Policy* **30** 235–243

Coenen L, Benneworth P, Truffler B, 2012, "Toward a spatial perspective on sustainability transitions" *Research Policy* **41** 968–979

Cooke P, Uranga M G, Etxebarria G, 1997, "Regional innovation systems: institutional and organisational dimensions" *Research Policy* **26** 475–491

Desrochers P, 2002, "Regional development and inter-industry recycling linkages: some historical perspectives" *Entrepreneurship & Regional Development: An International Journal* **14** 49–65

Deutz P, Gibbs D, 2008, "Industrial ecology and regional development: eco-industrial development as cluster policy" *Regional Studies* **42** 1313–1328

Duit A, Galaz V, 2008, "Governance and complexity-emerging issues for governance theory" *Governance: An International Journal of Policy, Administration, and Institutions* **21** 311–335

Geels F W, 2011, "The multi-level perspective on sustainability transitions: responses to seven criticisms" *Environmental Innovation and Societal Transitions* **1** 24–40

Granovetter M, 1985, "Economic action and social structure: the problem of embeddedness" *The American Journal of Sociology* **91** 481–510

Greenwood D, 2012, "The challenge of policy coordination for sustainable sociotechnical transitions: the case of the zero-carbon homes agenda in England" *Environment and Planning C: Government and Policy* **30** 162–179

Grin J, van de Graaf H, 1996, "Technology assessment as learning" *Science, Technology and Human Values* **21** 72–99

Grubler A, 2012, "Energy transitions research: insights and cautionary tales" *Energy Policy* **50** 8–16

Haarstad H, 2014, "Climate change, environmental governance and the scale problem" *Geography Compass* **8** 87–97

Hansen T, Coenen L, 2013, "The geography of sustainability transitions: a literature review", CIRCLE Working Paper No. 2013/39, Lund University, Lund, Sweden

Head B W, 2008, "Wicked problems in public policy" *Public Policy* **3** 101–118

Head B W, 2011, "Governance for sustainable regions: can government meet the innovation policy challenge?" *Regional Science Policy and Practice* **3** 219–231

Hews A K, Lyons D, 2008, "The humanistic side of eco-industrial parks: champions and the role of trust" *Regional Studies* **42** 1329–1342

Hull Kristensen P, Lilja K, 2011, *Nordic Capitalisms and Globalization: New Forms of Economic Organization and Welfare Institutions* (Oxford University Press, Oxford)

Jordan A, 2008, “The governance of sustainable development: taking stock and looking forwards” *Environment and Planning C: Government and Policy* **26** 17–33
Kemp R, 1994, “Technology and the transition to environmental sustainability” *Futures* **26** 1023–1046
Kolstad K, 1999, *Mongstad: frå utkantbygd til industristad* (Samlaget, Oslo)
Lindseth G, 2006, “Scalar strategies in climate-change politics: debating the environmental consequences of a natural gas project” *Environment and Planning C: Government and Policy* **24** 739–754
Lipp J, 2007, ‘Lessons for effective renewable electricity generation policy from Denmark, Germany and the United Kingdom” *Energy Policy* **35** 5481–5495
Malerba F, 2010, *Knowledge-Intensive Entrepreneurship and Innovation Systems: Evidence from Europe* (Routledge, Abingdon)
March J G, 1988, *Decisions and Organizations* (Basil Blackwell, Oxford)
Martin R, Sunley P, 1997, “The post-keynesian state and the space economy”, in *Geographies of Economies* Eds R Lee, J Wills (Arnold, London) pp 278–289
NAV, 2014, Årsmelding NAV Hordaland (The Norwegian Labour and Welfare Administration, Bergen)
Nebben B K, 2009, *Vi fant, vi fant: Norge ferier 40 år som olje- og gassnasjon* (Font forlag, Oslo)
Norberg-Bohm V, 1999, “Stimulating ‘green’ technological innovation: an analysis of alternative policy mechanisms” *Policy Sciences* **32** 13–38
NPD, 2012, *Facts 2012: The Norwegian Petroleum Sector* (Norwegian Petroleum Directorate, Stavanger)
Osland O, Rusten G, 2005, “Energiverk Mongstad I næringsøkonomisk perspektiv. Rapport 02/05”, (Samfunns- og næringslivsforskning (SNF), Bergen, Norway)
Peck J, 2011, “Geographies of policy: from transfer-diffusion to mobility-mutation” *Progress in Human Geography* **35** 773–797
Peck J, Tickell A, 2002, “Neoliberalizing space” *Antipode* **34** 380–404
Porter M, Kramer M R, 2011, “Creating shared value: how to reinvent capitalism - and unleash a wave of innovation and growth” *Harvard Business Review* **89** 62–77
Riksrevisjonen, 2013, *Riksrevisjonens undersøkelse av statens arbeid med CO2-håndtering. Dokument 3:14 (2012-2013)* (The Auditor General of Norway, Oslo)
Rittel H W J, Webber M M, 1973, “Dilemmas in a general theory of planning” *Policy Sciences* **4** 155–169
Rusten G, Bryson J R, Gammelsæter H, 2005, “Dislocated versus local business service expertise and knowledge: the acquisition of external management consultancy expertise by small and medium-sized enterprises in Norway” *Geoforum* **36** 525–539
Rusten G, Overå R, 2014, “Local and global geographies of innovation: structures, processes, and geographical contexts from a firm perspective” *Growth and Change* **45** 403–476
Røyrvik J, Schei Olsen M, Aasen T, 2012, “Political rationality and CCS discourse” *Energy Procedia* **23** 284–295
Ryggvik H, 2009, *Til siste dråpe: Om oljens politiske økonomi* (Aschehoug, Oslo)
Simon H A, 1957, *Models of Man* (Wiley, New York)
Smith A, Voß J-P, Grin J, 2010, “Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges” *Research Policy* **39** 435–448
Späth P, Rohracher H, 2012, “Local demostrations for global transitions - dynamics across governance levels fostering socio-technical regime change towards sustainability” *European Planning Studies* **20** 461–479
Stortingets kontroll og kons.komité, 2014, “Innstilling fra kontroll- og konstitusjonskomiteen om Riksrevisjonens undersøkelse av statens arbeid med CO2-håndtering”, in *Innst 161 S (2013–2014)* (The Norwegian Parliament, Oslo)
Tjernshaugen A, Langhelle O, 2009, “Technology as political glue: CO2 capture and storage in Norway”, in *Caching the Carbon: the Politics and Policy of Carbon Capture and Storge* Eds J Meadowcroft, O Langhelle (Edward Elgar Publishing, Cheltenham) pp 98–124
Tödtling F, Trippl M, 2005, “One size fits all? Towards a differentiated regional innovation policy approach” *Research Policy* **34** 1203–1219

Unruh G, 2000, "Understanding carbon lock-in" *Energy Policy* **28** 817–830
Verbong G, Loorbach D, 2012, *Governing the Energy Transition: Reality, Illusion or Necessity?* (Routledge, New York and London)
Zhang X, Strømman A, Solli C, Hertwich E, 2008, "Model-centered approach to early planning and design of an eco-industrial park around an oil refinery" *Environmental Science and Technology* **42** 4958–4963