Politics in energy system transformation

Conditions for the development of an offshore wind industry in Norway

Håkon Endresen Normann

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TIK Centre for Technology, Innovation and Culture
Faculty of Social Sciences, University of Oslo

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Summary

This thesis is motivated by the urgent need to transform a fossil based energy system to a system based on renewable energy resources. This transformation will rely on the expansion of sustainable alternatives as well as the discontinuation of use of fossil fuels. This presents a dilemma for countries with substantial income from production of fossil fuels and ambitious climate policy targets. This dilemma opens up for conflicts of interests that shape the conditions for new renewable energy technologies.

The thesis is positioned in the field of sustainability transition studies and draws upon ideas from innovation studies, historical institutionalism, and political science. Based on these perspectives, the thesis seeks to better understand how to integrate processes of politics in the analysis of sustainability transitions.

The politics of transitions has increasingly been recognised as an important research area within studies of innovation and sustainability transitions. The purpose of this thesis is to help understand the way in which the political context shapes the opportunities for developing and nurturing new renewable energy technologies. More specifically, the thesis studies how politics influence policies in a country deeply vested in a fossil-based energy system.

The thesis uses the case of offshore wind as the empirical setting to explore the topic of politics in energy system transformation. Offshore wind has been pointed to as an opportunity to diversify activities in the offshore oil and gas industry in Norway, and substantial public and private resources have been dedicated to explore this opportunity. Offshore wind is thus a suitable case for studying both the development of an alternative to fossil fuels and the possibilities to reorient fossil based industries.

The thesis consists of three individual papers, in addition to an introduction. The first paper uses a model of agenda-setting to study how offshore wind first rose on the agenda in Norway and subsequently why ambitions for the development of offshore wind were not realised. The second paper compares developments in offshore wind and carbon capture and storage in Norway. This paper uses a policy network approach to investigate how policy networks are formed and how these policy networks influence the possibility for actors to participate in the policy process. The first two papers explore how conflicts of interest and negotiations shape political outcomes, which has led to a lack of public support toward demand side policies for offshore wind. The third paper in the thesis takes a weak domestic market for offshore wind in Norway as a starting point and explores how a Norwegian industry might still link up to international markets for offshore wind.

Two main insights can be drawn from the thesis. The first relates to how niche technologies can exploit windows of opportunity. Public support for new technologies depends in part on the presence of articulated problems important to decision makers, and the capability of niche actors to attach new technology as a solution to these problems. This capability is in turn influenced by (i) the structure of policy networks, (ii) the alignment of interests between state actors, politicians and political parties, and business interests, and (iii) arbitrary or exogenous events, short-sightedness of politics, and uncertainty concerning technology. This final point underlines the difficulty in steering a transition.

The second insight relates to the dual role of incumbent industries in transitions. Participation of large, established firms can contribute towards niche development. Large investments in offshore wind by Statoil, the largest Norwegian oil producer, have been important for the legitimacy of offshore wind in Norway and have led to a number of sub-contracts for Norwegian suppliers. At the same time, incumbent industries can represent a barrier for system change. New opportunities in the offshore petroleum industry can reduce the incentives for incumbent firms to invest in new renewable energy technologies. Moreover, climate and energy policy principles in Norway have co-evolved with the interests of incumbent industries, and are less favourable for new and immature industries. Thus, policies that target new renewable energy technologies should be seen in conjunction with policies aimed towards established industries.

Appended papers

I. Normann, H. E. (2015). The role of politics in sustainable transitions: The rise and decline of offshore wind in Norway. *Environmental Innovation and Societal Transitions*, 15, 180-93.

II. Normann, H. E. Policy networks in energy transitions: The cases of carbon capture and storage and offshore wind in Norway. *A revised version of this manuscript has been accepted for publication in Technological Forecasting and Social Change.*

III. Normann, H. E. and Hanson, J. The role of domestic markets in international technological innovation systems. *Under review, second revision.*

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Oslo, September 2016

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1 Introduction

This thesis is about the ongoing transformation of the energy system. It is about the potential for growth in a Norwegian offshore wind supply industry based on the development of new technology and the application of existing competences in new areas. In this sense it is about new industry formation facilitated and driven by technological opportunities. However, it is mostly about the social and political conditions for moving from a fossil-based towards an environmentally more sustainable energy system. The thesis is therefore largely about the role of politics in sustainability transitions.

At the most basic level, an energy transition requires the dismantling or complete restructuring of the existing production system for the energy needed in transport, households, industry, services, and agriculture. In the last few years there has been an increased recognition that we cannot extract and burn all the known fossil energy reserves in the world, never mind the unknown reserves that substantial resources are being dedicated to find.

A dismantling or restructuring of the fossil based energy system has two major implications. First, we need to develop alternatives for production of energy for the applications mentioned above. Second, as the fossil industries represent large economic contributions to society (if we momentarily ignore negative externalities from pollution and climate change), these industries cannot simply be discontinued without major disruptions to the financial and labour markets. Moreover, given the political and economic influence these industries have in society, they are by nature extremely durable and resistant to change. These two implications represent the base of much of the research on energy transitions and can to some extent be studied separately. At the same time, these two implications are intimately linked. In other words, the way in which new technologies develop can impact on the potential for change in the established industries and technologies. Simultaneously, change (or lack of change) in the established fossil industries has an influence on the potential for development of new technologies. In order to study energy transitions, we therefore need to understand (1) what influences change and stability in established industries, (2) how new technologies develop, and (3) the interaction between the new and the old. In section 2, I will discuss these points separately.

In some way, a transformation of the energy system has much to do with technical and industrial change. How technologies mature and how industries evolve has been, and still is, an important topic in innovation studies. This is a research area that continues to progress through the introduction of new research methods, complementary perspectives, along with the continuous development of technology itself, all opening up opportunities for new research. However, whereas a great deal of research has contributed to the accumulation of scientific knowledge about the needs of new technologies and solutions, there has been a reluctance to seriously consider how to unsettle established configurations of economic, social and political interests (Smith, Voß, & Grin 2010). New technologies and industries often represent interests that are misaligned with the interests of the established industries

and institutions. Efforts to change the conditions under which both new and established industries evolve tend to involve negotiations and power struggles. These struggles do not only involve economic interests, but also political and state actors. Not only do politicians and state actors to a great extent influence the conditions under which negotiations take place, but they also have for different reasons interests themselves in the outcome of negotiations. In the end, the unfolding interaction between new and established technologies and industries thus involve complex processes of politics. Studies of system transformation thus need to integrate these processes of politics in the analysis.

The thesis is structured in the following way: The remainder of section one continues with the theoretical and empirical motivations that have led to the main research questions in the thesis. These questions address the role of politics and incumbency in energy transitions. Section two discusses the theoretical perspectives that have informed the overall discussion. Insights from historical institutionalism, innovation studies, and transition studies are used to characterise the energy system as path-dependent and resistant to change. The section proceeds to discuss how entrenched systems might be unlocked through a combined pressure on the system from exogenous change and from actors inside and outside the system. Section three presents the research approach and choice of methods before a summary of the three papers is presented in section four. The first paper analyses how political conditions and exogenous events influenced the rise and decline of offshore wind in Norway. The second paper compares efforts to secure state funding of large-scale demonstration projects for offshore wind and carbon capture and storage technology in Norway. Finally, the third paper studies how the offshore wind industry in Norway can link up with international markets in the absence of a domestic end-user market for offshore wind. Section five includes a broader discussion about the implications of the findings in the papers, with particular attention to politics and incumbency in sustainability transitions. Section six concludes with some reflections on the implications for the conceptual understanding of sustainability transitions. In this section, I also reflect on policy implications for a country with vested interests in fossil fuels. Full versions of the three papers are attached at the end of the thesis.

1.1 Perspectives on transitions

My background and approach to this research comes from studies of innovation and industrial dynamics. This is a field of research that seeks to identify the driving forces of economic transformation, and to understand the underlying processes of transformation (Carlsson 2016). An important part of the broader field of innovation and industrial dynamics has been the study of the role of policy in stimulating innovation. This has also opened up for studies of how innovation policy can aim to develop solutions to particular societal challenges, such as the current climate crisis (Fagerberg 2013, p. 31). Transformation processes need to be seen in a wider historical, institutional, social, political and geographic context, which means that the analysis of transformation processes transcend

disciplinary boundaries and involve multiple dimensions and levels (Carlsson 2016). This is reflected in the field of sustainability transition studies, which draws on a wide range of disciplines such as evolutionary economics, systemic perspectives on innovation, management studies, and science and technology studies (Markard, Raven, & Truffer 2012). This multi-disciplinarily is also reflected in my own approach to studying transformation processes in the energy sector.

A sustainability transition can be understood as a fundamental shift in the way sectors such as energy, water supply, or transportation are organised (Markard et al. 2012, p. 956). The purpose of research in this field is to understand what drives and blocks sustainability transitions and how such transitions can be accelerated.

Sustainability transitions are different from other large transitions involving industry. Historical transitions such as the first and second industrial revolution or the IT revolution have been primarily emergent and only to a lesser extent politically driven. A sustainability transition, however, represents change that is desired by large parts of society as it addresses critical environmental problems. Moreover, because sustainability transitions often do not offer obvious short-term benefits, change will require policies that challenge actors with vested interests in maintaining status quo (Geels 2011). Thus, a sustainability transition is inherently political (Meadowcroft 2011).

Two frameworks have been particularly dominant in the study of sustainability transitions: the multilevel perspective (MLP) and the technological innovation systems (TIS). In the three papers in this thesis I make use of many of the important concepts from these frameworks in the analyses. I will therefore in section 2 discuss in more detail how these frameworks can be used to study system transformation. I will in the following provide a brief introduction to some aspects of the TIS and the MLP that have motivated the direction taken in this thesis.

Both frameworks have been applied to studies of how new technologies can emerge within existing technological fields. A basic interpretation of TIS is that it encourages the analyst to focus primarily on the role of actors and networks and how these negotiate their surroundings with regards to the development of technology and industry formation and growth. The MLP emphasises to a greater extent how structural elements guide members of both established and emerging industries. However, as in all social science, the foundations and applications of these frameworks are more nuanced as both frameworks recognise the interdependency between agency and structure. Nonetheless, it is probably fair to say that in the TIS the level of analysis is mainly on the actor level whereas it is in the MLP more on the structural level (Markard & Truffer 2008) in what is conceptualised as the socio-technical regime.

The socio-technical regime (often referred to as the *regime*) is a central concept in the multilevel perspective. It encompasses the dominant institutions, organisations (including but not limited to

firms), and cultural and political values that give structure to a domain such as the energy sector. Emerging technologies and industries are conceptualised as developing in niches (the micro level) that under certain circumstances might challenge or become part of the regime. The interaction between niches and regimes are then influenced by exogenous developments conceptualised as the landscape level.[1]

The technological innovation system approach builds on a rather different heritage than the MLP and consequently involves a different analytical approach to studying the development of new technologies and industries. The most prominent feature of the TIS framework is that it allows the analyst to study the interaction between actors and networks under certain institutional arrangements (Markard et al. 2012) by evaluating the presence of a set of key processes (or functions) believed to be important for the development and diffusion of particular technologies (Bergek et al. 2008a; Hekkert et al. 2007). Examples of such processes include knowledge production, entry of firms, legitimation and incentives for actors to invest in particular technologies. By identifying what is referred to as "feedback loops" between different processes, which can be both positive and negative, it is possible to point to system strengths and weaknesses that can then be addressed by policy instruments. For instance, expectations, visions and other incentives that guide firms to invest in a particular technology can be linked to firm entry, and legitimation can influence the institutional framework (Bergek, Jacobsson, & Sandén 2008b).

Rather than competing perspectives, I see the MLP and TIS as two different frameworks that allow the analyst to explore different questions related to the same overall topic. The two frameworks provide analysts with a rich set of tools to study the "grand challenge" of transforming society to one that is more sustainable, and the results from empirical applications of these frameworks have not only had an important impact on our understanding of sustainability transitions but also on the development of policies promoting a transition (Markard & Truffer 2008; Truffer 2015). However, the two frameworks share a limitation in that they insufficiently facilitate the integration of politics in the analysis. Florian Kern suggests that *"analysis of actors and actor strategies should go beyond firms focusing on market entry, generating knowledge etc. and should much more closely investigate the political agency of a diverse set of actors and how they shape the selection environment in which they operate. This needs to include activities like coalition building, lobbying, creating narratives and counter-narratives, etc. (Kern 2015, p. 68)"*. Similarly, the multilevel perspective emphasises the importance of policy in transitions, yet the conditions for such policies have remained unclear. Smith

1 Other approaches that make use of the niche-regime-landscape concepts are strategic niche management (SNM) and transition management (TM). What sets these approaches apart from a multilevel perspective is that these approaches are specifically focused on the actor level. Moreover, these approaches deal with issues of governance and how actors can be mobilised to steer a transition in a particular direction.

et al. (2010) have therefore argued that there is a need to incorporate the analysis of public policy processes in the study of innovation in socio-technical systems.

1.2 The role of politics in sustainability transitions

Over the past decade, scholars have increasingly stressed the lack of attention to politics in studies of sustainability transitions. Such criticism has pointed to an unclear understanding of the role of power in transitions (Avelino & Rotmans 2009), with whom power resides and how power struggles influence policy-making (Markard et al. 2012). Further, the TIS framework has been criticised for not attending to strategic interventions by actors in established industries (Markard & Truffer 2008). Consequently, there has been an under-emphasis of the complexity of the policy-making process (Smith et al. 2010). Transition studies have therefore been criticised for being too concerned with the role of policy, and too little concerned with understanding under which circumstances policies are created (Meadowcroft 2011). From this, it has been suggested to include theoretical perspectives and analytical tools from other disciplines such as political science in empirical studies of innovation and sustainability transitions. The study by Jacobsson and Lauber (2006) on the diffusion of renewable energy technology in Germany is an early example of such as effort, where they make use of concepts from the political science literature on networks to study how actors compete over influence on institutions.

This area has recently gained more traction and a number of studies have in various ways demonstrated how politics in transitions can be studied. For instance, Kern (2010) focuses on how politics of transformations can be thought of as struggles about meaning. Kern brings in ideas from neo-institutional theory to analyse how these meanings or discourses are shaped through the interaction between actors and institutions. Building on Smith and Raven (2012), Kern et al. (2014) explore how and by whom niche-protection policies for offshore wind were created in the UK. More recently, a number of contributions have also combined perspectives on sustainability transitions with institutional perspectives (e.g. Boon & Bakker 2016; Lockwood 2016; Raven et al. 2016). Adopting a different approach, Paredis (2013) shows how Kingdon's multiple streams model of policy change can be integrated with transition perspectives. Finally, Markard, Suter, and Ingold (2015) have looked at the role of networks in policy formation related to energy transition policies. Networks are considered to be critical for the growth of technological innovation systems. However, a limitation to the technological innovation systems approach is that it does not provide the best tools for capturing the key processes that lead to network formation (Bergek et al. 2008b). One of the avenues that I explore in this thesis is to combine concepts from the sustainability transitions literature with theories about policy networks (e.g. Adam & Kriesi 2007; Marsh & Smith 2000).

The intention here is not to provide a comprehensive overview of studies in the intersection between politics and transitions (I discuss perspectives on politics and transitions further in sections 2 and 5).

Rather, I simply want to point out that even though combining evolutionary perspectives on innovation with notions of ideas, interests and institutions is a fairly new development, there is a growing body of empirical studies on these topics. The main motivation and objective of this thesis is to add to this emergent area.

1.3 Motivation for empirical focus

Norway represents a paradoxical and a rather unique context for studying energy transitions (Hanson, Kasa, & Wicken 2011). The Norwegian energy sector is dominated by two incumbent industries[2]. On the one hand, nearly all domestic electricity supply comes from hydropower resources. On the other hand, Norway is a significant petroleum producer, and activities from this sector represent a large share of total national carbon emissions. I will in the following provide a brief description of this context.

1.3.1 The incumbents

Global energy demand grew by more than 50 per cent between 1990 and 2012 and is expected to continue to increase in the decades to come (IEA 2013). Oil and natural gas still represent more than half of global energy consumption (55 per cent in 2013, IEA 2015) with oil as the dominant fuel. Norway has been an offshore petroleum producer since 1971 and production is now in a mature phase. The state has since the beginning taken an active role in the development of a Norwegian oil industry and has gained substantial financial rewards for these investments (Ryggvik 2015). Oil production has been in steady decline since the peak year of 2001, but this was made up by considerable growth in natural gas production in the first half of the 2000s. Total production reached its peak in 2004, after which this also began to decline (Ryggvik 2015, p. 32). Norway was in 2015 the third largest exporter of natural gas globally and cover more than 20 per cent of European consumption of natural gas (Norwegian Petroleum 2016).

To compensate for falling oil production, the authorities have introduced a number of measures to make investments more attractive. The most important was a reform in the tax regime introduced in 2004 that made it possible for companies with little or no income to receive the value of the deduction rate of 78 per cent paid in cash. This reimbursement system is meant to stimulate the search for more oil and can be considered as an investment support that many companies benefit from (Bjartnes 2015, p. 109).

[2] Established regime actors are in the sustainability transitions literature often referred to as incumbents. Throughout this thesis, I use the term with reference to established business actors (companies and groups) and established industries. However, the term might also include a broader set of actors including industry associations, lobby groups, and politicians.

Upstream petroleum activities have been, and still are, very important to the Norwegian economy. Even though revenues declined in 2015 compared with previous years, the petroleum sector represented 15 per cent of GDP and 39 per cent of total exports. In addition to petroleum exports, the supply industry is today Norway's second largest industry in terms of turnover (after exports of oil and gas). Long-term participation in advanced activities on the Norwegian continental shelf has enabled the specialised offshore supply firms to become competitive in many of the most advanced segments of the industry worldwide (Ryggvik 2015). Just under 40 per cent of turnover in the supply industry came from exports in 2013 (Rystad Energy 2014). In 2014 there were according to Statistics Norway 83 779 employees in the petroleum and petroleum-related industries combined (Ekeland 2014). However, total employees that rely on the oil and gas industry in Norway was in 2015 estimated to 239 000, which corresponded to 8.7 per cent of total employment in Norway (Prestmo, Strøm, & Midsem 2015, p. 16). Thus, whereas oil and gas production represents significant state revenues, the supply industry is important both in terms of revenues and employment.

The oil industry is cyclical which means that it fluctuates between periods of high and low investment levels. In 2009, following the global financial crisis, the industry experienced a period of rapidly declining oil prices and reduced investment levels. This led to a period during which the industry explored alternative revenue streams. After a rather quick revitalisation that began in 2010 and 2011, the industry reached its highest ever annual investment levels on the Norwegian continental shelf in 2013 and 2014. However, following the drop in the oil price in 2014 the industry is currently (2016) going through substantial cutbacks. Once more, investment levels have declined, vessels are without assignments, and there is again a need to look for alternative revenue streams.

A second incumbent in the Norwegian energy sector is the hydropower industry. During the years 1960-1990, vast hydropower resources were developed with the major construction boom from 1970 to 1985, and nearly all electricity in Norway is produced from hydropower (Christiansen 2002). This has two implications relevant to the topic of this thesis. First, electricity has been (mostly) comparatively cheap. Low and stable electricity prices has supported the development of energy-intensive process industries in Norway (Wicken 2011a). The hydropower and energy-intensive industries has therefore been referred to as the hydropower complex (Midttun 1988). This complex has included The Norwegian Water Resources and Energy Directorate, a number of public energy companies, major private and state energy-intensive companies, and the Ministry of Trade, Industry and Fisheries. Together, these actors have had considerable influence on policy-makers and governments on issues related to the energy sector (Kasa 2000, 2011). Second, because emissions from domestic power production are virtually non-existent, emission cuts must be taken in the transport sector, mainland industry, or offshore petroleum production. This is different to most other European countries where emission reductions can still be achieved by substituting fossil power

production with clean energy production (and sometimes switching from coal to natural gas). This has provided weak incentives for investing in new renewable energy capacity in Norway (Hanson et al. 2011).

As with the petroleum industry, the hydropower industry can be seen as an extension of the state. Local municipalities and the state own 90 per cent of the hydropower production capacity in Norway. The state owns through state enterprise Statkraft one-third of the production capacity and through state enterprise Statnett about 90 per cent of the transmission grid (Meld. St. 25 2015-2016, p. 70). Thus, the hydropower industry provides the state and local municipalities with considerable income. Even though the two most important functions fulfilled by the hydropower industry are as a foundation for energy intensive industries and as a revenue stream, it is also seen as relevant for employment and export of technology.

In sum, this makes the hydropower industry important to the energy intensive industry, the state and government. This influential position is also reflected in the 2016 government White Paper on Norway's energy policy "Power for change" (Meld. St. 25 2015-2016), which was labelled the *hydropower white paper* by one environmental organisation (WWF Norway 2016) due to its emphasis on hydropower at the expense of other new renewable energy technologies.

The importance of the petroleum industry and the hydropower complex has affected the possibilities for domestic emission reduction measures. About half of the domestic CO2 emissions in Norway come from offshore petroleum production and energy intensive industries (Statistics Norway 2016). These are two industries that historically have had strong connections to the two leading political parties (the Labour Party and the Conservative Party). Since the early to mid-90s, concerns for securing the value of Norwegian oil and gas has had an increased influence on Norwegian climate policies (Nilsen 2001), and it has been difficult to implement policies that might reduce the competitiveness of these industries (Hanson et al. 2011). The guiding principle in Norwegian climate policy has therefore been that measures should be based on cost-efficiency across sectors and across nations, meaning that it is more cost efficient to invest in emission reduction measures in other countries than in Norway (Tellmann 2012). With regards to renewable energy policies, this least cost principle has been strong in the Ministry of Petroleum and Energy and in the two largest political parties, the Labour Party and the Conservative Party (Boasson 2015).

1.3.2 The niches

The approach to stimulate the supply of new renewable energy technologies in Norway has predominantly been through public support toward research and development (R&D) with less emphasis on policies that stimulate demand (Wicken 2011b). Moreover, whereas public R&D spending has been directed towards less mature technologies (i.e. floating offshore wind, carbon

capture and storage, wave and tidal power), the approach for expanding production capacity has been market-based (Boasson 2015). This market-based approach has for long periods represented a barrier for technologies that have seen significant expansion elsewhere in Europe such as onshore wind and bottom-fixed offshore wind. Wicken (2011b, p. 81) thus attributes the weak growth in new renewable energy in Norway to a lack of policies that could have made it profitable to invest in this type of production. Moreover, Wicken points out that this has been a conscious political choice. Understanding the role of politics in transitions is therefore not only conceptually relevant (see section 1.2) but also empirically interesting and important.

Since 2012, the main support measure for new renewable electricity has been the tradable certificate scheme. This scheme entitles producers of electricity from new renewables (excluding large hydropower) to sell certificates in a common market between Sweden and Norway. This ensures revenues on top of the market price for electricity and is thus an operational support. The scheme, which was a result of a 12-year process, has facilitated some additional installation of small-scale hydropower and onshore wind in Norway. However, the certificate scheme is a technology-neutral policy instrument, and can be seen as a result of a preference for cost-efficient and market-based instruments in Norwegian energy policies[3]. Thus, due to low prices of certificates and electricity the scheme has not stimulated additional investments in less mature technologies such as offshore wind.

A reflection of a preference for a research driven approach is the Energi21 process initiated by the Ministry of Petroleum and Energy in 2007. The aim of Energi21 has been to design and develop an overall R&D strategy for the energy sector. This process has identified six prioritised areas, of which four can be linked directly to energy production: hydropower (described above), solar photovoltaics (PV), offshore wind power (OPW), and carbon capture and storage (CCS) (Energi21 2011, 2014).

The emergence of a Norwegian PV industry has built predominantly on knowledge, competences, resources and infrastructure from energy intensive process industries (Hanson et al. 2016). Due to the weak incentives for adding new renewable electricity capacity in the Norwegian system, the PV industry has been mostly oriented towards exporting components to international markets, although there has recently been increased activity related to developing a small domestic market.

The development of carbon capture and storage technology has been supported by substantial public funding. This funding has been linked to the important role of the fossil fuel extracting sector in that countries that display strong commitments to CCS are all petroleum producers (Tjernshaugen 2008).

[3] It has been well documented that the certificate scheme was actively resisted by the Ministry of Finance, Jens Stoltenberg who was prime minister between 2005 and 2013, and the Ministry of Petroleum and Energy (Boasson 2015). However, a technology neutral system that also included small-scale hydro was seen by economists as less market intrusive than technology specific policy instruments such as feed-in tariffs.

CCS initiatives in Norway have mostly been tied to CO2-separation from offshore natural gas and sequestration of CO2 from the emissions from natural gas power plants. This funding reached a peak in 2010, but as with similar projects in e.g. the UK (Kern et al. 2015), large-scale CCS initiatives have been difficult to get off the ground.

The offshore wind power industry combines technology and competences from onshore wind (turbines) and offshore engineering and maritime operations. The development of onshore wind in Norway has been limited and the object of policy has been energy production rather than industry development (Buen 2006). Thus, engagement in the part of offshore wind that has rested on onshore wind technology and competences has been constrained to a few unsuccessful attempts at developing turbine manufacturing. However, a significant offshore wind power supply industry has developed in Norway off the back of resources and competences from the offshore oil and gas industry (Hanson et al. 2016; Steen & Hansen 2014). An estimated 60-150 Norwegian firms target different segments of the offshore wind power market (Multiconsult 2012, 2015; Normann & Hanson 2015) and offshore wind has been identified as a strategic area of potential for Norwegian companies. I will in the following provide a brief introduction to offshore wind in Norway.

Even though some firms started development of offshore wind solutions in the early 2000s, most Norwegian firms got involved in the period from 2005 to 2010. Interest in offshore wind in this period was motivated by a combination of several factors. Expectations for growth in the international market for offshore wind, increased climate change awareness, and periodic decline in investment levels in offshore oil and gas led many firms to explore opportunities to exploit existing offshore competences and technology. Most notably, Statoil has made substantial investments in several projects, as have Statkraft until a decision was made to stop investing in offshore wind in 2015. Thus, the two largest incumbents from the petroleum and hydropower industries have been important actors in the offshore wind niche. However, most of the firms that make up the Norwegian offshore wind niche are suppliers of products and services in much the same way as the supply industry to oil and gas. Many of these firms see offshore wind as complimentary to their core activity in oil and gas. In fact, about 60 per cent of the Norwegian offshore wind firms base their activities in offshore wind on experience from oil and gas and another 20 per cent on experience from the maritime industry (Normann & Hanson 2015). Figure 1 shows that a large share of the firms is engaged in logistics and installations. Moreover, a number for firms deliver R&D, consultancy, and IT services. There are also many firms engaged in other parts of the offshore wind supply chain.

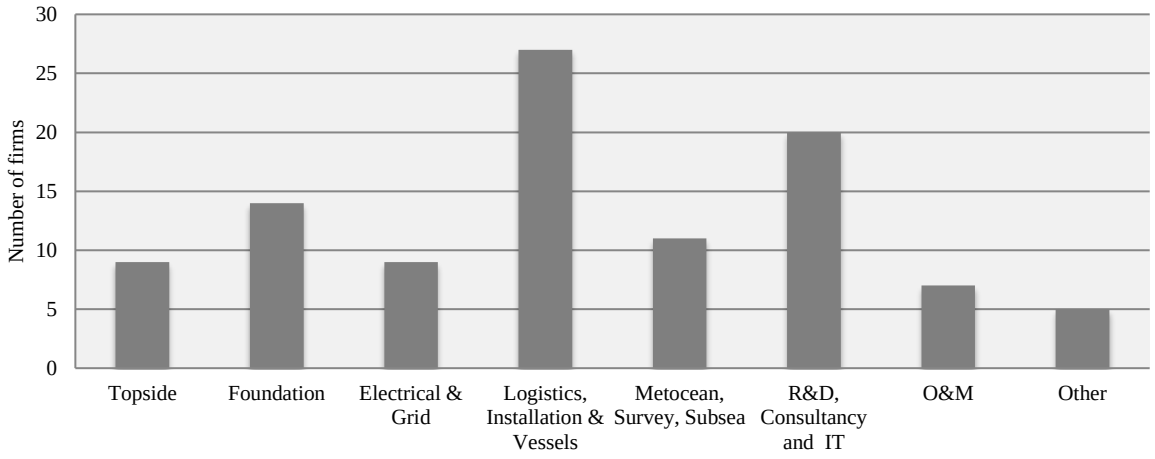

Figure 1 Distribution of Norwegian firms across the supply chain for offshore wind.
Note: Number of firms based on survey. Total numbers not reflection of total size of activity in Norway.
Source: Normann and Hanson (2015)

With the exception of a single test turbine commissioned in 2009, there is no domestic power production from offshore wind in Norway. There has only been granted one license for a commercial offshore wind farm in Norway (in 2009), yet this project was never realised. Thus, the stated aim for policy has in recent years been to support technology development and export activities of Norwegian offshore wind products and services. Given a need to reorient the existing oil and gas industry due to both climate change and reduced profitability, the potential for a Norwegian offshore wind supply industry is an interesting area for empirical research.

1.3.3 Transforming the energy system

In a transformation or replacement of the existing fossil based energy regime, it is the most powerful firms within this regime that are likely to become the most conservative forces (Perez 2002, p. 34). This is because these firms will have vested interests in maintaining stability in the regime (Moe 2012). Hess (2014) argues that in relation to the energy transition, efforts by the incumbent industrial regime to influence politics is so well organized that it should be at the centre of our analysis, even when we aim to study the development of new technologies. Thus, if we are to understand how a new industry such as offshore wind can develop in Norway, the analysis should also include the incumbent petroleum and hydropower industries as these influence the context within which new renewable energy technologies develop.

If we are to accept the scenarios presented by organisations such as the United Nations Environment Programme (UNEP 2011) or the Intergovernmental Panel on Climate Change (IPCC 2014), a sustainability transition will need to penalize the current activities of the petroleum industry through increased cost of CO2, decreased price on natural gas and petroleum, or restrictions on geographical areas open for exploration. The economic importance of the petroleum industry creates a dilemma for states with large fossil fuel reserves and strong ambitions on climate change. For instance, Geddes (1994) demonstrates in a study on Canada and environmental politics how policy struggles can be

particularly challenging in countries with both influential fossil energy industries and strong commitments towards addressing climate change. On a related note, Scrase and Smith (2009) point out *"that it is therefore understandable that nuclear power and CCS are very appealing to many regime members, despite high associated risks and costs, since they promise to cut emissions without disrupting too many alignments and linkages in the existing socio-technical regime (p. 711)"*. This political dilemma is observable in a country like Norway, with strong climate policy ambitions as well as financial dependency on petroleum activities.

1.4 Research questions

In the above, I recognise that incumbent industries can play an important role as both a provider of resources and as a potential barrier to the development of new and alternative technologies and industries. This has particular relevance for the energy system in countries that harbour a large fossil fuel industry. By investigating the interaction and influence between incumbent and new industries, I will necessarily need to explore the interaction between actors with often conflicting interests. The degree to which these interests are aligned with the institutional context will be unbalanced, as will the distribution of power to influence this context. This emphasises the need to integrate politics in the analysis of sustainability transitions. The overall research question in this thesis is:

- How do processes of politics influence a transformation of the energy system?

To answer this question, I study the development of an offshore wind industry in Norway. In particular, I focus on efforts to influence policy and on the conditions for industry development provided by existing policies. Based on the considerations discussed in this introduction, the overall research question will be dealt with by addressing three more specific questions:

- Under which circumstances have different actors been able to influence policies that promote the development of clean energy technologies?
- How does the presence of large incumbent industries influence the conditions for the development of industries related to clean energy technologies?
- In what way can we understand incumbent industries to fulfil a dual role in the energy transition?

I focus on policy-making as a process rather than on a policy-maker as an individual or group of individuals that create policies. Policies are shaped through conflicts and negotiations between a broad and heterogeneous group of actors that includes actors inside and outside of government, state and non-state actors, and thus also business actors and interest groups. Some of these actors have so-called executive power, meaning that they participate in the formal decision-making process, whether other actors influence policy indirectly through a host of different intentional and unintentional means. The

way in which this unfolds has been subject to a large body research across many disciplines in the social sciences. However, as a number of scholars have pointed out, the complexity of policy-making has been somewhat under-emphasised in innovation policy studies (Flanagan & Uyarra 2016; Flanagan, Uyarra, & Laranja 2011) and in sustainability transition studies (see for instance Kuzemko et al. 2016; Meadowcroft 2011). Thus, by addressing the questions above, I aim to contribute to an ongoing debate not so much about which policies *should* be implemented but which policies *could* be implemented and how (Flanagan & Uyarra 2016, p. 185).

2 Theoretical perspectives

Each of the three papers in this thesis employ different conceptual frameworks to study questions that in their own way relate to the overarching research objective of this thesis. I will therefore in this section not present the particular frameworks for each article as I elaborate on these in each individual paper. However, the three papers build on some shared ideas related to how we can understand stability and change, the role of exogenous events, and the interaction between structural elements, actors and networks, and technology. I will in the following discuss these ideas and how they relate to sustainability transitions at a general level and more specifically to the topic of this thesis. I will throughout this section, where appropriate, point to further elaborations on specific ideas in the different papers.

Transitions have historically proved to be slow moving and develop over many decades (e.g. Geels 2002; Verbong & Geels 2007). Many innovations also tend to take a long time to develop from their initial invention to commercial implementation (Clark, Freeman, & Soete 1981, p. 157; Lauber & Jacobsson 2016). This presents a problem for the particular transition that we are concerned with here in that we are not only interested in studying how it might unfold. Rather, we want to understand how it can unfold much faster. An initial question is then: why is a sustainability transition so slow and why are established industries so resilient to change?

2.1 Structural resistance to change

Established industries such as the coal or oil industry can be thought of as being part of a broader regime. Developments within such regimes are often considered to move fairly consistently along certain trajectories. We can trace this understanding of technological stability to Nelson and Winter (1977) who introduced the concept of technological regimes with reference to how firms and engineering communities are guided to explore certain directions based on shared technological routines. Firms have only a limited set of solutions and technologies to choose from and firms will therefore seek to learn along trajectories that they are already familiar with (Smith 2009).

Building on the technological regime concept, Kemp, Schot, and Hoogma (1998) argued that the regime concept ought to include both the technological search routines of engineers and the broader selection environment. Thus, they reasoned that the trajectories within established industries are influenced by, in addition to organisational and technological developments, infrastructure and the wider social and institutional context. The sum of these influences was conceptualised as the socio-technical regime, which is a set of rules that organise activities of groups and actors that reproduce different parts of socio-technical systems (Geels 2011; Kemp et al. 1998). By guiding actors to focus on particular problems and solutions, the socio-technical regime also has a powerful exclusionary effect by keeping alternative technologies hidden or as seemingly non-viable options. Socio-technical regimes are therefor considered to be very durable and resistant to change. As I in this thesis explore

industry development related to new energy technologies under the influence of an established fossil based industry, this understanding of regime resilience is important for my analysis.

In the multilevel perspective, a transformation or replacement of a regime can be understood to occur through power struggles between the regime and upcoming niches, under the influence of exogenous factors (Avelino & Rotmans 2009). An implication from this on my research is that questions about the reorientation of established industries and questions about the development of new industries need to be seen in conjunction. Moreover, an analysis of power struggles necessitates an analysis of politics. I will return to this in section 2.2.2.

2.1.1 The role of the selection environment

One of the explanations for structural resistance to change can be found by looking at the significance of the selection environment. The notion of a selection environment connotes actors are free to choose, but that this freedom is highly constrained (Freeman 1991). Freeman categorised the selection environment into what he labelled the natural environment, the built environment, and the institutional environment.

Even though some changes in the natural environment are human induced and may even be responsive to social control, the natural environment often confront us as purely external forces (Freeman 1991, p. 215). Examples of the natural environment can include climate change, extreme weather and natural disasters, all of which influence in various ways the selection of technologies and solutions in most sectors, including the energy sector. It is here important to separate between the presence of a condition in the natural selection environment and the articulation of this condition as a problem (Smith, Stirling, & Berkhout 2005). It is only when climate change has been articulated as a problem that we can talk about it as an influence on the selection of new renewable energy technologies at the expense of fossil energy technologies. For instance, the Fukushima nuclear accident played a decisive role in articulating the threat from natural disasters as a problem for the continuation of nuclear power in Germany. I address the importance of timing in attaching solutions (e.g. offshore wind) to articulated problems in paper 1.

The built environment typically consists of capital stock invested in infrastructure and in production of power, transportation, manufacturing etc. Large investments in certain types of power plants or distribution of energy carriers such as electricity or natural gas can restrict the selection of alternative technologies. Similarly, large investments in transportation infrastructure such as roads limit the rationale behind investments in alternative transportation solutions. The built environment will vary across different countries depending on social policies and priorities (Freeman 1991), but also depending on different natural conditions. For instance, parts of the built environment in Norway, which include large hydropower stations as well as infrastructure for the extraction and distribution of

natural gas, provide a different set of incentives to invest in new renewable energy technologies than, say, conditions in Sweden or Denmark. The availability of hydropower resources has led to the build-up of large capacity to generate electricity at a low cost, which makes more costly alternatives such as wind power less attractive. Similarly, vast offshore natural gas reserves has led to the build-up of infrastructure for the extraction and transportation of natural gas, which has motivated initiatives for increased use of natural gas in the domestic energy mix in Norway (Kasa 2011). I explore this further in paper 2.

Finally, Freeman refers to the institutional environment as an important selection mechanism. Institutions can be understood as any form of constraint that humans create to shape human interaction (North 1990, p. 4). It is with reference to expected profitability that Freeman sees that the institutional environment has its greatest influence. I.e. institutions influence the expected costs and benefits from investments in different technologies. However, Freeman also recognises the role of political power struggles in firms and governments and how powerful organisations influence the development of institutions (North 1990). Geels et al. (2016) show how differences in deep structures such as policy styles, ideologies, and economic structures can (in part) explain differences in renewable energy deployment between Germany and the UK. For instance, they argue that a neo-liberal ideology in the UK explains the preference for market-based policy instruments with an emphasis on cost-efficiency and close-to-market technologies (p. 910).

2.1.2 The path-dependent nature of politics and policy

Because of the constraining influence from often slow-evolving selection environments and the resilience of socio-technical regimes, technological and industrial change is often conceived of as path-dependent (David 1985). Arthur (1990, 1994) argued that increasing returns to adoption of particular technologies creates positive feedback-effects as adoption leads to increased competitiveness, which stimulates further adoption in a fortuitous loop. For instance, increased production of a particular product might lead to increased experience in the manufacturing process that can result in efficiency improvements and reduced production costs (Arthur 1990, p. 93). An existing technology also often has ‘sunk costs’ which reduce the incentives to invest in alternative technologies.

New products and technologies are often uncompetitive with established technologies because they tend to require significant post-introduction improvements before they can compete in terms of efficiency and performance (Hanson 2013; Smith 2009). Technologies with potentially superior performance to existing technologies may therefore be locked out of the system. In the energy system, alternative carbon-saving technologies are also locked out of the system due to the difficulties in removing outdated subsidy programs for fossil industries. These subsidies provide fossil fuel industries with an advantage making it more difficult for new alternatives to compete (Unruh 2000).

Because a technology is part of a wider system, it can be difficult to change or replace a technology without changes to the entire system (Smith 2009).

The automotive industry can be thought of as an example where technology competitiveness has been path-dependent. The industry has continued to invest in the internal combustion engine despite it representing a sub-optimal technology and increasingly also recognised as harmful to our environment. Path-dependency in this industry can be attributed to (amongst other things) large investments in extraction and distribution of petroleum (the built environment), vested interests of incumbents (Penna & Geels 2012) and asymmetric distribution of power favouring the fossil transport regime (Klitkou et al. 2015), "blindness" to alternative technological solutions, and uncertainty amongst manufacturers, retailers and consumers (the institutional environment) (Kemp et al. 1998, pp. 178-9). Yet, in recent years, we have seen that articulation of selection pressures from the natural environment (climate change) has guided investments increasingly towards technologies linked to electric vehicles.

Within the field of innovation and sustainability transitions, path-dependency is often referred to in relation to technology development. However, given the importance of policies for the development of new technologies, we should also recognise the path-dependent nature of policies. As Freeman (1991) noted, the institutional environment represents powerful selection criteria for investments in different technologies. Foxon (2002) therefore distinguishes between technological and institutional lock-in. Building on North (1990), Foxon points out that the features that underpin technological lock-in can also be applied to institutions. One of the mechanisms that contribute to institutional lock-in lies in the often asymmetric distribution of power (Pierson 2000; Smith et al. 2005). A feedback process that can develop as a result of such asymmetric distribution of power is that existing institutional arrangements can influence actors to pursue outcomes not in their own interest, which in turn contribute to cementing the existing (im)balance of power (Lukes 1974). This understanding of institutional stability and change is central in historical institutionalism, and I will discuss this further in section 2.2. Another mechanism that leads to institutional lock-in is the central role of collective action. According to Pierson (2000), actors tend to adjust their behaviour according to how they expect others to act. These self-reinforcing dynamics create path-dependency and lock-in of particular political institutions.

The Norwegian energy system exhibits evidence of both technological and institutional lock-in. For instance, the profitability and general role of the oil and gas industry reinforces an institutional framework that guides the search for more knowledge related to exploiting new opportunities in this industry. I explore this further in paper 2 and in section 5 where I discuss how these lock-in mechanisms influence the direction of search towards CCS. Moreover, the petroleum taxation system and the reimbursement system for exploration costs represent state funded investment support (Bjartnes 2015) that are maintained through arguments that they generate large revenues to the state (see for instance Schjøtt-Pedersen 2016). Finally, continued reinforcement of principles of cost-

efficiency in Norwegian energy and climate policy-making has arguably been motivated by the strong position of the hydropower complex in Norway (Hager 2014).

A logical continuation of the ideas of increasing returns and lock-in is that the success of new industries or technologies rests on the existence of the same mechanisms that lead to increasing returns (*learning effects*, *scale economies*, *collective action*) to compete effectively with incumbent and established technologies and industries. In order to stimulate the development of such mechanisms, Arthur (1990) recommended (amongst other things) that firms pool their resources to share upfront costs, marketing networks, technical knowledge and standards, and foster strategic alliances (p. 98). I investigate some of these types of initiatives in paper 2 and discuss the potential of such collaboration (and consequences of lack of resource-pooling) in paper 3.

Summing up this section so far, there are some mechanisms that primarily maintain institutional stability, resisting regime change and a sustainability transition to a low-carbon society. These mechanisms can be observed in the negotiation between incumbent and emerging actors over institutions. On the other hand, there are other forces that can create shifts in the balance between incumbent and emerging actors. These shifts can provide opportunities for actors to shape the selection environment. In the following, I discuss how developments that are locked into certain trajectories as a consequence of path-dependency might be changed or unlocked.

2.2 Power struggles and structural change

The perspective on regimes as a source of inertia, but also on how regime change might occur, draws upon ideas from historical institutionalism. Historical institutionalists emphasise that existing institutions give some actors more power than others over the creation of new institutions (Hall & Taylor 1996). Access to strategic resources, and even knowledge about institutions, is unevenly distributed. This affects the ability of actors to transform the context in which they find themselves (Hay & Wincott 1998). Because existing institutions distribute power unequally favouring incumbent actors, institutions are during periods of stability mostly constraining. However, at certain times critical junctures open up windows of opportunity for agents to induce change (Hill 2013, p. 77). This understanding of structural stability and change is sometimes referred to as punctuated equilibrium (Baumgartner & Jones 1993). The events that punctuate the equilibrium will often be exogenous events that occur beyond the influence of the actors that are affected by such events. However, political actors may also induce critical events. Small events can trigger feedback processes, which can lead to the adoption of a new political path (Pierson 2000).

Thelen and Mahoney (2010) challenge the notion of equilibrium between moments of radical change. They remind us that the role of institutions in distributing power can also induce change. Because power is unevenly distributed among actors, these actors are motivated to either seek to maintain or

change institutions. Consequently, stability is not a result of self-generating institutions, but a result of conscious efforts by actors benefiting from those institutions (pp. 8-9). Hay (2002) therefore refers to the process of punctuated *evolution*, pointing to the importance of incremental change both in established industries and among new entrants that may influence the way in which actors respond to critical events when they occur.

Institutional change is understood to be made possible through the exploitation of windows of opportunity that open up when there is a shift in the distribution of power. This raises two questions: What causes such opportunity windows? Moreover, how are actors able to either exploit or fail to exploit such opportunities? These are questions that I address specifically in paper 1.

In the multilevel perspective, triggering events are conceived to occur mostly at the landscape level. The notion of power as has been discussed above is then implicit in the way in which niche and regime actors compete to exploit the opportunities that may arise from such landscape changes (Avelino & Rotmans 2009). The degree to which actors are able to organise and exploit opportunities through negotiations and contestations can therefore have an important influence on institutions and policy. I analyse such processes in paper 2. I expand further on a multilevel approach to understanding structural change in the next section.

2.2.1 Pathways to regime change

Smith et al. (2005) understand regime change to be a function of two processes: Shifting selection pressures bearing on the regime and the coordination of resources available inside and outside the regime to adapt to these pressures. Returning to Freeman's selection environments, we can observe selection pressures on the regime associated with the energy sector in all three categories. First, as already pointed to, increased recognition of climate change creates a pressure on both governments and firms to invest in low-carbon emission technologies. Second, we can think of soon to be decommissioned coal power plants as changing the selection pressure in the built environment by creating an opening for investments in new renewable energy production. Finally, changes in the institutional environment such as increased attention to "stranded assets" and the financial viability of deep-sea or unconventional oil puts pressure on firms to invest in alternatives such as renewable energy. I explore the effect of changes in selection pressures with particular attention to this last example in paper 1.

However, changes in selection pressures also need to be accompanied by a response from resources organised inside and outside the regime. Smith et al. (2005) here distinguish between the availability of resources (capabilities, knowledge) and the degree of coordination of resource deployment. These dimensions and the basic understanding of change at the regime level are comparable to the understanding of change at the network level found in much of the literature on policy networks (e.g.

Daugbjerg & Marsh 1998; Marsh & Smith 2000). Paper 2 discusses this in more detail, and it will suffice to point out here that in the policy network approach endogenous change (i.e. change within the regime) is understood to affect outcomes only incrementally, whilst factors exogenous to the policy network can cause major changes (Smith 2000a). Moreover, Adam and Kriesi (2007) see network change as a result of both exogenous change and the adaptation of the network to such changes. Further, and similar to the understanding of change in the MLP, they distinguish between actors' attributes (comparable to resources) and ties between actors as determining the way in which a network responds to exogenous change (or selection pressures). Whereas Smith et al. (2005) refer to resources as capabilities and knowledge, Adam and Kriesi (2007) refer mainly to the notion of power. With regards to degree of coordination of resource deployment, Adam and Kriesi distinguish between competition, negotiation and collaboration.

From the above, it is possible to see responses to changes in the selection environment along two dimensions. First, in order to take advantage of changes in selection pressures, there has to be a presence of suitable resources. These resources can be technological capabilities and knowledge, but also the ability to influence institutions. Paper 1 (and to some extent paper 2) explores this dimension. Second, presence of resources may not be sufficient if these resources are not coordinated and deployed in a strategic manner, and such coordination involves negotiations and collaborations. Whereas paper 2 in particular investigates the degree of coordination of resource deployment, paper 3 focuses more on the availability of resources such as technological capabilities and knowledge, market access and financial resources.

Inspired by Smith et al's (2005) understanding of how regimes can respond differently to selection pressures depending on the capacity and resources within the regime, Geels and Schot (2007) introduced a typology of transition pathways where they emphasised particularly the nature and timing of niche-regime interaction. This interaction would follow different pathways depending on the level of development of niche-technologies and the amount of regime-pressure from exogenous change. I will in the following discuss some of the pathways and relate these to the topic of this thesis. It should be noted that these pathways are stylised categories, and developments in the real world will be less categorical.

First, if there is no external landscape pressure the regime will simply reproduce itself and remain stable. This is because with no attention to climate change and continued profitability in the fossil-based industries, there will be no pressure on regime actors to change their behaviour. Geels and Schot therefore called this a *reproduction process*. We can recognise this idea from historical institutionalism where in between critical events there will be relative tranquillity. Hay (2002), however, reminds us that important developments may also occur in between these sudden bursts of

change. Too much emphasis on the importance of critical events for regime change may lead us to underplay the possibility for change within the regime.

A second pathway (*the transformation pathway*) can be observed when there is moderate landscape pressure on the regime, yet alternative solutions (niche technologies) have not yet been sufficiently developed. In such a scenario, advocates of alternative solutions such as new energy technologies might not be in a position to exploit changes in the selection pressure. Rather, the regime will change from within, influenced by exogenous developments at the landscape level.

Any process that involves some degree of regime pressure and some more or less developed alternatives is likely to involve contestation, conflict and power struggles (Geels 2004). Moreover, the response to landscape pressure may involve conflicts both within the regime and between regime actors and groups outside the regime. Investments in CCS technology is an example that illustrates developments along this pathway. In many countries, CCS has been introduced or developed by regime actors as a response to landscape pressure from increased climate change awareness and new renewable energy technologies have in many cases not been seen as sufficiently developed. Thus, regime actors have modified the direction of the regime by investing in CCS without disrupting the general direction of the regime (which in this case is to fulfil energy demand with fossil resources). At the same time, CCS as a solution has been contested by actors outside of the regime (such as environmental organisations and elected officials), which has led to conflicts and negotiations. We can observe a related example of regime stability within a transformation pathway in the negotiations around the use of natural gas. Coal, natural gas and oil differ significantly in terms of how much CO2 is released per kWh produced. Natural gas is the "friendliest" of these energy sources, and is therefore by many regarded as a "transition fuel" to a low carbon regime (Bridge & Billon 2013). However, critics such as Greenpeace International argue that although investments in natural gas provide emission reductions in the short run, they may also delay a transition to renewables and reinforce carbon lock-in (Meadowcroft & Langhelle 2009a). This argument has also been supported in modelling of the impact of abundant supply of natural gas in the US power sector, where results show that increased use of natural gas may delay deployment of renewable energy technologies (Shearer et al. 2014). In paper 2, I explore the dynamics in such a pathway and draw some comparisons to the development of offshore wind, which can also in some way be related to a transformation pathway.

The pathways described above refer to changes under moderate landscape pressure. However, it is possible to envisage more radical change if the landscape pressure takes the form of 'disruptive change' (Geels & Schot 2007, p. 413) leading to *a technological substitution pathway*. Landscape pressure might in the beginning be considered to be moderate, and consequently stimulate moderate regime change. However, if the pressure is articulated as more forceful, previous adaptations in the regime can appear insufficient. A chain-reaction can then follow where incumbent actors lose faith in the

existing technologies at the same time as niche-technologies have developed sufficiently to take advantage of a window of opportunity. With a modified version of the transitions pathway framework, Geels et al. (2016) show how the electricity system in Germany has followed a technological substitution pathway with rapid improvements in solar cell technology and increased pressure on the fossil energy regime. An important question that remains then is what role the 'old' regime actors can and will play in such a technological substitution scenario. This question has in part motivated the direction taken in paper 3.

The discussion so far suggests that exogenous change is often considered as necessary for structural change. In all of the transition pathways described above, change at the landscape level is seen to influence regime change in one way or the other. Similarly, in the policy network approach, endogenous change tends to affect what we can think of as the policy regime only incrementally, whilst it is exogenous factors that can cause major changes to the policy regime (Smith 2000a). Such emphasis on exogenous change as an explanatory factor for structural change can be criticized for not providing any useful explanation unless we can also explain exogenous change (see for instance Dowding 1995). However, much of the strength of a multilevel or policy network approach is that they provide tools to understand how structures (and ultimately actors) *respond* to exogenous change.

The perspectives discussed in this section mostly focus on the structural level of analysis. However, I do not intend to argue that change occurs at the structural level. Only actors can exercise power. However, I follow Marsh and Smith (2000) in that networks and structures constrain and facilitate actors. It is by looking at how exogenous change can alter the way in which structures constrain and facilitate, and how actors negotiate both stable and changing structures that much of the interesting analysis on transitions can be done. Whereas paper 1 employs an agenda-setting model to analyse how *actors* negotiate opportunities provided by exogenous change, paper 2 attends more to how exogenous change influences negotiations at a *structural* level which in turn lead to particular policy outcomes.

The multilevel perspective and the policy networks approach are primarily focused on the regime or network level. Even though neither of these perspectives neglect the role of agency, it would still be fair to say that these perspectives emphasize structural elements (Smith et al. 2005, see also Geels 2011 for a response). The MLP in particular has therefore been criticised for not addressing how power struggles between actors and networks influence policy, which in turn has an important influence on structural stability and change. The next section will look closer upon how it is possible to study such struggles in relation to sustainability transitions.

2.2.2 Competition over the influence over institutions

Actors and networks associated with new technologies will usually be embedded in structures that pre-exist in a particular territory (Bergek et al. 2015). We can think of these pre-existing structures as the socio-technical regime, which include elements such as institutions that guide the interaction amongst actors. Typically, existing institutions will not adequately accommodate the new technologies and the change they represent and will therefore represent a barrier for niche technologies that in some way challenge the regime. Regulations and policies that have co-evolved with incumbent industries and technologies might block access to the regime from new entrants. For instance, Geels et al. (2016) describe how the preferences for technology neutral policy instruments in the UK created barriers for new entrants in the electricity sector. Markard, Wirth, and Truffer (2016) refer to this as institutional misalignment. Similarly, in Norway the interests of the hydropower complex and the petroleum industries has strengthened the logic of cost-efficiency in climate policies (Boasson 2005; Moe 2015, pp. 187-209), which has made the introduction of technology specific policies that favour further-from-market technologies tougher to realise. Actors involved in new technologies will then need to either adapt to or change the existing institutions (Bergek et al. 2015; Smith & Raven 2012). These alignment processes are often characterised by debates and power struggles (Dolata 2013) and the outcome of such alignment processes will be determined by the ability of advocates to influence institutions in the face of opposition often residing at the regime level.

However, politics does not occur on a level playing field (Marsh & Smith 2000). As pointed out in section 2.1.2, actors will have unequal access to resources that can be used to influence institutions. This asymmetrical distribution of power is clearly present in the energy regime. The financial resources that the oil and gas companies have had access to have provided the fossil industry with the ability to dedicate large sums towards lobbying and political campaigning and influence important political decisions[4]. Moreover, the fossil industries have arguably been able to attract qualified personnel as well as political attention at the expense of emerging industries (Bridge & Billon 2013). Thus, through processes of direct competition or more indirect 'crowding out' of new renewables, the incumbents in the energy sector have through asymmetric distribution of power been able to reinforce existing institutions and thus strengthen the fossil-based energy regime.

Nonetheless, the distribution of power between regime and niche actors can change during periods of regime instability (Avelino & Rotmans 2009). Pressure from changing selection environments at the landscape level can create opportunities for institutional change. The outcome of such periods of

4 The oil and gas sector spent a billion USD on lobbying between 1998 and 2010 in the US (Bridge & Billon 2013). An analysis by The Guardian in 2015 documented that the fossil fuel lobby was given far more access to UK government ministers in the period 2010 to 2014 (Evans et al. 2015).

instability is shaped and steered as a result of intense social, political, and ideological confrontations and compromises (Perez 2002, p. 22). How this steering occurs is however not so obvious.

In summary, this raises additional questions: How do these power struggles unfold? What explains how advocates of new technologies in the niche either exploit or fail to exploit opportunities when they occur? Such questions have been less explored in the sustainability transitions literature (although I point to notable exceptions in section 1.2).

To understand how a transformation process might unfold (or not unfold) we need to have a sense of the institutional context as well as how actors are connected through power relations (Kuzemko et al. 2016). We need to consider the interests of different groups and what their relations to decision makers are. However, to really get underneath how interests and power relations influence policy outcomes, we need to understand under which conditions different actors and groups will have the greatest influence on policy (Boasson 2015, p. 182).

In both paper 1 and paper 2, I suggest frameworks that help to address these issues. Paper 1, on the rise and decline of offshore wind, investigates particularly how instability occurs and points to the importance of timing (Geels & Schot 2007) and the need for solutions to be attached to appropriate problems during windows of opportunity. Paper 2 approaches the issue by looking at the structure of networks based on the notion that any explanation of policy outcomes must acknowledge and explain the *structural* inequalities that shape the political arena and the political agenda (Marsh & Smith 2000). Two relevant findings in these papers are that (i) network structures (developed mostly in the regime) provide barriers to institutional change, and (ii) niche technologies need to be sufficiently developed in order to exploit windows of opportunity (which is consistent with the transformation pathway in Geels & Schot). Given these barriers towards a transition, it is important to understand how new and alternative technologies can develop within the constraints from structural stability that have been described above. This has led me to investigate how an industry related to an emerging technology such as offshore wind can develop in Norway where there are available technical competences and resources but a lack of market formation (paper 3). I discuss some of the ideas that this third paper rests upon in the next section.

2.3 Protecting niches from the selection environment

So far, this chapter has discussed mostly how sustainability transitions occur through change at a structural level. Socio-technical regimes are perceived to be highly constraining. Even when put under significant pressure from exogenous change, regimes are remarkably durable and are capable of mediating pressure without disrupting the overall trajectory of the regime. Sociotechnical change can nevertheless occur as a result of a combined pressure from exogenous change and new technologies.

This section will look closer at how new technologies can evolve sufficiently to be able to compete with and potentially replace incumbent technologies.

With the need to develop new solutions comes the recognition that system builders and niches must play an important role in the transition process (Kemp et al. 1998). However, new technologies face many obstacles and constraints. Nathan Rosenberg (1972) pointed out that new and immature technologies will often be inferior to existing technologies. This is because it is the improvements that occur after technologies' initial introduction in the market that make the solutions commercially feasible. The process of replacing old technologies with new ones takes a long time because existing and incumbent technologies will have benefitted from improving in the market over a long period of time (see also section 2.1.2).

Innovation is a result not of individual firms but the interaction between many different actors within a certain context. Such actor relations exist not only between suppliers but also (and perhaps more importantly) between users and producers of technology. The importance of user-producer relations has been particularly highlighted in much of the work by Lundvall (e.g. 1988; 1992). Lundvall's arguments relate to the ideas by Rosenberg in that many important improvements in technology happen after they are introduced in the market. Improvements in efficiency or performance necessitate certain levels of basic and applied research and development. However, it is (according to Lundvall and Rosenberg) through feedback from customers and from learning-by-doing that many of the incremental innovations that lead to competitive technologies occur. A new technology therefore needs to endure a long period of competition with established technologies to become an important part of the dominant technological regime (Freeman 1991). Because of the inferiority of many new technologies during such a period as well as the inertia in the built and institutional selection environments, new technologies need to be shielded from these selection environments in order to prove their potential and profitability. Examples of shielding can be geographical regions outside the reach of the electricity grid that create a protected space for off-grid solar PV or actively constructed spaces through public policies, which alter incentives to invest in particular technologies (Smith & Raven 2012, p. 1027).

The need for long-term policies to protect, nurture and empower the new technologies that can help to transform the energy system points to a potential problem with democratic politics. Democratic politics is often characterised by negotiations and bargaining that can result in a slow but steady path toward resolving problems in society. The question is, however, whether slow and steady is sufficient when faced with a problem that increasingly requires a rapid response. Democratic politics are also characterised by short-term goals, sometimes hasty and not well thought out decisions, where governments come and go. Thus, there is a potential mismatch between the nature of democratic

politics and the policy requirements for a system transformation. I will return to this point in section 5.1.

2.3.1 Tilting the playing field

Because innovation is about more than knowledge creation processes through for instance R&D, there is a need for a more systemic perspective on innovation that recognises the interaction of different processes important for innovation (Mytelka & Smith 2002). These processes might include learning-by-doing and learning-by-interacting as pointed out above. However, a number of other processes such as the mobilisation of resources or creation of legitimation can also be important for the maturation of niche technologies. A systems approach to innovation can identify weaknesses in the system related to these processes that hamper technology development. Typical weaknesses can be that industries are locked-in to unwanted technologies such as coal or nuclear (Smith 2000b). Government intervention is then needed to both discourage further investments in such technologies and to encourage investments in alternative technologies. Moreover, and as I have discussed above, a system failure may also occur at the institutional level. A systems approach to innovation can help identify such weaknesses and point to possible policy solutions. Given the variety of processes that might be necessary for niches to grow, there will also be a need for a variety of policies. Moreover, the suitability of particular policies can depend on the nature of the technology, level of maturity, and the context. To this, Fagerberg (2016, p. 6) adds that if one critical factor (such as knowledge, finance or markets) is lacking, this may block the growth of the entire system. Smith and Raven (2012) here point to the technological innovation systems (TIS) approach as one possible analytical tool for studying how niches can be shielded and mature when faced with the constraints of socio-technical regimes.

One of the strengths of a TIS approach is that it helps to identify factors that hamper the dynamics of a system by for instance focusing on how certain system processes influence other processes. I.e. how a lack of legitimacy might block the entry of new firms, or how weak market formation might block the mobilisation of financial resources. From this perspective, innovation is seen as the result of more than R&D, which (although a very important activity) is perhaps sometimes given too much emphasis in policy-making at the expense of other policies. Mazzucato, Semieniuk, and Watson (2015) argue that the success of many influential technologies developed in the US came as a result of the combination of publicly funded basic research, funding for applied research, and provision of early stage high-risk finance. Public support programs can have a considerable effect on innovation not only through R&D support, but by helping smaller firms link up with national procurement programs and venture capitalists (Keller & Block 2012). Thus, to stimulate a technology transition, public R&D funding should be complemented with policies for early deployment and commercialisation.

This raises the question of whether the increases in new energy funding in Norway in 2009 have been coherent across the entire innovation trajectory.[5] Figure 2 shows a snapshot of R&D funding from the Research Council of Norway (RCN) in 2012 for all energy related technologies. This figure suggests that funding has been directed more towards basic and applied research, and less towards demonstration, deployment and commercialisation. All three papers in this thesis discuss different aspects of the importance of demonstration and deployment of technologies for industry and technology development.

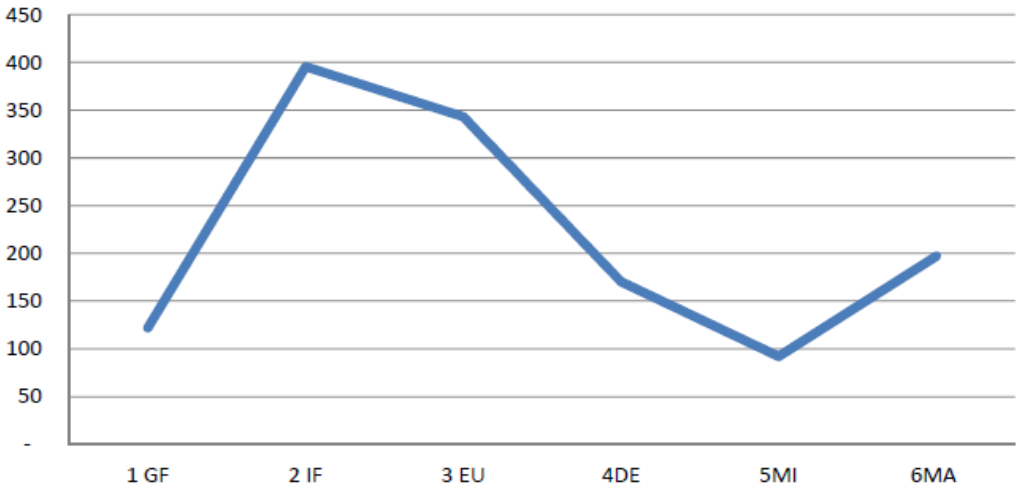

Figure 2 Total public spending on RD&D within climate friendly stationary energy technology, CO2 management, environmental friendly transport and stationary hydrogen in 2012 (mill NOK). Includes funding from Research Council Norway (RCN), Enova, Innovation Norway, Gassnova, Transnova. 1 GF: Basic research, 2IF: Industrial research, 3EU: Experimental development, 4DE: Demonstration, 5MI: Market introduction, 6MA: Market.
Source: Energi21 (2012)

One reason for increases in R&D funding towards new technologies might also be that public policies generally tend to engage with building niches in isolation. Putting pressure on the existing regimes is done with much greater timidity, simply because this is more politically contentious (Smith et al. 2010). However, in many cases of low-carbon innovation, existing institutions or regimes tend to block the development of new technological alternatives. A market based rationale for public intervention is limited to levelling the playing field between different technologies and solutions. Due to path-dependency and lock-in, this rationale will favour existing and unfavourable technologies. Mazzucato (2016) therefore argues for a public sector that tilts the playing field to favour certain types of change more than others (see also Mazzucato & Perez 2015). Mazzucato points to the need for state actors and private stakeholders to work together to define the direction of change and for the establishment of new institutions that favours a tilting of the playing field. However, it is less clear how such a shift can be induced.

[5] In 2008, a cross party agreement on climate policy was signed in Parliament. One outcome of this agreement was increased funding of new renewable energy technologies through the establishment of a number of research centres.

With this in mind, the strategic option for non-state actors such as firms or other advocates of new technologies is to attempt to influence the institutional framework so that this is tilted in their favour (Bergek et al. 2008b). This requires, amongst other things, legitimacy. Creation of legitimacy is necessary to increase the political power by enrolling new actors and strengthening existing networks supporting the technology. This can lead to feedback processes where additional legitimacy is built, which in turn further increases the possibility to influence institutions. The purpose of particularly paper 1 and 2 is to contribute to furthering our understanding of how such legitimacy is built and what potential challenges there are to developing sufficient legitimacy and support for certain technologies or policies. Further, paper 2 addresses the issue of how networks necessary for influencing policies are shaped, which is an area that has been underplayed in the TIS literature (Bergek et al. 2008b). Section 5 discusses further how state actors, politicians, and business interests can influence the conditions for change.

Technological innovation systems are analytically defined based on the selected technology or technologies in focus. Thus, the system will often transcend regional or national boundaries (Bergek et al. 2008a; Hekkert et al. 2007). However, there are a number of arguments that favour a national perspective also on technological innovation systems. First, firms rarely innovate alone because innovation often relies on firms with different competences, background and visions. Innovation therefore necessitates the interaction between a heterogeneous set of actors. Some of the learning processes that are important for innovation therefore rely on some form of clustering of resources (Carlsson & Stankiewicz 1991). Second, firms' ability to innovate is influenced by their home country's national innovation system: the quality and type of basic research, national policies affecting the competitive environment, availability of infrastructure, availability of natural resources (both fossil and renewable), price of labour and energy, and availability of private capital (Pavitt & Patel 1999, p. 94). We know for instance that the low energy prices, high labour costs and availability of both oil and gas reserves and wind and hydro resources are all factors at the national level that shape the selection environment in Norway for new technologies such as offshore wind (Hanson et al. 2011). Finally, even within highly internationalised industries the nature of the home market has been considered to play an important role in influencing the competitiveness of firms (Fagerberg 1992; Freeman 1995; Lewis & Wiser 2007; Lundvall et al. 2002). This ties in with a public debate about the need for public support towards market creation for new renewable energy technologies in Norway. An argument that has been put forward by a number of leading politicians is that deployment and commercialisation of technologies (such as offshore wind power) can take place in international markets where the incentives are more favourable to such activities (see for instance Stortinget 2010; Stortinget 2015). This topic is addressed in paper 3, where I investigate the role of home markets in the international offshore wind technological innovation system.

2.4 Summing up

Due to the path-dependent nature of technology and policy, socio-technical regimes are inherently resistant to change. The institutional selection environment tends to coevolve with the interests of the established regime actors, and will often disfavour new technologies. The trajectory of the regime thus involves constant competition between actors to influence the institutional (and to some extent the built) selection environment. Because these political struggles are shaped by the institutional settings where they take place, the power to influence institutions is distributed asymmetrically.

However, the articulation of pressure on the regime from changes in the selection environment might open up windows of opportunity for niche technologies to gain more influence on regime trajectories. The potential to exploit such opportunities depends on the technological and organisational readiness of these new technologies. In other words, it depends on the availability of resources and the capacity to organise these resources. Public policy can play an important role in stimulating both technological and organisational readiness.

The multilevel perspective and technological innovation system frameworks have been developed to capture many of these features of socio-technical change. However, there is at the same time much to be gained from including complimentary perspectives that better allow us to capture the conflicts of interests, negotiations and power struggles that so often impact on regime trajectories.

3 Research approach and methods

In this section I will give an overview of and discuss the research process of my PhD. This includes steps taken that have contributed directly to the results in individual papers and steps that have contributed more indirectly to the end results. Some parts of the research process have for instance involved collection of data that I have not referenced in the thesis, and some research steps might even be considered to have represented a dead end. Nevertheless, I believe that all the choices and steps taken in this process have somehow contributed to my overall understanding of the research area and have influenced the way in which I have interpreted and collected further data.

The methods used in each individual paper are presented in these papers and I therefore refer the reader to look at these for further details.

3.1 Reflections on studying policy processes

Studies of political processes face particular difficult challenges related to both identifying causal mechanisms and the potential for generalization. In order to identify crucial features leading to different outcomes, the researcher needs to compare similar situations (Benton & Craib 2011, p. 82). This implies that causal mechanisms cannot be identified in single case studies. However, political processes are atypical and normally consist of a unique set of events (Hill 2013, p. 9). The study of political processes therefore often has to be based on single case studies, and there may be limited lessons that can be drawn from these processes.

Given the often unique nature of political processes, it can be difficult to make studies of such processes more than a description of one thing after another. In order to solve this problem, Benton and Craib (2011, p. 38) suggest that we need to make some reference in the narrative to causal mechanisms, and even patterns of causal interaction. In a similar vein, Elster (2009, p. 24) argues that we should focus on mechanisms rather than laws and high-level theories in the social sciences. The objective of the first two papers in this thesis has been to analyse certain outcomes and the processes leading to these outcomes. Mjøset (2009) suggests a contextualized approach for this type of research and argues, in agreement with both Elster and Benton and Craib, for the use of general theory and the identification of mechanisms rather than universal range theory.

So how do we separate correlation from causation, and how do we identify causal mechanisms and patterns? Hay (2002) here points out that rather than searching for mechanisms, historical institutionalists pay close attention to the sequence and timing of events within a specified context. This approach favours rich descriptive narratives informed by theoretical insights. George and Bennett (2005) propose process tracing as a useful method for this purpose. Process tracing involves more than just describing a sequence of events. Events are built into a context that is both shaped and shaping. There is in other words a dual relationship between actors and context, and this relationship can be

captured by the process tracing (Pettigrew 1997). The analytical strength of process tracing is that it can turn a historical narrative into an analytical causal explanation, based on certain theoretical foundations. This implies that even with the absence of high-level theory, there is a need for a conceptual framework or a middle range theory from which to identify such mechanisms and to guide the analysis in search for causal mechanisms and patterns in the empirical data. As I am specifically interested in the politics of sustainability transitions (particularly in papers 1 and 2), I use frameworks and theories from both innovation studies and political science for this analytical guidance.

In paper 1, I make use of concepts from the MLP together with the agenda-setting model developed by (Kingdon 1984/2011). In paper 2, I use concepts from both TIS and MLP together with the middle-range theory of policy networks. Finally, in paper 3, I use concepts from TIS together with insights from organisational studies, innovation studies and evolutionary economic geography. These frameworks and theories have guided the research in this thesis. At the same time, the research process has been iterative meaning that the development of research questions and identification of relevant literature has co-evolved with the development of methods and collection of data. This dialogue between theory and evidence has resulted in a theoretically informed historical narrative (Hay 2002). It has also been somewhat iterative between the different steps in the data collection, although it has mostly followed the steps in the order described below.

First, I created an initial narrative of offshore wind development in Norway. With this narrative as a starting point, I conducted a handful of scoping interviews in order to better identify and situate potential empirical research problems (Van de Ven 2007). I also read transcripts of parliamentary debates and hearing submissions before I conducted the majority of the interviews that has formed the most important part of my material. Finally, I conducted an industry-wide survey together with the co-author of paper 3. This survey was then followed up by 7 additional interviews where topics from the survey were further explored.

3.2 Initial narrative

I decided at an early stage in the research process to focus on the development of the offshore wind industry in Norway and the interaction between this industry and the incumbent oil and gas industry. As a first step, I therefore put together a narrative of the development of offshore wind in Norway. I had initially not yet identified the particular areas that I wanted to investigate further or which issues related to the interaction between offshore wind and oil and gas. This first narrative was therefore broad and covered topics such as the development of policies related to energy, climate and industry development, the development of both the onshore and offshore wind power markets and industries in Norway, changes in the broader political context, changes in the oil and gas industry, as well as changing perceptions on issues related to energy and climate change at a national and international level.

Source material for this initial narrative consisted of a combination of empirical studies published in journals, expert reports on the petroleum and renewable energy industries in Norway, and industry reports on the international offshore wind industry. However, the main source material was obtained from archive search in the Retriever online media database. In this database, I searched for keywords related to renewable energy technologies, policy, energy companies, research centres, individual business leaders, entrepreneurs and politicians etc. over a longer period (ca. 1990 until 2013 which represents the main period for the narrative). Based on this material, a chronological narrative was put together. From this, I could identify critical events at the landscape level, important developments in the offshore wind niche, potential issues that involved power struggles, and many of the important actors and networks.

3.3 Parliamentary debates and official hearings

Having created the initial narrative and executed the first scoping interviews, I continued with a review of parliamentary debates and replies to hearings. The review of hearing replies covered 8 hearings on reports and proposed policies on energy and climate in the period between 2005 and 2013. The review of parliamentary debates covered issues related to natural gas and offshore wind, broader debates on energy and climate issues, and to some extent debates about the petroleum industry. In total 41 debates in the period between 2005 and 2010 were reviewed.

The purpose of this exercise was not to perform a comprehensive analysis of the parliamentary treatment of energy and climate issues in this period. Rather, the purpose was for me to develop an understanding of the positions and interests of both individual politicians and organisations such as firms and interests organisations. Moreover, I used this exercise to get a better understanding of the issues that were associated with certain conflicts, and which actors such conflicts engaged.

Insights from this review process combined with the initial narrative formed the basis for developing research problems for further exploration and for identifying interviewees. Moreover, this background information provided a foundation from which I could use to identify specific topics to address in the different interviews.

3.4 Semi-structured interviews

One of the objectives of this thesis has been to study the role of politics in the formation of policies that influence transition processes. Political processes often entail power struggles. Because many of these power struggles are hidden, studying the policy process can be challenging (Hill 2013, p. 10). Moreover, policy is a result of both action and inaction. Inactions are difficult to observe because they are not represented in the policy-process through legislative enactment (Hill 2013, p. 15). Tracing political processes often involves the analysis of political developments at the highest level of government. I have therefore based much of the analysis on elite interviews with people that had

inside knowledge about such processes. Elite interviews are particularly suitable for political process tracing as it enables the researcher to reconstruct political episodes by putting together individual accounts from first-hand sources to form a description of broader and more complex phenomena. Moreover, elite interviews can shed light on the hidden elements of the policy process that might otherwise be invisible through other sources (Tansey 2007).

The interviews included current and former members of the political elite, company executives, senior representatives from interest organisations, civil servants, engineers and researchers, and lobbyists. Based on the previous steps, I developed an initial list of people that I had identified as relevant to interview to understand the most critical events and processes. The majority of the people that I approached for interviews responded positively to be interviewed. However, I also approached some that either declined or that I was unable to get in contact with. In cases where this happened, I tried to find alternative interviewees. However, in some cases there were no alternatives if the person was likely to hold unique insights into a particular issue (i.e. I was unable to get access to a former minister and leader of a political party).

Following the first group of interviews, I used a snowball sampling method to identify additional interview subjects. Having identified the initial set of respondents, this method involves requesting that they suggest other subjects relevant for the research topic. One of the benefits of a snowball sampling, which is particularly relevant for elite interviews, is that it can help identify influential actors whose identities are publicly unknown (Tansey 2007). The sampling and interviewing was a continuous process throughout most of the research for this thesis as new evidence gave rise to new insights, which in turn opened up new areas that required additional data. I purposely conducted the first set of interviews with industry representatives to further improve my understanding of the empirical field, and only at a later stage in the research process I conducted the majority of the interviews with high-level politicians and representatives from interest organisations. The reason for conducting the interviews in this order was to ensure that I had as much knowledge of the topics of interest as possible before conducting interviews that addressed more explicitly potential power struggles and negotiations. An overview of the 42 interviews conducted for the thesis, including when and where they were conducted, is included at the end of this thesis.

The objective of the interviews was to get an insight into the way in which the actors had played a role in influencing particular policy processes and how they had interpreted and responded to various developments identified in the narrative or events raised by the interviewee. I therefore adopted a semi-structured approach as this is more suitable for these types of elite interviews than structured questionnaires (Richards 1996). The interview guides were developed individually for each interview depending on the area of expertise and experience of the interviewee. However, most of the interviews covered some common themes to do with the main topics of this thesis.

I followed the suggestions by Richards (1996) and Leech (2002) of starting the interview with broader and more general questions to build rapport with the interviewees, letting the respondents give a "verbal tour" of something they knew quite well (Leech 2002). Moreover, in order to maximize response validity, I used open-ended questions throughout the interview as they provide the respondents a better opportunity to organise their answers within their own frameworks (Aberbach & Rockman 2002). Finally, if there were particular details I needed information about I posed some closed-ended questions. If I had sensitive questions, I would generally save these towards the middle or end of the interview (Richards 1996).

One of the risks of using elite interviews as material for the analysis is that the information given can be of a highly subjective nature (Richards 1996). Interviewees will have some limitations to how they recall historical processes or to their knowledge about an issue (Thies 2002). Moreover, interview subjects might adjust their interpretation of an event in order to avoid being seen in a poor light, or they might have a personal interest in framing something in a certain way (Richards 1996). I therefore wanted to collect a rich set of data points by interviewing a number of people in different positions on selected topics. In addition, I supplemented data from interviews with events documented in the media archive search (see section 3.2). By consulting a variety of different sources of evidence, I was able to identify inaccuracies or biases in the individual sources and therefore present a more precise representation of events (Thies 2002). Moreover, by comparing evidence from interviews with journalistic sources from the time, I was able to evaluate the relevance of events perceived as important by interviewees (George & Bennett 2005, p. 97).

I transcribed the interviews shortly after having conducted them. The process of transcribing interviews was valuable in itself as it let me familiarise with the material. Moreover, it helped me improve my interview technique as I could note where I could have probed further or posed questions differently. Having transcribed the interviews, I undertook several rounds of coding. As a first stage, I coded according to certain themes that I had found to be relevant for the overall topic of my thesis with a purpose of getting a good overview of my material. From this overview, I was better equipped to relate the material to the conceptual frameworks for the different articles. This was very much an iterative process between processing the interview material and readings of theoretical literature. As the frameworks for the individual articles became more clearly defined, I then coded the interviews according to key concepts extracted from these frameworks (the operationalization of these concepts is discussed in more detail in the individual articles).

3.5 Quantitative data

The first two papers focused mostly on the historical development of the industries in the intersection between offshore wind and petro-maritime industries. In the third paper, I therefore wanted to investigate the potential for growth in the Norwegian offshore wind industry within the constraints

provided by the (lack of) national policies indicated in the first two papers. Thus, the purpose of the third paper was in part to perform an assessment of the current state of the Norwegian offshore wind industry rather than an historical assessment. I decided to collect data with a survey for such an assessment.

As a first step towards developing the survey, I reviewed the available data on the involvement of Norwegian firms engaged in the offshore wind industry. This encompassed a review of published reports on the Norwegian offshore oil and gas industry, reports on the offshore wind industry, and a review of the 4C offshore database (4coffshore.com). By putting together data from this database, I was able to get an overview of the most important parts of the offshore wind supply chain where Norwegian firms had supplied products and services. I also used this database to create an initial list of Norwegian firms that had delivered products and services to the international offshore wind market. More firms were added to this list by looking at member lists of different interest organisations, and a number of firms were also added manually.

3.5.1 Developing the survey

The survey was developed together with the co-author of the third paper and was done in parallel with putting together the recipient list for the survey, and also consisted of several steps. First, we identified possible independent and dependent variables that could help to explain some of the initial questions that we were interested in. These variables were identified from reviewing the literature on international technological innovation systems, innovation studies on export performance, and organisational studies. From this, we developed a range of indicators for firm size, degree of specialisation versus diversification, export orientation, place in supply chain, perceived barriers, role of home market and so forth. For the dependent variable, we wanted some measure of performance or perceived performance. However, we found it challenging to find good and reliable indicators for this variable. I will return to this below.

We decided to carry out the survey as a telephone survey inputting the answers in an online questionnaire. A major advantage of doing a telephone survey is that it generally provides high response rates (Robson 2011, p. 263).

3.5.2 Analysing the survey data

The collection of responses for the survey lasted two weeks. Following this, we put together a descriptive analysis of the data in order to identify particularly interesting parts of the dataset. This descriptive analysis resulted in a report (Normann and Hanson 2015). Based on feedback from both colleagues and industry experts on this report, we explored further how a slightly more sophisticated quantitative analysis than a pure descriptive one could strengthen our overall analysis of the

internationalisation of the Norwegian offshore wind industry. The results from this analysis are presented in paper 3.

3.5.3 Lessons from the quantitative analysis

I see myself as primarily a qualitative researcher. The motivation for employing a method that included a quantitative analysis in the third paper in this thesis was primarily that I considered this to be a suitable method for addressing the research questions that I was interested in for this paper. A second motivation, however, was that even though I will likely continue to use mostly qualitative research methods, I believe having some experience with developing quantitative research designs and performing quantitative analysis improves my ability to collaborate with quantitative researchers in mixed-method research projects. However, I was also aware of the risk of depending on a research method that was initially somewhat unfamiliar to me. I will here point to two lessons for future projects.

First, with the benefit of hindsight we should probably have tried harder to find good indicators for our dependent variable. Even though we were aware of the importance of this when we designed the survey, we felt at the time that we could not find good indicators of firms' export performance or perceived performance. We therefore had to settle for other indicators for a dependent variable such as perceived challenges associated with lack of a home market. Even though this (in my opinion) still led to interesting research, the results would possibly have been more interesting with better indicators.

Second, many of the questions concerning barriers towards internationalisation had dichotomous alternatives (i.e. yes or no) rather than Likert-type alternatives (i.e. strongly agree, somewhat agree, indifferent, somewhat disagree, strongly disagree). The reason for choosing dichotomous alternatives was that we thought that asking many questions over the phone with many alternative responses could be challenging for the respondents. Thus, we suspected that it could jeopardise the completion rate and the reliability of the survey. However, in hindsight, it would perhaps have been better to cut down on the length of the survey to facilitate the use of more Likert-type alternatives, which would have provided more possibilities in the analysis of the data.

4 Summary of papers with main findings

In the following, I provide a brief summary of the three papers in this thesis. The summaries include motivation and background for the papers, a brief note on the theoretical perspectives and framework, a description of the empirical cases, and a presentation of findings.

4.1 Paper 1: The role of politics in sustainable transitions: The rise and decline of offshore wind in Norway

New technologies need protection from mainstream selection environments through public policies. Much of the literature on sustainability transitions has therefore focused on the role of policies for creating protective space for immature clean energy technologies. However, it is important to understand the political processes that underpin particular types of policies. The development of offshore wind in Norway is used as a case to study the role of politics in policy formation.

In this article, I discuss how regimes often contribute to maintaining stability, and how regimes can be destabilised. One possibility for regime destabilisation is through pressure on the regime that can open windows of opportunity for change. The multilevel perspective recognises this, but does not sufficiently address how such opportunities open up, how actors are able or not able to exploit windows of opportunity, and why windows of opportunity close. Further, the article points out that the multilevel perspective has not provided a good enough understanding of the political circumstances that lead to opportunities for policy formulation. I therefore propose to use the agenda-setting framework developed by Kingdon (1984/2011) to analyse the rise and decline of offshore wind in Norway. One of the main strengths of this framework is that it is particularly suitable for studying the availability of appropriate problems and actors' ability to attach solutions to these problems. This development is conceptualised as occurring in three streams of problems, policies, and politics. The timing of the development in these streams and how they interact can be understood to influence agenda-setting and in the end policy formation. Thus, the framework adds important insights about the timing and nature of niche-regime interaction with particular attention to conditions for policy change.

In the empirical section, I describe the development of offshore wind in Norway in the period 2005-2012. Initially in this period, offshore wind rose on the agenda. This was despite rather than because of contextual conditions as the typical drivers for development of new renewable energy technologies in Norway had been mostly absent. The article then shows how attempts were made to attach offshore wind to different problems articulated at different points in time: (1) the issue of energy security, (2) climate change, and (3) industry development. Coupling offshore wind with energy security and climate change did not provide sufficient conditions for the exploitation of the window of opportunity. In other words, these couplings were not seen as politically realistic and did not have the potency to create opportunities for policy change. The problem of industry development was articulated as a result of decline in the petroleum industry and the coupling of offshore wind as a solution to this

problem had greater potential than coupling with the other problems. As a consequence, a number of favourable policy initiatives for offshore wind were introduced. However, the paper describes the need for niche-protection policies and that numerous initiatives to lobby for such policies were unsuccessful. I then suggest some possible explanations for this: (1) Attention from environmental organisations and advocates of clean energy had been spent on other policy solutions such as tradable certificates and CCS, (2) offshore wind lacked an enduring 'policy entrepreneur' (Kingdon 1984/2011 pp. 179-83), (3) offshore wind as a solution was not sufficiently developed, and (4) actors supporting offshore wind were poorly organised. I pick up on this last point in paper 2. Finally, the paper shows how increased activity in the offshore petroleum industry due to a recovering price of oil and new petroleum discoveries closed the window of opportunity for offshore wind. However, the paper suggests that the failure to realise offshore wind in Norway might also have been influenced by changes in the political elite.

In conclusion, the paper shows that an analysis of three streams of politics, solutions and problems can be useful for understanding the complexity behind policy formation, which has until recently been underplayed in the transitions literature. Further, the paper shows how the reliance on exogenous events and how they influence the potential for regime change illustrates the difficulties in steering a transition. One of the key contributions of the paper is that it underlines the importance of aligning the readiness of a technology as a solution to articulated problems when windows of opportunities open up for policy change. Finally, the paper concludes that although various perspectives in the transitions literature do point to the importance of networks and the need for strengthening these, they rarely study adequately how the balance of power between and within networks evolve and how the structure of network changes. This particular issue is addressed in paper 2.

4.2 Paper 2: Policy networks in energy transitions: The cases of carbon capture and storage and offshore wind in Norway

In this paper, I pick up from paper 1 by pointing out that new and immature technologies are often not cost-effective compared with the more mature technologies and that they therefore need niche protection policies. However, how such policies can be shaped in part through pressure from different groups of interested actors have been less studied in the sustainability transitions literature. This paper therefore sets out to study the role of networks in formation of policies important for an energy transition.

Two cases are explored: carbon capture and storage (CCS) and offshore wind power. These cases are selected based on a range of similar features, but with one important difference, which is the level of government commitment and the resulting differences in public investment in large-scale demonstration. Whereas the state invested limited resources in offshore wind beyond R&D funding,

nearly € 1 billion was invested in CCS between 2007 and 2012. These investments in CCS were made despite running against the principle of cost-efficiency that has dominated Norwegian energy policies.

As also pointed out in section 2.2 and in paper 1, opportunities to influence policy are not equally distributed between interested actors. Developments at the landscape level can alter the balance between these actors. However, whereas paper 1 emphasises the importance of timing, this second paper focuses on the role of networks in adapting to selection pressures from the landscape. Networks have been recognised as important in the transitions literature, and perhaps particularly in the TIS literature. However, *how* networks are shaped and how network structure influences policy has been less explored. A policy network approach is therefore employed to analyse how relations and negotiations between different types of both state and non-state actors influence policy, and how this impacts on the cases of carbon capture and storage and offshore wind.

The development of CCS has been closely linked to efforts by influential actors in Norway to pursue increased domestic use of natural gas. However, natural gas met opposition from the environmental movement. CCS advocates then positioned CCS as a solution to this conflict. In the paper, I describe how the CCS and natural gas advocates united in one network and how this network was strengthened through negotiations and compromises. From this, industry actors and interest organisations gained access to the policy process. Finally, the CCS case shows how the public funding of large-scale demonstration of CCS was a result of a political compromise that resolved a large political conflict within the government.

In the case of offshore wind, I describe how several smaller networks emerged in different regions motivated by a growing international market and available competences from the petro-maritime industries. With the drop in petroleum activity in 2008, these networks gained further momentum as more firms, politicians and interest organisations directed their attention to developing a Norwegian offshore wind industry. However, as was also described in paper 1, these networks did not manage to realise lobby efforts to secure public funding of large-scale demonstration. In the paper, this is explained in part by differences in network structure as the offshore wind network did not develop into one united network but rather remained somewhat more fragmented and loosely organised than the CCS network.

The cases show how both CCS and offshore wind networks expanded from efforts by network actors to exploit windows of opportunity that opened up as a result of different changes at a landscape level. A comparison between the cases also reveals some differences. Most notably, they illustrate the importance of building strategic alliances and the importance of compromises in developing such alliances. On the one hand, the cases then show that strategic actors can influence network structure. On the other hand, the cases also show how changes at the landscape level can contribute to network

change by putting pressure on existing regimes and by opening up opportunities. The influence of exogenous change on network formation is particularly evident in that as the pressure on the petroleum industry eased when the oil price recovered in 2010 and 2011, the offshore wind network lost its momentum.

The paper concludes by pointing to three general findings. First, participation in networks through mutual resource dependency can provide actors privileged access to policy-makers. Second, the findings in the paper underline the importance of including the interests of state actors, politicians and political parties, and how these interests are aligned with economic actors, in the analysis. Third, the paper demonstrates how a conceptualisation of niche-regime interaction can further help to explain how policy networks are influenced by the institutional context, and thus how the institutional context influences policy outcomes.

4.3 Paper 3: The role of domestic markets in international technological innovation systems

Papers 1 and 2 point to the lack of a domestic market for offshore wind in Norway. At the same time, the papers reveal that there is a potential for a Norwegian supply industry for products and services to the international offshore wind markets. As pointed out in section 1.3.2, a number of firms have attempted to exploit this potential. Paper 3 takes this as a departure point and studies how industries in non-leader countries can link up with international markets without the presence of a home market.

Internationalisation of industries has recently become an increasingly popular theme within studies of technological innovation systems. Here, researchers have raised the question of whether all system functions (i.e. knowledge production or resource mobilisation) need to be developed in all regions or countries. Empirical studies have shown that markets or knowledge production in one country can spill over to other countries that lack local access to these functions. At the same time, there are reasons to believe that actors in different geographical locations will not have equal access to system functionality such as markets.

Based on insights from evolutionary economic geography, innovation studies, and management studies, we suggest three propositions that we subsequently empirically explore: First, we propose that a lack of a home market will negatively affect the ability for firms to link up with an international offshore wind TIS. We therefore also set out to study how the lack of a home market influences both on a firm and industry level. Second, we propose that larger firms will be less challenged by weak local market formation. Third, we suggest that access to a successfully related industry such as the offshore oil and gas industry can in part compensate for weak local market formation for offshore wind.

The analysis is based on a survey of Norwegian firms and on semi-structured interviews. From the survey, we identify more than 100 firms that consider the offshore wind industry as a current or future

part of their business. Most of these firms are what we call “diversified”. Many of the firms we call “dedicated” (i.e. they see offshore wind as a core activity) are small in terms of total revenues and number of full-time equivalents dedicated to offshore wind. Most of the firms are oriented towards international markets and three-quarter of the firms consider the lack of a home market as a challenge to internationalisation. We then investigate in more detail how the lack of a home market poses a challenge to firms, and how firm size and experience from the offshore petro-maritime industries can compensate for weak local market formation.

Our data suggests that larger firms are less challenged by weak local market formation than smaller firms. In addition we conclude that larger firms can play an important role as intermediaries helping the many smaller firms with access to financial and research resources and with access to markets.

Based on the interview data, we provide possible explanations to why internationalisation can be challenging without access to local markets. Further, we examine why smaller firms are particularly challenged by lack of access to home markets. Finally, we discuss the implications of the close relationship between the offshore petro-maritime industries and the offshore wind industries. We see this relationship as dualistic in that it provides not only access to experience, competences and resources, but also that this relationship makes the offshore wind supply industry in Norway vulnerable to changes in the oil and gas industry. This dual relationship is important for the discussion about politics in transitions because it underlines that policies that target new industry formation need to be seen in conjunction with petroleum related policies.

The paper contributes to the debate about international dimensions of technological innovation systems by pointing out that even though the lack of system functionality in one region can be offset by strong functionality in other regions or countries, access to these resources will differ depending on a range of factors. In this paper, we point particularly to firm size and existing competences from related industries.

In terms of policy, we suggest that policy should aim to help smaller firms and firms with few existing relations to international markets. One option could be to support the development of a small home market. However, an alternative could be to stimulate larger firms to act as intermediaries and help smaller firms gain access to financial and research resources, and with access to international markets.

5 Discussion

The overall motivation for this thesis rests on the recognition of the societal challenge that follows climate change. One of many implications of this challenge is that we need to switch from an energy system built around fossil fuels to a system that is emission free and that rely (at the very minimum) significantly on the supply of renewable energy production. One of the reasons that this is challenging is that the existing energy regime constrains such a system transformation, as has been discussed throughout this thesis introduction.

The implication for fossil fuel producing countries is that a transformation will require a major reorientation of important industries in these countries. This issue has also at different times received substantial political attention in Norway, most recently following the decline in oil prices that began in 2014. The topic of this thesis therefore relates closely to current political debates concerning the role of incumbent industries faced with pressure from climate change and the global energy transition.

Throughout this thesis I have argued that the role incumbents play in an energy transition is deeply embedded in processes of politics. Established economic groups are part of the political processes and they are influenced by the outcomes of the political processes. These processes influence further the conditions for both incumbent industries and emerging niches such as offshore wind.

In this section, I first discuss how to integrate politics into a theory of sustainability transitions. Considering the critical role of incumbents in transitions, I look at how incumbent industries can be seen to influence the development of new low-carbon energy technologies in Norway. Finally, I consider how new renewable energy technologies and the associated industries might grow and improve, given the many constraints that these niches experience. In this final part I will also reflect on policy issues that come out of the discussion in this section.

5.1 Politics in sustainability transitions

The purpose of this thesis has been to better understand the way in which politics influence the opportunities for developing and nurturing new renewable energy technologies. Moreover, I have sought to develop a better appreciation of how these processes of politics unfold and influence policies in a country deeply vested in a fossil-based energy regime. I believe this is important to understand because for a transition of the energy system to really take place, the fossil-based industries will need to change drastically over the next few decades.

5.1.1 The role of institutions and policy

In section 2.3 and in the individual papers in this thesis, I have discussed how new renewable energy technologies need to be protected from the mainstream selection environment to eventually compete with incumbent energy technologies. This protection will often require the introduction and

maintenance of various public policies. Some of these policies such as increased public R&D support do not in any substantial way challenge the dominant actors in the socio-technical regime and are therefore rarely particularly contested. Smith and Raven (2012) refer to these policies as part of a 'fit-and-conform' pattern because they help the targeted industries or technologies to develop within the existing institutional setting. However, a transformation of the energy system also requires institutional realignment that might (1) involve removing subsidies favouring incumbent industries or (2) introduce policies that break with existing practices and norms. Cost-effectiveness has been an important principle guiding policies related to energy and climate in Norway (and in the EU) (Gullberg & Skodvin 2011) and we have seen from the example of offshore wind that policies that break with this principle have been difficult to introduce.

The institutional framework will shape the direction of search for knowledge and skills, and that direction will influence long-run developments in a particular society (North 1990). This can be related to the guidance of search function in the technological innovation system framework. The development of a number of manufacturing linkages extending from the exploration and processing of oil has left Norway with a system of innovation and an industrial culture that is highly oil-dependent (Mjøset & Cappelen 2011). The second paper in this thesis illustrates how this dependency influences the direction of investments in knowledge creation and market creation towards CCS rather than offshore wind.

Policies that challenge the socio-technical regime, and therefore established institutions, are generally more contested, as established actors will often oppose the introduction of such policies. Institutional change therefore tends to involve power struggles and politics. This is why studies of energy transformation processes require an understanding of politics. There is a vast literature on how policies are made, and this thesis has drawn on some of this literature. Moreover, the papers presented in this thesis give some examples of how policies are made.

Broadly speaking, politics concerns the distribution, exercise and consequences of power (Hay 2002) .[6] This power is distributed between state actors, economic groups (including interest groups and environmental organisations), and politicians and political parties. An understanding of how politics influence sustainability transitions should therefore distinguish between how these actors engage with the policy process, and to what extent economic, state and political actors are able to influence policies related to the energy system.

[6] I here understand the exercise of power to extend beyond Robert Dahl's classic definition of power which states that 'A has power over B to the extent that he can get B to do something that B would not otherwise do' (Dahl 1957, in Hill 2013, p. 30). Actors can also use power to influence which issues are on the public and political agenda. Finally, actors can influence the perceived interests and preferences of other actors (Lukes 1974). Powerful actors can thus influence the context that defines the range of possibilities for other actors (Hay 2002, p. 185).

5.1.2 Economic governance

Economic groups and actors rely on policies and institutional structures. Offshore wind is an example of an issue where numerous economic actors have had interests in certain policies, without much success in influencing policy development. Considering the asymmetrical distribution of power between economic groups, advocates of niche technologies will typically struggle to achieve political breakthrough. An important concern for transition studies has therefore been to understand how different economic actors convert interests into policy. Based on a comprehensive study of Norwegian climate policies, Boasson (2015) provides three lessons that help to understand the role of economic actors in political processes.

First, even if economic actors have clear interests in a policy area, they will not automatically seek political influence over that area. We have seen examples of this in the case of offshore wind. Paper 1 suggests that there was a lack of effort by offshore wind actors to participate in a debate about how the tradable certificates could be setup to deliver to offshore wind. Further, paper 2 points out that the formal offshore wind networks as well as many of the firms and research organisations had limited ambitions to engage in the policy process.

Second, and on a related note, Boasson notes that networks of actors dominated by many small and loosely coupled companies will have far less political impact than those dominated by a few, large, professional corporations. This is in line with the findings presented from the comparative study of CCS and offshore wind in the second paper in this thesis. Economic groups and actors cannot influence policy unless their interests are represented in the formal decision-making process (Gullberg & Skodvin 2011). Non-state actors such as firms, unions and pressure groups therefore compete over access to policy-makers. Often, we will find that incumbent firms have closer relations with policy-makers and are therefore better positioned to influence policy (Geels 2014). This can in part be due to the economic and political importance of these firms to state and political actors. However, some groups also enjoy better access to decision makers through their presence in tight networks (Daugbjerg & Marsh 1998). It may of course be that powerful incumbents are better positioned to form and participate in such tight networks. However, network participation can also facilitate access to the policy process for other actors as illustrated with the example of Bellona in paper 2 in this thesis.

Finally, economic actors are more likely to influence policy when state and business interests are aligned (Boasson 2015, p. 189). This is hardly surprising, but nonetheless important to recognise when we analyse policy processes in sustainability transition studies. I will move on to discussing the role of state actors below. However, it is worth noting here that the interests of important state actors and civil servants in the Ministry of Finance and the Ministry of Petroleum and Energy have not been aligned with the interests of offshore wind actors in introducing policies that break with the principle of cost-effectiveness. Thus, in the case of offshore wind the opportunities for economic actors to influence

policy have understandably been scarce. Boasson's second point here is that when state and economic interests are not aligned (as in the case of offshore wind), there will be a greater opportunity for political steering. Politicians have some degree of possibility to shape policies. A high degree of political steering implies the formation of policies that are aligned with the preferences of the political leadership of the parties in power (Boasson 2015). Thus, politicians' interest and ability to engage in a policy area such as the development of new renewable energy technologies matter for the feasibility of certain policies.

5.1.3 Politicians and party politics

The evidence of climate change is now overwhelming. There have been numerous summits, the scientific community is in an unusual agreement on the effects and threats of climate change, and politicians in power continuously pledge that action has to be taken. Yet, we have seen little decisive political action. The lack of policies that stimulate an energy transition is sometimes explained by a lack of "political will". For instance, Former Minister of Petroleum and Energy (2007-2008), Åslaug Haga, has claimed that it was not the lack of available policies, but the lack of political will that stopped the introduction of full-scale demonstration of offshore wind (Haga 2012, p. 250). However, "political will" is a fuzzy and not particularly useful concept. It is therefore more useful to talk about the "political feasibility" of certain policies (Meltsner 1972; Skodvin, Gullberg, & Aakre 2010). The feasibility of certain policies is in part conditioned on the preferences of the political elite. It is therefore helpful to investigate the way in which politicians' policy preferences can be influenced by other actors and the political and institutional context of a given policy issue. Political feasibility is also conditioned on politicians' ability to act upon their preferences. Given that no political actor will be able to control decision-making processes single-handedly, we need to understand the extent to which politicians can shape the policy process under different conditions.

Norway is a parliamentary democracy, which gives Parliament control over the government (Gullberg & Skodvin 2011). The government can control the formal decision-making process as long as the government holds the majority of the seats in Parliament (provided that members of parliament representing the party or parties in government are loyal in their voting behaviour). However, under a minority government, the government relies on support from the political opposition to achieve the necessary majority in Parliament. Norway is a country with strong corporatist traditions, meaning that interest groups have preferred corporate channels in efforts to influence decision makers. However, a longer period with minority governments from 1986 to 2005 shifted the decision-making power from government to parliament meaning that interest groups relied on access to members of parliament as well as the government (Rommetvedt 2005). The introduction of a majority government in 2005 moved power back to the government, and once more strengthened the importance of corporate channels (Gullberg & Skodvin 2011).

The formal decision-making rule of the Norwegian government is consensus. The consensus rule gives, in principle, every minister power to block a decision, while consensus requires support (or at least lack of opposition) from all the ministers. The policy-making process is therefore typically characterised by bargaining and negotiation which makes policy change challenging (Gullberg 2013). At the same time, politicians can influence policy through political entrepreneurship. Entrepreneurial activities include efforts to present particular solutions as the preferred policy solutions. This can be achieved through actions that aim to position solutions as compatible with dominant norms and institutional logics, or alter norms and cognitive frameworks of influential groups so that their preferences better match a particular solution. Entrepreneurial activities can also aim to overcome barriers to influence policy created by the structural distribution of authority to make formal policy decisions. Such entrepreneurship might include networking and agenda setting activities (Boasson 2015, pp. 62-79). The case of offshore wind shows that politicians in government only to a limited extent can be understood to have engaged in entrepreneurial activities. Cabinet ministers Åslaug Haga and Terje Riis-Johansen framed offshore wind as a solution to climate change and later industry development. Although this contributed to place the issue on the political and public agenda, these activities did not contribute to observable changes in the preference for policies based on a cost-efficiency principle among influential groups.

Political actors have limited capacity for entrepreneurship. As a result, not all policy issues gain entrepreneurial attention from politicians and issues tend to stay on the agenda for only a short period (March & Olson 1983). Political engagement is not only dependent on politicians' normative preconceptions of an issue. For instance, political elites are more likely to treat issues related to energy and climate concerns if they become subject to political competition (Carter 2006). Moreover, a preference for policies that favour new renewable energy technologies might be overruled by other factors such as whether the issue is part of a political conflict or not (Boasson 2015). The comparison between CCS and offshore wind shows how politicians devoted more effort toward the CCS issue because CCS was a more contested issue than offshore wind. Moreover, there can be multiple objectives for policy, which means that policy proposals aimed towards developing new renewable energy technologies might also need to be justified through other rationales or solve other problems to receive sufficient political support (Kuzemko et al. 2016). The case of CCS shows how policies that supported this technology had the added benefit of addressing multiple rationales. The importance of linking policies to political problems is also illustrated in the paper on the rise and decline of offshore wind. This paper shows that when the opportunity for policy change opened up, advocates of offshore wind were unable to find a suitable problem in which to attach offshore wind as a solution. In the period that the window of opportunity was open, attempts were made to attach offshore wind to the problems of climate change and energy security, and later on industry development. However, these problems did not place sufficient pressure on government actors. Thus, offshore wind was not

positioned as a solution to a problem within government that needed to be resolved. From this, it is possible to link the notion of timing from the literature on transition pathways (Geels et al. 2016; Geels & Schot 2007; Smith et al. 2005) with political engagement. From the sustainability transitions literature we know that system change requires both articulated problems caused by exogenous pressure and available solutions to these problems most often developed at the niche level. Papers 1 and 2 in this thesis show that the potential for solutions to not only solve societal problems but also to solve political problems can be important criteria for the political engagement that is sometimes required for policy change. This also suggests that niche actors should pay closer attention to how they can identify and position niche technologies as critical problem-solving technologies for decision makers. Paper 2 illustrates this as it describes how CCS was purposefully positioned as a technology that could (and did) solve a potent problem within government, which led to substantial political support and public funding. This underlines that political engagement depends in part on whether a policy solution is attached to an appropriate problem.

Sometimes problems are solved through the use of symbolic politics where politicians introduce watered-down policies whilst fulfilling public demand to take action (Blühdorn 2007; Edelman 1967). We can observe evidence of symbolic politics in Norwegian energy and climate policy-making. In some way, the Norwegian energy system resembles the Canadian system with a high share of hydropower in the energy mix as well as an influential fossil-based industry. In a study of the fossil industries in Canada, Haley (2011) argues that fossil vested interests use the promise of CCS as legitimation for not taking immediate policy action on climate change. CCS in Norway represents a similar example where CCS policies were presented by government representatives as meaningful steps to combat climate change. Thus, the government was able to maintain credibility during a time when there was a lack of visible prioritization of other comprehensive measures. The response from the Minister of Petroleum and Energy when questioned in Parliament in 2009 about government spending on climate measures is illustrative of how CCS investments was bracketed together with climate change measures.

> *"When it comes to environmental technologies in general, I will mention that when the Government proposes and Parliament today resolves to spend 3.5 billion (NOK) on environmental technologies related to carbon capture and storage, I cannot understand what signals we can transmit beyond that (Stortinget 2009)".*

Presenting the government's strategy for tackling climate change as substantial due to high investments in CCS is not an example of a watered down policy. However, when we consider the arguments in paper 2 in this thesis that two important motivations for investments in CCS has been as a legitimacy of gas power plants and to secure the long-term value of Norwegian gas reserves, it can be interpreted as a policy that is in part designed to support continued investments in the oil and gas industry whilst presented as a policy to tackle climate change.

A second example of symbolic politics is the introduction of tradable certificates in Norway. Initially, tradable certificates entered the political agenda as a solution to domestic energy deficits towards the end of the 90s and early 00s. However, Boasson (2015) argues that the political discussions around the certificate scheme took place more from a need to show commitment to renewable energy than from an interest in understanding how to best promote more renewable energy. The certificate scheme can therefore be seen as a result of political strategy and from pressure to appear to be doing something about climate change.

Finally, the international dimension of policy provides a third facet to the notion of symbolic politics. Hay (2002, p. 259) argues that politicians can use globalism as an escape from developing national policies. Norway has since the early 90s been one of the drivers on the international arena for implementation of clean-development mechanisms (CDM). The point of the CDM is that it is meant to induce investments in the most cost-effective climate mitigation action regardless of which country the action takes place. Such a policy is in line with the Norwegian vested interest structure (Moe 2015) as it avoids penalising Norwegian industry through comparatively expensive domestic climate policies. Thus, such international policies allow politicians to seemingly take action, whilst pursuing domestic non-action.

In sum, these three examples illustrate that even when there are pressing problems on politicians in power, these political problems can be solved without necessarily doing much to solve the societal problems from which this pressure arises.

The arguments and evidence discussed so far leads to some important points to consider when we want to better understand how processes of politics influence a transformation of the energy system. Political party organisations and individual members of parliament have power to influence which kind of issues that get on society's political agenda and politicians in or close to government have direct influence on decision-making processes. However, the number of issues that politicians will engage with is limited. Politicians tend to pay far less attention to issues on which they all agree, than to the issues where they disagree (Boasson 2015). CCS has been a much more politically contested issue than offshore wind in Norway and has therefore attracted more attention from politicians. On issues where politicians devote less effort, policies are more likely to be aligned with the interests of state and/or economic actors. Renewable energy is an example of an issue that due to a lack of political engagement was moved further downwards to be solved by civil servants and corporate actors (Boasson 2015).

5.1.4 The role of state actors

Power is shared between public and private actors in a relationship of mutual dependency (Rhodes 2006). It is not only business actors that have an interest in policy outcomes. State actors also have interests. Thus, we need to understand the role of the state as separate to non-state actors.

Scoones, Newell, and Leach (2015) suggest that to realign institutions, the state needs to play an important role. This role should go beyond facilitating innovation through a national innovation system that provides R&D incentives, patent regulations and so forth. Mazzucato (2015) argues that a green transformation requires a more active role of the state. She emphasises particularly the importance of a state that can take risks and provide long term funding. An important question, however, is whether states can and will pursue policy goals that challenge incumbent power.

The state is a distinct set of institutions that have the authority to govern society and includes institutions such as the government, the civil service, the judiciary, Parliament, and local government. Consequently, the state is not unified but can represent multiple and often conflicting interests (Smith 1993, p. 2). The role of the state is of a particular concern when we consider the many ways in which state actors are interwoven with economic actors. First, the state has economic interests in industry growth and state revenues. As pointed out in section 1.3.1, many of the large companies in the energy sector provide the state with substantial income. Second, state actors have interests in policy outcomes and rely on the support from business interests to influence decisions (Smith 1993, p. 225). Third, many of the most influential economic actors in the energy sector in Norway have close formal ties to the state. For instance, the Norwegian State has a 67 per cent ownership in Statoil administered by the Ministry of Petroleum and Energy and a 100 per cent ownership in Statkraft administered by the Ministry of Trade, Industry and Fisheries. The state also owns large shares of major companies in the energy sector such as Gassnova (state enterprise on CCS), Petoro (state holding company that holds about a third of Norway's oil and gas reserves), Statnett (state enterprise and transmission system operator), Kongsberg Group (publicly traded international technology group), and Aker (publicly traded industrial and financial investment company).

The close relations between state and business actors in the energy sector can be problematic. This holds particular true in circumstances where policy issues do not receive sufficient attention from politicians in power, and are consequently moved down to be handled by civil servants and corporate actors.

Scholars such as Mazzucato (2015) and Block (2011) argue that new renewable energy technologies require strong support and involvement by the state. The papers included in this thesis and the discussion in this section have shown that the development of a substantial offshore wind industry has required policies that break with principles of cost-effectiveness and technology neutrality. These are

principles endorsed by state actors such as the Ministry of Finance and the Ministry of Petroleum and Energy. Thus, important state actors have favoured policies that are not well aligned with a new and immature niche such as offshore wind. Moe (2015, p. 199) therefore points out that technology neutrality is not neutral as this policy principle favours existing technologies as it does not provide preferential treatments of less mature technologies (i.e. protected space). Thus, technology neutrality preserves the existing system rather than stimulate structural change. This emphasises the need for an active state that can tilt the playing field in favour of new renewable energy technologies.

It is hardly surprising that the most important state actors have not taken up such a role. Cost effectiveness and technology neutrality plays into the hands of the hydropower complex and the petroleum industries, and these principles have been defended both by the ministry of Finance and the Ministry of Petroleum and Energy (Moe 2015, p. 199). Introduction of policies that could empower (Smith & Raven 2012) a niche technology such as offshore wind has therefore been impeded by an institutional misalignment.

With institutional structures substantially biased towards incumbent industries, an active state requires the encouragement from politicians in power. Yet, political engagement can be diverted due to lack of clear incentives for politicians in power, limited capacity to sufficiently engage with many different issues, and the possibility to solve political problems with symbolic politics. There is also a misalignment between the temporal nature of politics and the nature of innovation processes. The nature of democratic politics is that politicians are often interested in the short-term consequences of their actions. The main reason for this is that elected officials generally seek to be re-elected and the decisions of voters are taken in the short run (Pierson 2000). The implications of political decisions, however, play out in the long run. This holds particularly true for the types of innovation processes discussed in this thesis. System transformation takes a long time, and therefore requires political support over long periods of time (Lockwood 2015).

Altogether, this underlines that the transformation of the energy system can be particularly slow and difficult in countries with influential incumbent industries and with vested interests in the fossil based energy system. It also seems clear that a transformation of the energy system requires purposeful action simultaneously from state actors, political actors, and business interests.

5.1.5 Structural change revisited

Structural change is in the multilevel perspective understood to occur when there is simultaneous pressure on the regime from exogenous change at the landscape level and developments at the niche level. Paper 1 illustrates that exogenous change does not in itself lead to large shifts in the regime. However, exogenous change can open up opportunities for change, which can then be exploited. In paper 2, I analyse two cases where exogenous change put pressure on the fossil fuel-based energy

regime that opened up windows of opportunity for advocates of CCS and offshore wind to exploit. In the case of CCS, the pressure on the incumbent regime was primarily driven by a strong articulation of climate change as a problem. The problem of climate change also contributed to a change in the selection environment for offshore wind. However, it was the combined pressure from reduced activity in the oil and gas industry and perceived international market opportunities that in the end created the opportunity for offshore wind. An important difference between the offshore wind and CCS cases is that whereas support for CCS could be seen to contribute to maintain regime stability, large support for offshore wind could be understood to in some way disrupt regime stability. These observations of multilevel interaction have two implications.

First, it demonstrates that it is easier to introduce policies that support new technology if it also maintains the position of the existing sociotechnical regime. Introducing policies that support new technology that might be seen to challenge existing institutions (i.e. preference for cost-efficiency or fossil energy system support) is more difficult.

The second point relates to the importance of exogenous change. Exogenous events often occur (from the perspective of regime and niche actors) as random and it can be difficult to plan for such events. Even though it is possible to create opportunities from technological breakthroughs or through change driven by "institutional entrepreneurs" (Kukk, Moors, & Hekkert 2016), the cases presented in this thesis show that windows of opportunity open up because of changes at the landscape level. What does this mean for the possibility of a transition? In a discussion about innovation policies, Fagerberg (2016, p. 21) raises the question of whether an effective innovation policy requires a crisis to get sufficient momentum. The question seems just as relevant to pose in the context of an energy transition. Does it mean that a transition cannot be envisaged just through the interaction between regime and niche actors? The paper on the rise and fall of offshore wind shows how important exogenous events can be for the possibility for significant policy change, and thus illustrates the difficulties in steering a transition.

In this section I have raised two issues that need some further treatment. First, I have pointed out that public support for new technology is more likely to occur when this also maintains the positions of the established actors. This underlines the importance of incumbent actors in an energy transition and I will in the next section discuss this further. Second, a consequence of an apparent reliance by niche actors on exogenous change is that advocates of new technologies need to be capable of exploiting opportunities when they open up. The section on incumbents will therefore be followed by a discussion about how new solutions can develop within the constraints discussed so far in this thesis.

5.2 Incumbent industries in the energy transition

In the introduction to this thesis, I argued that to transform the energy regime, the incumbent fossil fuel industry needs to be either dismantled or reoriented. Further, given the economic role this industry holds in the global economy, and in the national economy of many countries (including Norway), regime change through a reorientation rather than a dismantling of existing industries is preferable. In the following, I will discuss the possibilities for reorientation. First, I will present evidence from this thesis that point towards incumbent industries as enabling the development of new industries. I will subsequently present evidence that point in the opposition direction before I discuss the dual role of incumbent industries in both enabling and impeding the emergence of new niche technologies.

5.2.1 Incumbent industries as an enabler and resource provider

One of the findings presented in paper 3 is that more than one-third of all firms in our survey primarily operate in the petro-maritime industries and as such can be seen as diversified firms. Many of these diversified firms are maritime companies, and as such may not be seen as representatives from an incumbent regime from the perspective of a nascent offshore wind industry. Yet, the maritime industry is closely linked to the offshore oil and gas industry in Norway and thus the established energy regime. These findings therefore corroborate previous assertions that activity in offshore wind in Norway has been enabled by resources available from within the energy regime represented by the oil and gas sector (e.g. Hansen & Steen 2011; Volden et al. 2009).

In paper 1, I have shown that it was particularly the decline in offshore oil and gas activities in 2008 and 2009 that led to a discussion about how Norway could transfer competences and resources from this industry to other industries, such as offshore wind. Further, the paper shows that the decline in petroleum activity coincided with an increase in the attention from politicians towards offshore wind, and an increase in private investments in offshore wind, mostly by firms operating in the petro-maritime industries and the hydropower sector. Thus, the findings exhibit both changes in selection pressures *and* a response from resources organised inside and outside the regime, which Smith et al. (2005) consider to be necessary ingredients for a regime change. As discussed in section 2.2.1, a response from resources entails both availability of resources and a coordination of the deployment of these resources. All three papers provide evidence that point to the availability of resources. Most notably, we can observe from paper 3 that a clear majority of the offshore wind firms base their activities in this industry on experience from the oil and gas industry. This supports the idea that resources from incumbent industries can enable activities in niche technologies. In addition, papers 1 and 2 show that resources mobilised from within the regime was also coupled with resources mobilised from outside the regime, most notably through the establishment of large research centres on offshore wind. Resources made available from incumbent industries include technical knowledge and research facilities, access to qualified personnel, and access to formal and informal networks. Thus,

incumbent industries can be seen to have strengthened many of the functions that are considered important (Bergek et al. 2008a; Hekkert et al. 2007) for the growth of a technological innovation system for offshore wind. However, in particular paper 2 concludes that the coordination of these resources where weak. Moreover, a lack of financial resources necessary to test and verify technology has represented a barrier for many firms. An area for a more active state could therefore be to take risks that private firms and banks are unwilling to take through the provision capital that supports longer term investments (Mazzucato 2015).

Considering incumbent actors as a potential enabler of a transition is in line with Geels et al. (2016) who argue that incumbent actors can reorient themselves towards alternative solutions (p. 898). Both paper 1 and paper 2 recognise that large firms from the hydropower and the petroleum sectors (both representing the incumbent energy regime) have provided financial resources and competences to the offshore wind industry. Moreover, the engagement by these actors have strengthened legitimacy for offshore wind and in general lifted the niche up on the public and political agenda. Moreover, I argue in paper 3 that large firms from incumbent industries can (and must) also play a role as intermediaries facilitating access for smaller firms to various types of resources and markets. Thus, the reorientation of large incumbent firms seems to be an important element of a successful energy transition, particularly considering the need to dismantle the existing fossil energy regime that I have discussed elsewhere in this thesis. Geels et al. (2016, p. 899) suggest that the speed and degree of reorientation of incumbent firms depends on perceived market opportunities and the strength of the socio-political pressure. Despite examples of political entrepreneurship, the misalignment between state and business interests (in offshore wind) combined with insufficient political engagement has led to a weak socio-political pressure. Hence, the reorientation of firms that I observe in papers 1 and 2 has been driven mostly by perceived market opportunities and less so from socio-political pressure.

One of the conclusions in paper 2 is that the offshore wind network needed the participation of large industrial firms to build the momentum needed to influence policy change. The lack of participation by large incumbent firms in these networks may in part be explained by a lack of sufficient socio-political pressure. However, it should be noted that papers 2 and 3 show that this lack of participation in networks was probably not so much due to lack of reorientation, but rather that the larger incumbent firms reoriented towards international markets instead of domestic markets. These findings underline the importance of international dimensions of transitions. Nonetheless, the observed reliance on perceived market opportunities for reorientation of incumbent industries (in Norway) might be problematic. The oil and gas industry is cyclical and paper 1 in particular shows how vulnerable niche industries can be without the simultaneous presence of both market opportunities and sustained socio-political pressure.

5.2.2 Incumbent industries as an obstruction

I have in section 2 discussed how incumbent regime actors can block the development of niche technologies, for instance through superior lobby resources, strong relations with decision makers, existing subsidy programs, favourable infrastructure etc. Findings in this thesis do not contradict any of these assumptions about niche-regime interaction. However, I also observe that incumbent industries might obstruct new renewable energy technologies in Norway through what can be referred to as a 'crowding out effect'.

In both papers 1 and 2, I suggest that because the government had dealt with major conflicts related to the certificates scheme and natural gas with CCS, there was little room left for supporters of offshore wind in or close to the government to fight for this issue. The introduction of a certificate scheme was based on a least-cost principle that (although the scheme was still not favoured by the Ministry of Finance or the Prime Minister) was more in line with the existing institutional regime than technology specific policies which would have favoured technologies such as offshore wind. Similarly, the support for CCS was an outcome of the energy regime responding to selection pressure without altering the general trajectory of the regime (i.e. still relying primarily on hydrocarbons). Paper 2 argues that the motivation for investing public funding towards CCS was in part to secure the future value of natural gas as an export product for Norway.

Possible crowding out of new renewables by CCS raises important questions about the role of CCS in a transition of the energy system. There are widely different perspectives on the role of CCS that have divided the environmental movement in Norway (Meadowcroft & Langhelle 2009b). A *positive perspective* on CCS is that it is a necessary part of a transition because fossil energy will be continued to be extracted. This perspective has been advocated by environmental organisations such as Bellona and Zero as well as supporters of continued long-term investments in the oil & gas industry in Norway. A second and more *apprehensive perspective* is that although CCS is a necessary part of the solution, investments must not come at the expense of new renewables. Finally, a *negative perspective* is that CCS is an end-of-pipe solution allowing business as usual and that CCS draws funds away from new renewables. This third perspective is in line with the transformation pathway discussed in section 2.2.1 in that investments in CCS postpone regime change. This perspective has been advocated by organisations such as Greenpeace and Friends of the Earth. It is implicit in these two latter perspectives that there is a competition between different low-carbon technologies. However, there has been little empirical research on possible competition between these different solutions because each technology tends to be analysed as different and independent streams (Meadowcroft & Langhelle 2009b). Future empirical research should therefore aim to better capture the effects of investments in multiple low-carbon technologies.

There is no evidence in this thesis that directly links public investments in incumbent industries with a lack of investments in new renewable energy technologies in Norway. However, principles of cost-effectiveness and technology neutrality have played into the hands of the hydropower and petroleum industries. These principles have also been pillars of the Norwegian new renewable energy regime and have represented an institutional structure biased against industries such as offshore wind (Moe 2015). This is therefore, in the case of new and less mature technologies, an example of institutional misalignment that has been maintained through the interests of incumbent industries.

5.2.3 Duplex role of incumbent industries

As pointed out in section 5.2.1, reduced activity in the offshore petroleum industry opened a window of opportunity as a number of incumbent actors reoriented towards offshore wind. However, as all three papers in thesis show, when activity picked up again in the petroleum industry in 2010 and 2011, the interest in offshore wind decreased significantly among politicians, interest organisations, and in the petro-maritime industries. We therefore argue in paper 3 that there is a duality to the relationship between offshore wind and the petroleum industry. In this paper, we see that the petroleum industry provides opportunities that can be exploited in the development of a Norwegian offshore wind industry. However, we also see that reliance on resources from the oil and gas industry has resulted in competition over these resources. Moreover, the fact that most firms see offshore wind as a secondary activity might hamper the possibility of building sufficient critical mass necessary for developing a successful offshore wind supply industry. This relationship between oil and gas and offshore wind is also evident in paper 1, which shows how activity levels in oil and gas influenced the interest of firms (and other actors) to invest in offshore wind.

Figure 3 below shows the annual number of Norwegian firms (numbers captured in an industry-wide survey) starting up activities in offshore wind (both new and diversifying firms) and the price of oil in the period from 2000 to 2014. One interpretation of this figure is that activity in the offshore wind industry is positively correlated with a high oil price. However, considering the motivation for firms to diversify from oil and gas to offshore wind as described in the papers in thesis, another interpretation is that the sharp decline in the price of oil was followed by a surge in offshore wind activity. Further, as the oil price recovered the annual number of firms starting up new activity in offshore wind eventually decreased. Many of the interviews for this thesis support such an interpretation. This illustrates the vulnerability of relying on the close relations between the oil and gas industry and offshore wind when there is a perceived lack of sufficient policy instruments as documented in all three papers in this thesis. Moreover, it suggests that policy-makers should pay attention to how policies that stimulate continued activity in an otherwise declining oil and gas industry will also have consequences for the willingness to invest in alternatives such as new renewable energy.

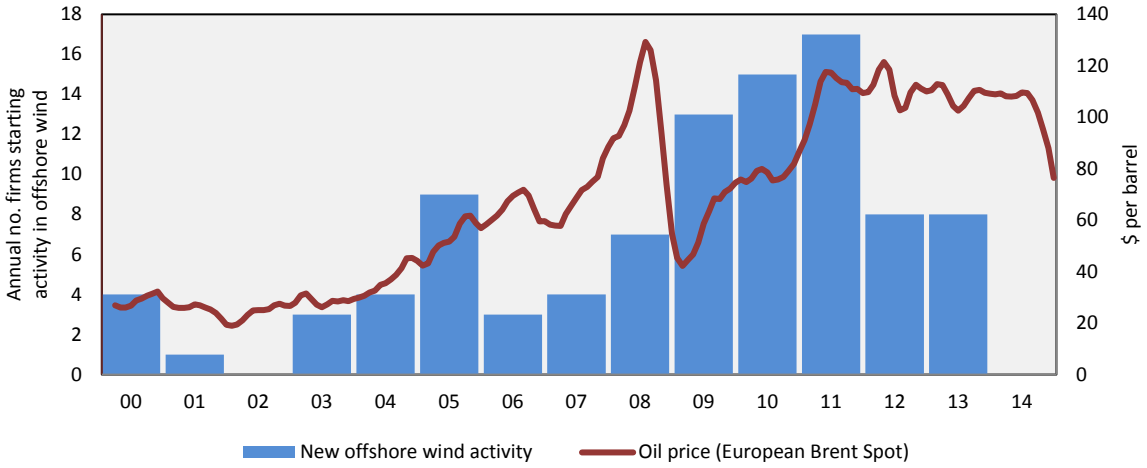

Figure 3 Number of firms starting up new activity in offshore wind and price of North Sea oil (2000-2014).
Source: Normann and Hanson (2015), U.S. Energy Information Administration 2015 (www.eia.gov, accessed February 19, 2016).

5.3 How can alternative solutions emerge within the constraints of established industries?

Papers 1 and 2 describe in different ways the development of a Norwegian supply industry for offshore wind. Both papers show that there has been great potential for growth in this industry based on existing resources and capabilities, mostly linked to activities in the petro-maritime industries. Building on this potential, substantial public funding has been channelled towards offshore wind R&D activities. This funding has strengthened the already strong knowledge-base for offshore and maritime activities. However, a systems perspective on innovation suggests that innovation relies on a number of other processes in addition to knowledge development. Technology and competences need to be put into use through market participation, financial resources need to be mobilised, and networks need to be strengthened. Public policy can play an important role in giving nutrition to these processes (Keller & Block 2012).

In paper 1, I point to what many of the interviewees refer to as the offshore wind 'valley of death' with reference to the lack of niche protection between the phases of product development and commercialisation. Further, the paper suggests that a lack of policies for local market formation can be seen (at least in part) as a consequence of reduced attention towards offshore wind following changing activity levels in the oil and gas industry. Paper 2 also discusses weak local market formation, but in the analysis I relate this to poorly organised networks and a lack of large, strategic actors in the network. Paper 3 builds on these findings and finds that despite large markets for offshore wind in the UK and Germany, the lack of a domestic market is seen as a barrier for potential suppliers to these markets. The paper therefore suggests that policies need to (in addition to incentivise R&D) stimulate market formation and/or strengthen intermediary actors (that can bridge access to international markets).

In conclusion, I find that there has likely been a lack of what Mazzucato et al. (2015) refer to as a coherent and proportional level of funding over the entire innovation trajectory. The next section discusses whether this lack of coherency can be attributed to a fragmented innovation policy system in Norway.

5.3.1 Policy fragmentation as a barrier

Norway has a large number of ministries combined with an emphasis on sectoral governance principles (Spilling 2010). Fagerberg (2016) argues that a consequence of this is that Norwegian innovation policy today appears fragmented and poorly coordinated (p. 15). Sectorisation and fragmentation can prevent transformative change because representatives of certain interests in the public administration might favour sectoral interests at the expense of the overall societal interests (Kjellberg & Reitan 1995). Policy areas that transcend several ministries can be particularly difficult to govern (Tranøy & Østerud 2001). The energy transition takes place in such an area.

Energy policies are handled by the Ministry of Petroleum and Energy, climate policies by the Ministry of Climate and Environment, and industry development by the Ministry of Trade, Industry and Fisheries. In addition, all major issues treated by the government must be approved by the Ministry of Finance which means that the Ministry of Finance might make professional judgements on issues that fall under the responsibility of other ministries (Skjeie 2001). Advocates of new renewable energy technologies often have to relate to, and more importantly gain the support from, all of these ministries and associated agencies.

On the supply side, the multiplicity in ministerial involvement is managed by the Norwegian Research Council, which supported by funding from several ministries has funded substantial research on new renewable energy technologies. Demand side policies and regulations have primarily been managed by agencies or directorates subject to the Ministry of Petroleum and Energy. It is particularly demand side policies that offshore wind actors have sought to influence.

I point out in paper 2 that actors need to be able to offer something in return for access to the policy process. The case of CCS is an example of a technology that could offer a solution to a pressing political problem. Offshore wind, however, has been positioned at various points in time as a solution to climate change, electricity deficits and potential unemployment in the offshore industry. It has been unclear whether offshore wind should be part of energy policy, climate policy or industrial policy. The Minister of Petroleum and Energy had little to gain from investing political capital and resources in offshore wind due to the availability of more cost-efficient methods for stimulating more production capacity. Paper 1 shows that the strategy with the greatest potential was to attach offshore wind as a solution to industry development and job creation. However, offshore wind fell outside the domain of

the Ministry of Trade and Industry, which led to a lack of interest from the political leadership of the ministry.

The Norwegian national strategy for research, development, demonstration and commercialisation of new energy technology (Energi21) has pointed out that the motivation for large investments in offshore wind R&D is the export potential of Norwegian industry. The argument we make in paper 3 is that a small niche market might be necessary to realise this export potential. Yet, several of the interviewees pointed out that the proposed demonstration projects for offshore wind in Norway have been considered to be a part of energy policy and to a lesser extent within the mandate of the Ministry of Trade, Industry and Fisheries. The problem then is that the Ministry of Petroleum and Energy has prioritised energy supply above the development of an export industry. It has therefore been difficult to position offshore wind as a solution for the relevant state and political actors.

After the Former Minister of Petroleum and Energy (2007-2008), Åslaug Haga, left the political arena, she asserted that the ministries operate too much in siloes, with the implication being that politicians spend too much resources defending the particular interests of each ministry (Haga 2012, p. 298). The question then is whether this system encourages investments in industries and initiatives that fall between these different policy domains. Norwegian innovation policy has been criticized by the OECD for lacking coordination at the aggregated level (Fagerberg 2009). However, a transition which ultimately must involve a reorientation of incumbent industries arguably requires a coordinated effort that manages to see industry, energy and climate goals in conjunction.

6 Conclusions

In this thesis I have set out to better understand how we can integrate politics in the analysis of sustainability transitions. Actors and groups have different interests and opportunities to participate in the policy process. These differences are not only contingent on the types of actors, their available resources and access to networks, but also on the wider context. An analysis of politics in sustainability transitions should distinguish between how actors engage with the policy process, and to what extent economic, state and political actors are able to influence policies related to the energy system in a particular empirical setting.

I have in this thesis responded to calls to include perspectives from political science in studies of transitions. In this regard, I have drawn upon a variety of resources, but in the analysis I have most explicitly used the agenda-setting model (Kingdon 1984/2011) and the policy network approach (e.g. Marsh & Smith 2000; Smith 1993). The empirical application of these frameworks has been on the development of immature clean energy technologies in Norway with particular focus on offshore wind and to a lesser extent carbon capture and storage. I will in the following point to implications for the conceptual understanding of transitions, followed by some reflections on the most important empirical findings in the thesis.

Coupling solutions to problems

An assumption in the transitions literature is that the possibilities for niches to influence the regime can increase during so-called windows of opportunity. I have shown that whether such opportunities are exploited depends on the relation between timing and the capability to attach solutions to articulated problems. Solutions such as offshore wind need to be matched to the right problems at the right time. There are many factors that will influence the extent to which certain solutions are appropriately matched with problems, and I will here point to three factors that have been particularly visible in the study of offshore wind in Norway.

First, the structure of policy networks is influenced by, and influences, actors' ability to attach solutions to appropriate problems. In this thesis I have observed that relations between political parties (and individual politicians) and business interests can shape the policy preferences of the former. The strengths of these relations are conditioned in part on the degree of resource dependency between actors. This has implications for studies of sustainability transitions in that it underlines the importance of capturing these relations and the interests of a broad set of actors including industry, civil servants and politicians in the analysis. Moreover, by adopting a perspective on politics as shaped through negotiations between different interests, we should also recognise the importance of bargaining in the formation of policies. This is in line with a recent critique of how policy-making is sometimes interpreted as a result of theoretical rationales (Flanagan & Uyarra 2016).

Second, how the interests of state actors, politicians and political parties, and business interests are aligned should be included in the analysis of sustainability transitions. Section 5.1.3 discusses how alignment or misalignment of interests not only influences the differing potential for economic actors to participate in the policy process, but it also influences the ability of different types of actors to steer these processes. The potential for economic interests to influence policy is likely to increase when these interests are aligned with the interests of the relevant state actors. The analysis of the conditions for a sustainability transition needs to take this into account. A related and important point is that politicians' engagement tends to be directed towards issues that can help solve political problems. In a recent contribution to the development of the TIS framework, Bergek et al. (2015) has called for a better integration of the political context in the analysis of technologies required for a transformation of the energy system. One suggestion based on the arguments presented in this thesis is to assess to what extent the technology in focus is positioned as a problem solving technology for decision makers. A measure of this could for instance help to better assess the functionality of legitimacy and may help to explain the political feasibility of certain policies.

The importance of alignment or misalignment of interests between state actors, politicians, and business actors relates to the implications of fragmentation in policy-making. Section 5.3.1 points out that because a transition needs to include the development of new technology *and* the reorientation of established industries, there is a need to see industry, energy and climate goals in conjunction. With this in mind, a fragmentation of Norwegian policy-making represents a barrier for new renewables. To influence policy, actors need to position niche technologies so that they can solve salient problems for decision makers. However, the energy system connects with several different policy domains and niche technologies can potentially solve very different problems for different decision makers. An apparent lack of coordination between ministries and policy domains can therefore represent a particular difficult challenge for advocates of niche technologies in the energy system.

A third factor that influences the potential to couple solutions to appropriate problems is what we can refer to as exogenous events. Events beyond the influence of regime and niche actors have had a significant influence on the selection environment for different energy technologies. These events include the effects of the financial crisis and a stronger articulation of climate change as a serious problem. However, we could also include more local events in the political sphere. Åslaug Haga, perhaps the strongest political advocate of offshore wind, was forced to step down after only 9 months as The Minister of Petroleum and Energy following a media story that revealed a failure to apply for the necessary approval for a building construction on her private property (Dagbladet 2008). Such media driven scandals might seem trivial in the bigger picture of an energy transition. Yet, in his recent book about democracy in crisis, David Runciman argues that superficial conflicts and scandals draw political energy from a more substantial treatment of political structures. In this sense, the

attention and effects of such political scandals exemplifies the absence of perspective that characterises democratic politics (2015, pp. 173-4).

The broader story here is that due to the impact of exogenous events and arbitrary political events the policy process can be characterised by a degree of randomness and irrational behaviour. Policy entrepreneurs that might have had an influence on renewable energy policies are replaced due to scandals that have little to do with renewable energy issues, policies can be introduced without politicians in power having really understood the implications, and politicians sometimes address socio-political problems by solving the political part without necessary solving the societal part of the problem (see 5.1.3 on symbolic politics). It does not seem obvious under which circumstances politicians engage with only solving the political problem and under which circumstances they also engage in solving the underlying societal problem. This seems to be an important area to better understand if we are to include the role of politicians and political parties in the analysis of sustainability transitions.

Summing up, exogenous change that political or economic actors have little or no influence over can impact on the likelihood of the introduction of different kinds of policies. Moreover, democratic political processes can be characterised by short-term, irrational, and spontaneous policies (Runciman 2015, p. 329). Finally, technology development and innovation is of course associated with a high degree of uncertainty concerning the feasibility and efficiency of specific solutions (Mowery, Nelson, & Martin 2010). This underlines the difficulty in steering the development of certain technologies, and even more so, steering an energy transition.

Possibilities to link up with international systems

One consequence of the difficulty in steering a transformation of the energy system is that the offshore wind supply industry in Norway has been hampered by a lack of support through public policies. The issue most often referred to has been the lack of a domestic market. However, there is a rationale for supporting this industry through other policy instruments without the need to invest in domestic offshore wind power production due to the international markets available in the North Sea. This rationale has been articulated by leading politicians and in the Energi21 strategy. There is also some support for this rationale in recent contributions to the literature on international technological innovation systems (see section 2.3.1 and paper 3). I find that the strength of this rationale in the context of developing a Norwegian offshore wind supply industry in Norway depends on a couple of factors.

First, *incumbent industries can play a dual role in influencing the emergence of new renewables*. The development of offshore wind builds substantially on a broad set of resources from the petro-maritime industries (and to some extent the traditional hydropower industry). At the same time, the dominant

role of incumbents and their influence on the trajectory of the socio-technical energy regime have guided the attention of firms, politicians and public administration, interest organisations (and possibly public investments) towards the fossil-based regime at the expense of investments in new renewables. Moreover, I have found that although competences and resources from the petro-maritime industries can be transferred to offshore wind, a heavy reliance on this link between the old and the new makes the continued development of the offshore wind niche vulnerable to changes in conditions affecting the regime such as the price of oil. The conditions for the incumbent industries are not only affected by the price of oil. The state actively supports the petroleum industry by providing financial incentives to explore and by facilitating the development of new areas to explore. It is important to recognize that this industrial policy also affects the conditions for private investments in new renewable energy technologies, and thus the longer term transition of the energy sector. Transition policies should thus aim to both stimulate new and destabilise old technologies (Kivimaa & Kern 2016).

Second, *participation of large firms is important for niche development*. The reorientation of large firms in the oil and gas industry can be an important, and possibly necessary, element of the broader transformation of the energy regime. Several large Norwegian incumbents from both the petroleum and hydropower sectors have participated in the international market for offshore wind. This participation has contributed positively to the development of legitimacy for offshore wind and has to some extent facilitated participation in international markets for smaller suppliers. However, this niche participation is still minor compared to the main activities of these firms in the existing regime. I suggest that large incumbents should be incentivised to (1) play a role as intermediaries facilitating access for smaller firms to various types of resources and markets and (2) increase their dedication to niche activities to mitigate the risk associated with the vulnerability pointed to above.

There is in Norway substantial potential to develop new industry as part of the ongoing transformation of the energy system, and the established industries that are part of the fossil-based regime can play an important part in this transformation. At the same time, the institutional and industry structures provide weak incentives for public investments in new renewable energy technologies in Norway. The papers in this thesis suggest that it has been easier to introduce policies that do not challenge the institutions and regime interests, resulting in substantial R&D efforts with less emphasis on broader social and institutional change. As Kern (2010) points out, technology as a solution to climate change has become commonplace in the literature on climate mitigation policy as well as in policy documents (p. 6). This approach was recently exemplified with the launch of *Mission Innovation* in conjunction with the United Climate Change Conference 2015 (COP21) in Paris. The programme, which is backed by 20 leading countries, aims to accelerate clean energy innovation through increased public research and development investments. As important as this is for improving the readiness of new technologies, investments in research and development should not draw attention from the need for state and

political actors to actively tilt the playing field in favour of clean energy technologies by also challenging incumbent industries.

I have in this thesis studied politics in transitions at the national level. A second lesson to be drawn from Paris is that the agreement represents a shift from global collective action towards individual nations' contributions to solve the accelerating climate crisis upon us (i.e. each of the 187 countries put forward plans for how to cut and curb emissions until 2030). I believe this shift justifies a continued emphasis in the sustainability transitions literature on national strategies towards solving problems and how these link up at an international and global level. In this thesis, I have suggested that the analysis of national strategies should include how political, economic and state actors together condition the introduction and maintenance of policy for sustainability transitions. An interesting opportunity for future studies could be to systematically analyse how these conditions vary across sectors, space and time.

Interviewees

The following 42 persons were interviewed for this PhD project. Most interviews were conducted in person, but 10 interviews were done via telephone. Most interviews were done with one person at a time, but six interviewees were interviewed in pairs.

Aamodt, Arne, Former CEO, Lyse Produksjon AS, phone, 20 March 2014.

Alfstad, Haakon, Senior Vice President onshore vind power, Statkraft, Lysaker, 4 November 2014.

Breistein, Dag, Former Head of contracts, Vestavind Offshore, Bergen, 8 March 2013.

Byklum, Eirik, Technology Manager Floating Wind, Statoil, Fornebu, 21 December 2015.

Bysveen, Steinar, Executive Vice President Corporate Development, Statkraft. Former Director, Energy Norway, Lysaker, 14 May 2013.

Dale, Jørgen, Business developer, Scatec, Oslo, 2 April 2013.

Dirdal, Harald, Owner, Havgul, Oslo, 15 August 2013.

Dugstad, Jon, Director, Intpow. Oslo, 21 Oktober 2014.

Ellingsen, Anne Grete, Former CEO, Vestavind Offshore, Kristiansand, 3 April 2013.

Enge, Andreas K, Head of strategy and business development, Enova, Trondheim, 30 April 2013.

Engevik, Tore, Director of wind, Aibel. Former CEO, Vestavind Offshore, phone, 14 February 2014.

Flataker, Ove, Former Head of Climate, Industry and Technology Department, Ministry of Petroleum and Energy, Oslo, 6 June 2013.

Fossli, Grethe, Director, Department of Industrial Policy, The Norwegian Confederation of Trade Unions (LO), Oslo, 12 June 2014.

Frøysa, Kristin Guldbrandsen, Director, NORCOWE, Oslo, 6 March 2013.

Gotaas, Sverre, CTO, Kongsberg Group. Former SVP Statkraft, Lysaker, 12 June 2014.

Haga, Steinar, Business development, Automasjon & Data, phone, 23 November 2015.

Halvorsen, Kristin, Former leader of Socialist Left Party (1997-2012), Minister of Finance (2005-2009), Oslo, 18 March 2014.

Henriksen, Per Rune, Former State Secretary, Ministry of Petroleum and Energy (2010-2013), Oslo, 20 June 2014.

Hesstvedt, Karl, Project leader and partner, Havgul, Oslo, 18 September 2015.

Hjørnegård, Sigrid, Director renewable energy, climate and environment, Energy Norway. Former political advisor and State Secretary, Ministry of Petroleum and Energy (2008-2011), Oslo, 4 June 2014.

Holm, Kristian, Former Scanwind and GE (2004-2012), Trondheim, 3 November 2014.

Holmås, Heikki, Socialist Left Party MP, Oslo, 25 April 2014.

Isachsen, Øyvind, CEO, NORWEA, Oslo, 4 March 2013.

Karal, Petter, CEO, Seatower, Oslo, 17 December 2015.

Kaski, Kari Elisabeth, Deputy Director, Zero, Oslo, 27 November 2013.

Kvassheim, Gunnar, Former Liberal Party MP, phone, 25 March 2014.

Larsen, Trine Lie, Communication Advisor, JKL, Oslo, 14 August 2013.

Lie, Olav, Advisor, Department of Industrial Policy, The Norwegian Confederation of Trade Unions (LO), Oslo, 12 June 2014.

Lygre, Asle, Director, Arena NOW, Bergen, 8 March 2013.

Matland, Erling, EVP Renewables, Aibel, phone, 25 January 2016.

Nordtun, Tore, Former Labour MP, phone, 20 March 2014.

Pilskog, Roger, District Secretary, LO Hordaland, phone, 18 March 2014.

Riis-Johansen, Terje, Former Minister of Petroleum and Energy (2008-2011), phone, 3 June 2013.

Rye-Florentz, Carl Gustaf, Advisor, NORWEA, Oslo, 4 March 2013.

Sandberg, Johan, Head of renewable energy, DNV GL, Oslo, 17 June 2013.

Schlaupitz, Holger, Head of department for nature and climate, Friends of the Earth Norway, Oslo, 10 June 2014.

Sjumarken, Terje, Managing Director, Fjellstrand, phone, 18 November 2015.

Slengesol, Ivar EVP Director of Lending – Industry and renewable energy, Export Credit Norway, Oslo, 28 October 2015.

Strømmen Lycke, Anne, Former Vice President Wind Power, Statoil, Former Director, Gassnova, Oslo, 29 April 2013.

Sørensen, Heidi, Former State Secretary, Ministry of the Environment (2007-2012), Oslo, 18 March 2014.

Tande, John Olav, Director, NOWITECH, phone, 9 August 2013.

Østmo, Trygve, Executive Director, The Federation of Norwegian Industries, Oslo, 13 May 2013.

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