Floating Production Networks: A case study of a new offshore wind technology in two oil & gas economies

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Abstract

This paper employs global product ion network (GPN) approach to analyze the development of the renewable energy market. Through a case study of the development of floating offshore wind technology across two oil and gas economies, the paper sheds light on the key drivers and role of core actors in the creation of renewable energy markets. In the process, we make a novel methodological contribution in the investigation of the development of GPNs by investigating the process from inside-out (following firm reaching outside its home territory) and outside-in (from a host country) perspectives.

Our analysis reveals that, the role of lead-firms and states is vital in the development of renewable energy market. Configuration of extractive production networks depends on actor strategies and involves intense bargaining processes. Capabilities of local suppliers shape the sourcing strategies of renewable energy firms. Network linkages are mediated through the materiality of natural resources, not only in terms of the formation of such linkages, but also through the reuse of existing networks. We find that materiality fosters spatial flexibility of networks, and can influence the bargaining processes between firms and states over better terms and conditions for value creation and capture, with potentially far-reaching development implications.

Introduction

The GPN approach analyzes the horizontal and vertical networks that interconnect firms and extra-firm actors and assess how these relationships shape the organization of industries, and the regional development outcomes (Coe, Dicken, and Hess 2008). It highlights how a variety of important forces influence these networks of firms and extra-firm actors involved in the production of goods or service, and the distribution of power within these networks (Bridge, 2008). Value creation and capture in extractive industries are shaped by the materiality of natural resources in combination with intense power struggles and extensive bargaining process between the production network actors (Dicken 2015). Because of the territorial embeddedness of natural resources, the role of states is central in the extractive industries. What is underdeveloped in current GPN literature is: the role of states and other non-statutory actors and the mechanisms through which they foster and develop extractive markets,; 'lead firms'' value capture trajectories through technological upgrading and innovations; and the implications of this process for new market development. Renewable energy (extractive) markets in particular are typically constructed through state-specific support regimes. They are characterized by a consolidated, relational production network (Gereffi, Humphrey and Sturgeon 2005), which reflects a constrained market and state regulation (MacKinnon and Dawley 2016).

The aim of this paper is to contribute to the literature on extractive GPNs by analyzing the key drivers and role of core actors in the development of renewable energy market. We do this through an analysis of the emergence of renewable productions networks, focusing on offshore wind. We assess the business and sourcing strategies of a lead firm, the development strategies of the host state and the physical and institutional conditions that frame the process and the territorial configuration of the resulting production network. In so doing, we extend the research in extractive GPN to the renewable energy sector. In the process, we make a novel methodological contribution, which entails applying a multidimensional perspectives; *inside-out*, following firms from a particular territory when reaching out to establish relationships with global production network actors based outside their home territory and *outside-in*, through taking host country perspective, in investigating its integration into GPNs.

Empirically, this paper explores the development of a floating wind power (FWP) market, through a case study of an offshore wind production network during the development and commercialization of floating wind power (FWP) project in two oil and gas economies, namely, Norway and Scotland. Hywind is a first-of-its-kind floating offshore wind developed by the Norwegian energy company, Statoil and installed in Scotland in 2017. Scotland possesses good wind resources and deep waters with proximity to the UK electricity grid, making it suitable for the deployment of floating wind technology. Relying on the GPN approach, the paper shows how the firm and extra-firm actors shape their assets to develop the FWP market. It sheds light on the drivers behind the development of the offshore wind sector and the mechanisms through which the floating production networks are established and maintained. It further highlights how these network configurations are influenced, by politico-economic dynamics, and the materiality of FWP, as well as the potential of this sector's development.

The reminder of the paper is organized into six sections. The next section focuses on the theoretical background of the paper with a special focus on GPNs in the extractive/natural resources sector. Then follow a brief presentation of the methodology. The empirical analyses includes three sections covering, Hywind as a case or floating production networks, market development mechanisms and network development practices. The paper concludes with a discussion on the theoretical implications and suggestion for further research.

GPN and the extractive industries

Rising to prominence in economic geography in the early 2000s, the GNP approach offers a "broad relational framework" for understanding contemporary forms of industrial organization and governance, and their relationship to local or regional development processes (Coe et al. 2008, 272). A production network is the nexus of globally interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed (Coe et al. 2008). A GPN is one whose interconnected nodes and links extend spatially across national boundaries. The architecture of the GPN framework is raised on three principal pillars that are multi-scalar, and multi-actor and interrelated political economic processes: value, power, and embeddedness (Henderson, Dicken, Hess, Coe and Yeung 2002; Coe et al. 2008). Core actors in GPNs i.e., both lead multinational companies (lead-firms) and states are constantly trying to create value, ceaselessly circulating power and partake in the process of embeddedness by solidifying social and spatial arrangements to accrue maximum benefits. Power, relating to corporate, collective, and institutional control over production systems, is multi-scalar, and is derived from local and non-local structural conditions i.e., markets, political institutions, and is mobilized by firms and extra-firm actors who participate in GPNs (Henderson et al. 2002). Embeddedness on the other hand shows how lead firms economic activity becomes interwoven within networks of social relations and concentrated in certain locations (Amin and Thrift 1995). The GPN approach is helpful in gaining a better understanding of the cultural, political, and institutional dimensions of networked economic and non-economic actors operations (Hess and Yeung, 2006).

Compared to the manufacturing and service sectors there are few studies on resource-based extractive industries in GPN research (Bridge 2008; Bridge and Bradshaw 2017). The basis of the extractive industries is the notion of the *natural resource*: materials created or produced in nature that can provide the basis for the extraction and sale of a particular commodity (for example oil or the use of wind power to generate electricity). Bridge (2008), characterizes production networks in the extractive sector through two basic tensions: first, the tension between resource-holding states and resource-seeking firms (lead-firms) (this tension is in focus of this paper); and second, between producers and consumers regarding the distribution of value. Bridge (2008), further outlined three characteristics of the landed nature of the extractive production networks, which are: the nature-based character of extractive enterprises; the influence that materiality of resources has on the organization of production; and the *territoriality* of resource embeddedness in the territorial structures of the nation-state.

In the analysis of the extractive GPN, accounting for these characteristics is helpful in capturing how social relations are mediated through the “natural” environment and the developmental outcomes of these social relations. *Materiality* in particular illuminates the functioning of the 'econo-natural networks' through which nature is transformed into resources, commodities and conditions of production; the mutual production, transformation and regulation of biophysical and socio-economic processes; and the productive and generative capacities of the non-human (Bakker and Bridge 2006). Bakker and Bridge argue that “Matter matters” because things other than humans make a difference in the way social relations unfold. They assert that it is through the socioeconomic production of nature that the geographically uneven character of capitalist development takes shape. In the extractive GPNs, accounting for materiality emphasizes how production networks are organized around moments of natural (material) production and transformation, where the biophysical qualities of materials shape strategies for value capture (Bridge and Bradshaw 2017). The material qualities alongside other factors such as ownership, access and control over resources, very much affect the way value is created and captured (Bridge 2008).

Through his analysis of Oil GPN, Bridge finds that the locationally specific nature of resources often limits the spatial flexibility of the social networks. We will, however, argue that this can be relative and we need to see how materiality can also play an enabling role for the spatial flexibility of social networks, meaning that the extractive production networks can also become stretched over space, paralleling the manufacturing networks with which they often overlap as well.

The GPN approaches distinctively geographic mode of analysis, which is highly relevant to the extractive sectors, has been advanced through a special attention in network development practices (Murphy 2012). *Network development practices*, illuminate how network linkages are established, sustained, and reorganized over time and space by the power struggles and networking strategies of economic actors located in different territorialities. Network development reflects actors' common interest, familiar practices and routines, shared identities, as well as the mutual recognition of each other's positionality in a relationship (Murphy 2012).

Murphy, identifies factors such as; trustworthiness, social performances, adherence to mutually recognizable and appropriate behavior patterns and shared experiences, determining whether interacting actors can become relationally proximate or not (Boschma 2005).

The network development practices emphasize the intentions and strategies of firms and extra-firm actors and the pattern of how they behave (Bathelt and Glückler 2003). In the context of GPN, the intentional nature of network development practices can be linked to the notion of strategic coupling, which is a dynamic process by which regional assets are matched to strategic needs of lead firms in GPN (MacKinnon 2011). Contemporarily, strategic coupling is considered as the key mechanism that derives economic development (Coe and Yeung 2015). This articulation has two dimensions: *Outside-in*, the inward investment of key firms in GPN, allowing for local firms to forge economic relationship with the wider production system; and *Inside-out*, the reaching out of established firms from a particular territory to establish relationships with global production network actors based outside their home turf (Coe and Yeung 2015, 171). These coupling mechanisms can serve as multiple perspectives through which we can study a given GPN. In analyzing the development of extractive industry, natural resources are considered as important preconditions for development, but it is essential that analytical attention is given simultaneously to both the endogenous and exogenous growth factors (Coe et al. 2004). Moreover, because of the territorial embeddedness of resources, the role of state is absolutely central, as access to such resources is essentially controlled, by the national state in which they are located (Dicken 2015).

Indeed, the process of fitting regional assets with the strategic needs of GPNs requires the presence of an appropriate institutional structure that simultaneously promotes regional advantage and enhances the regions articulation in GPNs' (Coe et al. 2004, 474). Coe et al., argue that three dimension of such institutional structure are crucial for regional development. These dimensions involve: *the creation of value* through the efforts of regional institutions in attracting value-added activities through training and educating the local workforce, promoting start-up firms and supplier networks, facilitating venture capital formation and encouraging entrepreneurial activities; *value enhancement,* through knowledge and technology transfer and industrial upgrading; and ensuring *value capture* through the exercise of power and control (Coe et al., 2004).

Value capture in particular involves power struggles and extensive bargaining processes between firms and state, also lead firms and suppliers over better terms and conditions. The power that actors possess depends on their relative control over key resources/assets (Dicken 2015). 'Structurally, power is derived from an individual or firm's positionality in relevant social and economic systems, especially the markets and institutions that regulate or govern an industry' (Murphy 2012, 6). In the extractive GPNs the state operates mainly as a *regulator* over the exploitation of its natural resources, Ownership of these natural resources affords states potentially enormous power over how such resources are exploited. However, this often results in tensions between states, lead firms, and other states, as these parties are preoccupied with capturing as much value as possible (Dicken 2015). How much value each party captures is, however, determined by the relative bargaining power of these actors. For example the extent to which a state feels the need to offer large incentives to attract a foreign investment or to retain an existing investment, or is able to impose access or performance requirements, will depend on its relative bargaining strength. On the other hand, the extent to which a lead company is able to obtain such incentives, or to operate as it wishes, will depend on its relative bargaining strength (Dicken 2015).

However, the mechanisms through which these economic and institutional actors shape the development of extractive markets is not very well addressed in the current literature on extractive GPNs. Moreover, the approach has not yet been applied to the renewable extractive sector. This paper will close this gap by providing an understanding of these mechanisms through the investigation of the development of FWP, an extractive renewable energy technology. In the analysis of the development of floating production network, our analytical framework revolves around three mutually interrelated elements namely; the role of materiality of natural resources, network development practices of production network actors particularly the lead firm and the development strategies of states. Accordingly, we will investigate the role of state in the development of renewable extractive market and how the development process is affected by the materiality of FWP and the network development practices of the floating production network actors. We identify the network actors and their network development strategies and the factors that influence the development of these strategies. We will also investigate how the materiality of FWP shapes the territorial configuration of the particular production network and implications thereof.

Methodology

To analyze the development of FWP sector we applied a novel, multidimensional approach that involves investigating the development of the sector from *inside-out* and *outside-in* perspectives. Our 'inside-out' approach follows the activities of the lead company from early i.e., concept development, demonstration phases at home (Norway) to piloting (in Scotland) and reflects over future commercialization in international waters. By contrast, the 'outside-in' approach analyzed the development of FWP from host country (Scotland) perspective, focusing on how state development strategies shaped the production network.

Our research method included a combination of primary and secondary data collection. The primary data was collected through semi-structured interviews in 2016-2017 with 13 informants who occupy middle and senior level management as well as academic/research positions in the FWP production network that includes: Lead Energy Company, Engineering Company, shipping companies, port, meteorology institute, academic/research institute, technology and innovation research center as well as governmental departments and agencies. The majority of the interviews were conducted face-to-face in the meeting rooms of these institutions in Norway and Scotland. Apart from one case where an interview note was taken, all the interviews were recorded and transcribed. The interviews lasted approximately one hour.

The interviews were complemented with analysis of secondary data, including: a wide range of FWP related industry reports and publications, policy documents, company histories, project documents, market and technological appraisals and the Global Offshore Wind Farm Map and Database (4Coffshore) and participation in several local and regional conferences and related industrial events.

Floating production networks: the case of Hywind

Offshore wind power (OWP) first emerged through incremental innovation from the onshore wind industry. Denmark pioneered OWP with the first offshore farm (Vindeby) in 1991. Currently, the sector is increasingly shaped by firms from the offshore O&G industry and the maritime sector. Growth in OWP has been the result of technological progress, upscaling of industrial capacity and the introduction of specialized turbines and installation and deployment technologies for the offshore market (Steen and Hansen 2013).

Almost all of the current OWP is built on bottom fixed foundations. However, bottom fixed offshore wind is restricted to waters with less than 50 meters deep (IRINA, 2016). This has been ruling out sites with the strongest winds and access to large markets, as many of the coastal areas of the world are too deep for the bottom fixed technology. The OW market is different from the global consumer market typical of GPN research, operating as part of the network industry of electricity generation and supply, characterized by its production of a basic necessity, reliance upon large-scale infrastructure and role in supporting economic growth more broadly (Joskow 1996). The market is national by nature as electricity from wind farms is sold and distributed through the national grid and subsequently supplied to consumers. As such, the size of the national market is vital in shaping the investment decisions of OWP developers. Floating foundations, a new generation of deep-water wind power technology, are on the verge of opening the way for power generation from deeper waters to allow countries and coastal regions with deep-water coastlines to develop domestic wind markets.

While FWP technology has developed to such an extent that the focus is moving into the mainstream power supply. There are four different forms of floating foundations: *barge, spar-buoy, semi-submersible and tension leg platform*. The semisubmersible and spar buoy substructures have especially entered a phase (>8) in terms of the technology readiness level (TRL), which means that the technology is now deemed appropriate for launch and operations (WindEurope 2017).

Hywind, is a floating offshore wind concept owned by Statoil, which is majority owned by the Norwegian state (Statoil 2017). In order to meet the fundamental challenges, ranging from climate change and geopolitics to the fluctuating energy markets that the O&G industry is facing presently, Statoil is looking for new ways to utilize its expertise and exploring opportunities in new energy markets,. Statoil is working to create value, i.e., gain *technological rent* (Henderson et al., 2002) through new technology development and innovations, and application of niche strategies, i.e., through exploitation of, the subsidized, demo, experiment and develop niches (Ortt, Shah & Zegveld 2007). Statoil sees OWP in particular as a profitable business area that can complement its O&G portfolio (Statoil 2017). As such, in 2015 it established a new "new energy solutions" division to capture business opportunities in renewables. In addition to its other bottom fixed OW projects, Statoil is involved in the development of FWP. For Statoil, the focus on the development of FWP is justified by the potential size of the market and relevant and appropriate resources from its O&G activities.

The Hywind concept was developed in 2001 by two Norwegian experts at the new energy division of Norsk Hydro. In 2008, with the takeover of Norsk Hydro's O&G division by Statoil, the concept was moved to Statoil. Statoil subsequently invested in R&D, model testing and demo in order to bring the concept to the pre-commercial phase in 2017. The concept combines conventional technologies well known from the offshore O&G operations, in a completely new setting and opens up (with little technological modifications to fit the FWP context) possibilities for capturing wind energy in deep-water environments (Interview with Statoil, 2017).

The Hywind concept has been demonstrated and verified through 8 years of operation of a full-scale demonstration WTG unit, the Hywind Demo. After receiving a green light from the Norwegian government, the Demo, which consisted a standard 2.3 MW SIMENS WTG solution, was deployed in 2009, 10km south-west of the island Karmøy, in the west coast of Norway. 13% (NOK 59 million) of the project finance (NOK 460m) was a grant from a Norwegian Public body, Enova. The Demo provided validation of the Hywind technology through the collection of full-scale measurements on motion control and electrical output (Interview, geophysicist at the University of Bergen, 2017).

With excellent production capacity and well-suited for serial production, the next phase for Hywind as world's first floating offshore wind unit, was to enter into the global OWP market. The first of this process was finding a suitable location for deployment of a pilot park.

According to Statoil, the identification of a suitable location for the Pilot Park was influenced by factors such as; wind resources, water depth, proximity to the grid, proximity to deep-water navigation route, and importantly by institutional and regulatory conditions, such as the availability of support and sufficient risk reward mechanisms (Statoil 2015). Initially, Statoil had identified three locations that met all or most of the physical criteria. These locations were, the Gulf of Main, Norway and Scotland. In the Gulf of Maine, Statoil had been granted lease but the company pulled out due to uncertainty over obtaining a power purchase agreement with the local grid operator. The Norwegian option was omitted due to the insufficient political will and support for the development of offshore wind in Norway (Interview with Statoil 2017; Carbon Trust 2015).

Scotland, with its deep waters and abundant (25% of Europe's) offshore wind resource (Hansen, 2001), fulfilled all the criteria. On top of that, Scotland had an attractive support mechanism that gave a total value of £187/MWh (2017 price) for floating wind projects. These made Scotland an ideal location for Statoil for the deployment of its pilot park (Statoil 2017). Buchan Deep off the cost of Peterhead, was selected as it is further offshore with less environmental sensitivity, and offering better availability of grid connection (Statoil 2015). In addition to Hywind, two other floating projects, namely, *Kincardine* and *Dounrey tri* have also been recently approved by the Scottish authorities. These are based on semi-submersible and semi-spar technologies respectively.

The materiality of the FWP is related to the wind strength, deep waters and proximity to shore. A given floating project in its entirety involves; planning, fabrication and assembly of WTGs, marine operations, transportation, on site installations, as well as operation and maintenance (O&M) activities.

Market development mechanisms in Scotland

Scotland has indicated its commitment to tackling climate change through strong support for renewable energy. This commitment is reflected in the country's legislations and policies. Scotland's energy strategy (2017), stipulates that 50% of Scotland's energy consumption to be met by renewable energy by 2032. This succeeds the previous goal of 100% electricity from renewables by 2020 target, which was instrumental to growth of OWP. As stipulated in its Offshore Wind Road Map (2009/13), the Scottish government is very keen to maximize Scottish offshore renewable resources. FWP in particular, has been identified as a suitable technology to cost-effectively decarbonize the Scottish energy systems (Interview with SG, 2017).

In addition to decarburization of energy systems, FWP has the potential to offer economic and industrial benefits, both domestically and through exporting products and services to emerging markets. With the expected 90 MW installed capacity of FWP by 2018 Scotland has an opportunity to develop supply chain capability to exploit opportunities in the global market (Carbon Trust 2017). "*Scotland is specifically looking to take advantage of floating developments happening around the world such as Japan, France and the US*" (official at the Scottish Enterprise (SE), 2017). Realizing these benefits of floating technology therefore there has been growing support and funding for floating R&D and demonstration activity in Scotland. As part of its endogenous economic niche development strategy, the Scottish government has been supporting innovation activities in Scotland. Technology developers in Scotland are eligible for various types of support depending on the stage of maturity of their technologies (Carbon Trust, 2017).

To facilitate these inward investments and thereby the development of FWP market in Scotland, the Scottish authorities have put key policy and regulatory conditions in place. These policies and regulatory conditions primarily reflect; the licensing & consenting processes, subsidy & grant support mechanisms and the Supply chain development imperative (Carbon Trust 2017).

Wind farm development starts with a seabed lease, which has to be obtained from the Crown Estate (DE), a statutory organization, which owns the seabed out to the 12 mile territorial limit. However, Hywind was outside the normal process (where CE identifies the sites and award them to developers), as it was Statoil that approached the CE to get approval for the site they themselves selected (Interview with CE, 2017). In addition, a marine license is required from Marine Scotland), demonstrating the regulatory role of the state in offshore wind

Having these regulatory conditions are necessary preconditions. Nevertheless, "*the availability of financial incentives have been vital in attracting inward investments of floating projects in Scotland…f*or *Hywind in particular the availability of this financial support played a crucial role in its site selection process*" (SG representative, 2017; interview with Statoil representative, 2017). The main form of financial support for renewable energy on the UK prior to the introduction of Contracts for Difference (CfD) in 2015, was the Renewable Obligation (RO).

The ROC was banded to provide varied level of support based on the level of maturity of the renewable technologies. In Scotland, floating wind technology exclusively, received an enhanced, subsidies.

As the floating technology is yet to mature it is still costlier than both onshore wind and fixed bottom offshore technologies. Therefore, one of the ideas behind the presence of the 3.5 ROCs in floating wind was to make sure that floating technology is feasible in Scotland. This was very attractive and favorable for developers also in comparison to other projects with other technologies. However, the ROCs has been recently replaced (effective March 31, 2017) by the

Contract for Difference (CFD) scheme (ofgem, 2017). The narrow time window meant that the consenting process for the three of the floating projects was rapid (Interview with SG, 2017).

As indicated above, the main drivers for the Scottish support for this niche market development has been, the window of opportunity it presents Scotland with a first mover advantage, by taking a lead on an innovative, commercially driven and globally scalable technology. To achieve this goal, Scottish authorities are actively working to embed the floating and other technology development projects within Scotland to facilitate knowledge and technology transfer and upgrading of domestic industrial capability. This is designed to strategically couple demosetic suppliers, particularly from the O&G industry, local economy to the growing global OWP industry as it is believed that it can be a key mechanism that can contribute to the domestic economic and industrial development aspirations (Interview with SE, 2017). This *outside-in* mode of incorporation (Coe & Yeung 2015) into the floating production network signifies a transplantation approach to new industry development, which entails the importation and diffusion of radical new technologies from abroad (Martin & Sunley 2006), an approach that appears quite typical in the British context (MacKinnon et al., In press).

The key embedding mechanisms by Scotland involve, the introduction of *local content requirements* and tasking development agencies with supply chain development duties. UK's offshore wind industrial strategy clearly stipulates 50% local content aspirations (UK government 2017). Moreover, the Scottish enterprise (SE), Scotland's main economic and development agency, actively supports Scottish supply chain. The support provided by SE includes issuing guides to provide domestic companies, specifically those in the O&G industry, with an understanding of the main diversification opportunities in the offshore wind sector. In addition to SE, Scottish development international (SDI) and Offshore Renewable Energy (ORE) catapult, a technology innovation and research center for advancing wind, wave and tidal energy, are also supporting local suppliers to capture more value from their involvement in the OWP markets (Interview with representative from ORE, 2017). These activities by development agencies and facilitating bodies are initiatives for strategic coupling of domestic industry into GPN (MacKinnon 2011).

In the case of Hywind both SE and SDI were in continuous discussions with Statoil to inform them on the Scottish capabilities and help in identifying the Scottish suppliers capable of meeting their requirements. SE in particular ensured face-to-face discussions between Statoil and local suppliers by organizing three 'meet the buyer' events in different regions of Scotland. Furthermore, SE runs Offshore Wind Expert support program, which provides the companies that are interested in OWP a two-day free consultancy service (interview with SE, 2017). These facilitators strive to match relevant and appropriate suppliers with the lead firm and as such contribute to strategic coupling (MacKinnon 2011).

Network development practices

In the Hywind project, Statoil ended up contracting suppliers with strong international track-record, most of which are established international suppliers from the O&G sector. In the supply chain map, the UK is represented by two first tier Scottish and one, first tier supplier from Sedgefiel (Durham) and another second tier supplier from Manchester. The success of the embeddedness processes is contingent on the states' relative bargaining power (Dicken 2015), which in turn is contingent, as demonstrated by the FWP, on the level of maturity of an industry/market and the domestic capabilities, i.e., the absorptive capacity of local suppliers for new knowledge. These elements can give the lead firm/technology developers an upper hand in the bargaining process with the state when configuring the production network. For an emerging market like FWP, the main preoccupation of actors is with bringing down costs and minimizing risks and feasibility of the sector, which in turn require contrasting strategies.

In the Hywind project, Statoil's project execution strategy was based on a Multi-contracting strategy as opposed to awarding engineering, procurement & construction (EPC) contracts. The Multi-contracting strategy involved Statoil itself choosing contractors for each element of the project. Statoil employed this approach, as it provided possibility of close interaction and monitoring of all the project activities. "*For us, close interactions with the suppliers was vital as these close interactions are helpful in coming up with the optimal solutions, CAPEX minimization, increasing effectiveness and market effect maximization"* (Statoil middle-level manager, 2017).

Another and related strategy pursued by Statoil was, reutilization of existing supplier relations. "*Even though Statoil tried to ensure competition, the few number of [capable] suppliers overall in OWP sector was a challenge*" (Statoil project manager, 2017). Where possible the company ensured competition. This was done through pre-qualified tenders, which entails putting out tenders to an already identified (pre-qualified) group of suppliers. Statoil runs supplier-database to make sure that it has an overview of all the potential suppliers. This highlights the importance of familiarity and the development of trust based relationship for Statoil. This is an important risk minimization strategy for Statoil as it ensures that it is dealing with suppliers with a proven track-record (interview with Statoil, 2017). Factors influencing choice of suppliers are shared experiences, trustworthiness and appropriate behavior patterns, listed by Murphy (2012).

Local content was one of the key elements that Statoil took into consideration when the company set up its supply chain. "*Even though they had not set a specific percentage, the Scottish authorities had a clear expectation that Statoil would do all it can to source things locally*" (Statoil project manager, 2017). However, there were no levers in the contracts that Statoil signed, that obliged it to achieve local content (interview the CE, 2017). Moreover, as Hywind was funded under a regime where it was not subject to submitting supply chain plan common under a later scheme (Interview with SDI, 2017). In addition, in order to prevent anti-competitive effects on the markets there exists EU legislation, *stat aid,* which regulates government assistance to industry and public procurement that the UK and ultimately Scotland has to abide by (interview the CE, 2017). This renders the 50% LCR more of an aspiration than a binding one.

Initially, Statoil had identified Kishorn as a suitable port for assembly of its five Hywind WTGs. However,…*Scotland lacked infrastructure and suitable port for assembly…*" (Statoil middle-level manager, 2017). Also lack of track-record meant that Kishorn missed on the contract to NorseaGroup's Stordbase in the west coast of Norway. As the process was refined, the requirement was forced to change to allow for optimization of the installation vessel time, as this was a significant cost driver. Once assembled at Stordbase, the turbines was towed in an upright position to the deployment area, in the Buchan Deep (Carbon Trust, 2017).

As demonstrated by Hywind project, the majority of the material for a floating wind farm can be built and assembled anywhere and smoothly be transported to site for installations at a reasonable cost. By contrast, assembly of the bottom-fixed foundation has to take place in an operational park setting. Assembly of floating on the contrary could be carried out from distance at specific places with deep harbours that are equipped with the necessary infrastructure as in case of Hywind.

Floating projects developers have the opportunity to choose an assembly site/harbour that comply not only to the requirements for infrastructure and depth, but also find an assembly site/ harbour it is familiar with. This means that lead firm could rely on suppliers close to the assembly site/harbour not just because they have competitive advantages due to physical proximity, but also due to its relational proximity to former and trusted suppliers.

For many of the suppliers involved in the project, it is evident that involvement in the Hywind demo led to contracts on the Pilot Park. *"We have had long and good relations with Statoil…NorseaGroup, our parent company, has supply base agreements for all its offshore installations which helped in us having good knowledge of Statoil and its operations… The Hywind demo was assembled at Dusavivik base near Stavanger"* (CEO, Stordbase, 2017). This highlights the benefits of first-mover advantage, which demonstrates the importance of early involvement of suppliers to build not only the needed track-record but also cultivate the trust and relationships with the developers. (Interviews with Statoil, engineering company, Shipping Company, met. Institute, 2017). This has in turn contributed to the very low UK content, at least in the deployment phase.

The materiality of FWP as discussed above appears to have also contributed to the lower local content. The range of suppliers selected from across Europe highlights the geographical decoupling possible with floating wind technology. On the other hand, the small-scale nature of the project coupled with the lack of visibility of future offshore wind pipelines (market uncertainties) meant also that it was difficult for the local suppliers to make huge investments on capability and infrastructure upgrading.

In the deployment phase, these possibilities have very much given Statoil an upper hand in its relative bargaining process with the Scottish authorities in configuring the floating production network. As shown in, many of the selected contractors are suppliers with strong international track-record, most of which are established international suppliers from the O&G and maritime sector. The involvement of suppliers from the O&G and maritime industry is evident, especially in the pre-construction as well as the construction and installation phase of the project.

"*In Scotland, there were no manufacturing plants neither for the WTGs nor for Spar solutions.* (Statoil middle-level manager, 2017). The fabrication of the Siemens turbines took place in Denmark as Siemens had already partnered Statoil both in the Hywind Demo as well as in the company's other OWP projects. Aibel was involved in the design of the Spar substructures. Aibel has a proven track-record in the floating technology (Interview with Aibel, 2017). The choice of the Spanish consortium (Navantia-Windar) is justified by the companies' familiarity with the spar technology. Also this choice of the supplier is regarded as a result of low cost sourcing strategy. When compared to bottom-fixed, local (host region) suppliers can potentially lose their short distance advantages in floating projects. As proximity to deployment site of floating wind park becomes less important, suppliers from elsewhere in the world can compete on more or less similar conditions.

By moving from fixed to floating technology, the significance of physical proximity is reduced or reconfigured, and relational proximity may become relatively more significant. The latter especially applies to cases, particularly in the R&D phase of development (niche development strategy, e.g. pilot park) when quality, risk minimizing and feasibility are more important than cost reduction through price competition, requiring close and frequent interactions between firms in the production network. In a commercial phase with a stronger imperative of cost minimization, we must expect that lead firms will, to a higher degree, source from low cost suppliers on a wider geographical scale. Physical and relational proximity will probably play a less important role than in the development phase. In contrast to the constraining role that materiality plays, as in the case of gas/oil (unwieldy commodity) (Bridge, 2008), floating technology is more enabling with regard to spatial flexibility of networks. Also relative to the fixed technology, by towing the complete WTG unit, the supplies and networks are further decoupled from the host region than in the case of fixed technology where installation have to take place at the deployment site.

This can pose a potential threat to the developmental aspirations of the host region. The threat could, however, eventually be eliminated by the export opportunities it provides to the local economy. The opening up of the sector for more competition, could play a major role in bringing down costs (i.e., lower electricity prices), which in turn can have a far-reaching developmental implications for the other parts of the local economy. Furthermore, the disembedded and rootless nature of FWP (as there is less concern with the seabed conditions) can further promote standardization and enable the achievement of economies of scale.

Conclusion

In this paper, we set out to investigate how firm and states shape their assets in order to foster the development of an extractive renewable energy market (FWP). We did this by analyzing the driving forces behind the development, as well as the processes and the mechanisms through which the floating production network is established and maintained. We also investigated how the network configuration, is influenced by politico-economic dynamics, as well as the materiality of the renewable resource and network development practices of network actors.

The development of the FWP signifies a strategic coupling process, which can be seen from two perspectives: *Outside-in*, through inward investment of key firms in GPN; and *Inside-out*, firms from a particular territory reaching out to establish relationships with global production network actors based outside their home turf. These two perspectives have methodological implications, which we have taken into account when doing fieldwork and in our data collection in two countries. This approach is helpful in capturing all the actors involved and as such in broadening the GPN-network analysis.

In common with other renewable energy sectors, offshore wind can be seen as particularly state dependent, as its development has been driven by policy objectives and targets and supported by financial subsidies (MacKinnon et. al., In press). Our analysis revealed that the national state plays an important role in the development of domestic renewable markets through setting up favorable institutional framework and facilitating transplantation processes balanced with enhanced local content. Nevertheless, in the configuration of extractive renewable production networks, social relations are mediated through the "natural" environment where materiality of natural resources plays an enabling role in broadening of the potential network as well as for reusing of existing ones. We recognize that network development reflects interests, practices and routines of lead firms and host states, as well as the mutual recognition of each other's position in a common GPN in line with Murphy (2012). Furthermore, we find that materiality is playing a vital role on networks spatial configuration. Rather than solely playing a constraining role, as suggested by Bridge (2008) in his study of petroleum GPN, we recognize, based on our study of the FWP production networks that materiality could have an enabling role in incorporating distant and trusted suppliers. GPN. Our findings further show that materiality can have a counterbalancing effect to the state's exercise of power in extractive GPNs. This may in turn delimit/constrain the local embeddedness of projects by states.

The success of the embeddedness strategies of states depends on their relative bargaining power, which in turn is dependent, as demonstrated by the FWP, on the domestic capabilities, i.e., the absorptive capacity of local suppliers for gaining new knowledge. However, all this can be contingent on the stage of development of a technology or the level of maturity of an industry sector and the institutional context of the host economies. Thus, further research is needed to look at the strategies and value capture trajectories of firms and extra-firm actors (states) in mature extractive industries/markets and well established networks. Better insights could be gained through a comparative research of developers' network development strategies in more mature extractive markets such as the fixed bottom OWP. Moreover, different national legacies and contexts can influence the development strategy that a particular state pursues. Thus, an international comparative research is also needed that sheds a special light on the different strategic coupling mechanisms of states with varying institutional contexts to the OWP GPN.

Additional research is also needed on the dynamics of the embedding mechanisms of development projects by host states in their local economies.

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