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Research Article

Renewable energy and industrial development in pioneering and lagging regions: the offshore wind industry in southern Denmark and Normandy

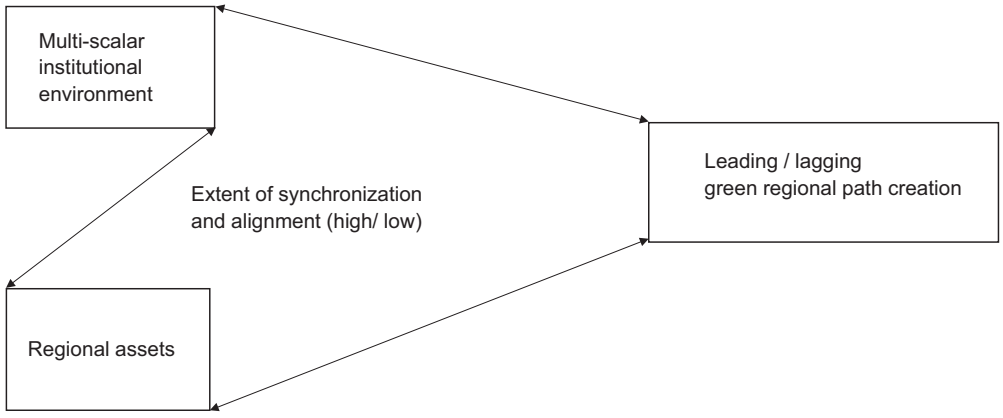
Suyash Jolly [1,*], Markus Steen[2], Teis Hansen[2,3] and Samson Afewerki[4,5]

[1]Business Research Group, Nordland Research Institute, Bodø, Norway
[2]Department of Technology Management, SINTEF, Trondheim, Norway
[3]Department of Food and Resource Economics, University of Copenhagen, Copenhagen, Denmark
[4]Department of Aquaculture, SINTEF Ocean, Trondheim, Norway
[5]NORCE Norwegian Research Centre, Bergen, Norway
*Corresponding author. Email: sjo@nforsk.no

Abstract

The increasing deployment of renewable energy (RE) hinges on the development and upscaling of manufacturing and logistics capacities, offering industrial development opportunities for regions and countries. In this paper, we analyse how contextual factors pertaining to pre-existing regional assets and multi-scalar institutional environments influence RE-related industrial development at the regional scale. To this avail, we purposefully selected two contrasting regional case studies of offshore wind energy-related industry developments in Southern Denmark (a pioneering region) and Normandy (France, a latecomer region) and discuss developments until 2020. Our qualitative analysis is informed by theoretical and empirical insights from the economic geography and sustainability transitions research fields. The identified contrasting regional path creation processes reflect substantial differences in context conditions, providing insights into how regions can capture value in the ongoing energy transitions.

Graphical Abstract



Lay summary: There has been significant interest regarding the development of new regional green industries and how to promote them to achieve desired objectives, such as meeting national climate goals, industrialization and creating new green jobs. Amid this growing regional and national interest in developing new regional green industries, the paper provides novel insights regarding the key factors that can make some regions more successful while others are less successful.

Key words: regions; offshore wind; path creation; Southern Denmark; Normandy

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INTRODUCTION

In the face of global climate change and the need for 'greening' of not only energy systems but economies at large, there is an increasing interest among both scholars and practitioners concerning how this may result in the development of new (green) industrial growth paths, i.e. an umbrella term referring to the development of new economic activities in regions ([1]; p 1636). In this paper, we are particularly concerned with the regional scale and how regions differ both with regards to the deployment of renewable energy (RE) and industrial development associated with RE expansion. Our theoretical point of departure in this paper is in the field of economic geography, which is devoted to the analysis of spatially uneven processes of economic development [2]. Within economic geography, a region is understood as a sub-national geographical area, and '*(…) at once both an environment within which individual firms, industries and institutions evolve, and in some sense a "macro-level" system that itself evolves by virtue of the development of its constituent individual firms, industries and institutions*' ([3]; p 410).

How local and regional level processes contribute to energy system transformation [4, 56] and related industrial development varies considerably and is influenced by both endogenous and exogenous factors. Endogenous factors refer to the place-specific factors that may influence regional energy transitions [5, 56]. Such localized assets include both natural resources (e.g. different energy resources) as well as assets in the form of infrastructures, skills, knowledge and so forth. A large body of work within economic geography has demonstrated how new regional industrial growth paths are often based on pre-existing assets [3, 6, 7], such as when firms diversify into new product markets based on previously established competencies. Many localities and regions also use various policies and instruments to facilitate industry growth around green technologies [8].

The role of such endogenous factors, however, needs to be seen in relation to broader extra-regional processes and institutional and political environments. This is certainly the case in the realm of energy, where technology development in many instances is dominated by global lead firms (e.g. Vestas in wind turbine technology development) and supply chains transcend territorial boundaries and where important framework conditions related to the market formation and growth is a matter of national and supra-national policy [9]. Understanding regional variation in energy system transformation (both deployment and industrial development), therefore, necessitates a multi-scalar approach that accounts for both endogenous and exogenous factors.

Against this brief background, we take a geographical political economy (GPE) approach [10] in this paper to analyse regional industrial development related to the rapidly growing offshore wind power (OWP) in Europe, focusing on the regions of Normandy in France and Southern Denmark. The GPE approach is apt for studying the spatial nature of the energy transition processes as it accounts for both multi-scalar dimensions, such as the role of policies at various levels, as well as how new regional renewable energy industries are shaped by historically developed preconditions and assets [11]. Given that OWP is a relatively novel industry, we refer to this industrial development as path creation, defined as '*the emergence of new development trajectories in a region based upon the growth of new industrial sectors or new products, techniques and forms of organisations*' ([12]; p3).

We pose the following research question: *How have regional assets and multi-scalar institutional environments influenced green path creation in regions at different stages of OWP development?* Empirically we conduct a longitudinal comparative case study of regional path creation related to offshore wind energy (OWP) in Southern Denmark and Normandy (France) up to 2020. Similar to other green economy initiatives, much of the rhetoric around offshore wind energy (OWP) has focused on both its supposed environmental (low carbon energy generation), i.e. addressing climate change, as well as economic (job generation, inward investment) benefits for regions [13, 14].

The two cases are interesting to analyse due to differences in OWP deployment despite significant natural resource potential in both regions. Today, Denmark has multiple offshore wind energy farms in operation with a total installed capacity of 2.3 GW, with an additional 14 GW is planned in the latest political agreement [15]. The North Sea primarily served through the harbour of Esbjerg in Southern Denmark, is central to these ambitions. Although France has the second largest offshore wind energy resource potential behind the U.K. in Europe, the installations have not been at par with the target of 3GW by 2030 [16]. Whereas Southern Denmark is a pioneering region in the OWP industry, Normandy is a latecomer, albeit with seemingly strong potential for OWP-related path creation due to its proximity to the North Sea OWP markets and domestic aspirations in France for OWP deployment and industry development.

The bulk of previous economic geography research into this rapidly expanding new industry has focused on the UK, Germany, Netherlands, Germany and Norway (see, e.g. [12, 13, 17–20, 58]), albeit with other relevant studies in the USA and Taiwan [21, 22]. By focusing on regions in Denmark and France, this paper contributes empirically to a growing literature on regional green industry path development and the deployment of OWP in a regional context.

The paper proceeds as follows. Section 2 reviews the literature on the geographical political economy approach. Section 3 presents the research method. The comparative case study analysis unfolds in Section 4. Section 5 discusses the main findings, and section 6 concludes and points to promising avenues for future research.

THEORETICAL BACKGROUND

Geographical political economy

The geographical political economy (GPE) [10, 23] approach emphasizes how regional development processes unfold within and are influenced by broader dynamics of uneven development. It furthermore highlights how multi-scalar institutional environments mediate the interaction between different types of stakeholders [23] and how multiple types of actors (e.g. firms, entrepreneurs, government agencies, industry associations, non-government organizations and citizens) may directly or indirectly influence industrial development processes. The GPE approach thus provides a holistic theoretical and conceptual framework for connecting the micro and macro levels of analysis of regional path creation processes [24].

Within GPE, regional path development processes are conceptualized as resulting from the dynamic interplay between five essential elements: regional and extra-regional assets, economic, social and institutional actors, mechanisms of path creation, market construction and institutional environments [10]. Building on these insights, this paper explores the role of regional assets and the multi-scalar institutional environment in shaping regional industry paths.

Regional assets

Regions differ in their opportunities for developing new green industries, contingent on asset endowments and institutional capacities [4, 10, 25]. Here, the argument is whether pre-existing assets and features of the institutional environment condition new green growth paths that emerge (in a region) or whether path dependencies hinder new growth paths. Regional assets encompass the skills, knowledge, competencies, experiences and infrastructure from previously inherited regional industries and existing patterns of regional economic development, as well as natural resources and institutional endowments (rules, routines and norms that shape actors' behaviour) [26, 27, 59].

Regional assets are actively modified and reconstructed by actors' deliberate and purposeful activities, for example, when firms and other actors engage in R&D and innovation activity or when physical infrastructure is repurposed for new use. Pre-existing regional assets thus often need to be modified or adapted (i.e. valorized) to be of value to new circumstances, whereas new assets needed for path creation must be developed or also often imported from elsewhere [27–29]. Industrial and human assets, such as relevant technology, knowledge and skills, can be drawn upon from outside the region by utilizing extra-regional linkages [30].

Multi-scalar institutional environment

While the attention to place-based factors has significantly improved our understanding of regions' differentiated opportunities for nurturing new green industries, path-creation processes unfold in a broader institutional environment that also needs to be taken into account [11, 12]. The GPE literature focuses on multi-scalar institutional environment and presents an integrated account of the multiple actors, institutions and mechanisms that shape regional industry path creation [10].

The institutional environment is conceptualized as multi-scalar (local, regional, national, supra-national) and comprised of broader structures of formal and informal rules, conventions and practices that shape regional development, spanning both 'hard' organizational structures and regulations and 'soft' norms and habits [12]. It encompasses, for instance, market subsidy regimes; national, regional and local industrial policies and strategies; rules and regulations governing the use of infrastructure resources and influences the regional diversification process [31, 32]. While the multi-scalar institutional environment thus refers to a broad set of influences on actors' behaviour, strategies and actions [10], our emphasis here is on formal institutions and policies.

The national state is critical in supporting the regional path creation process by enabling the coordination and alignment between the horizontal (energy) policy, vertical (industrial) policy and spatial (planning) policies. The horizontal policy instruments use energy market regulations, subsidies, R&D support mechanisms and legal and regulatory frameworks. The vertical policy instruments attempt to develop local industrial capabilities and new industrial strategies to rebalance the economy by targeting new manufacturing activities for high-growth potential activities in the future. The spatial policy instruments focus on fostering path creation by developing appropriate planning mechanisms and consenting procedures, including guidelines for natural resource exploitation [31, 33, 34].

Important policies conditioning the opportunities for industrial development in regions are defined at the national (and supra-national) level, such as energy market regulation, industrial policy, feed-in tariffs, renewable purchase obligations (RPO), R&D instruments, carbon taxes and spatial planning laws. These can all support or hinder the development of new regional industry paths. As the regional path creation process depends on institutional synchronization between the regional and national levels, the state needs to act as a system builder or engage in institutional entrepreneurship to influence multi-scalar institutional arrangements [34], e.g. for developing new market opportunities [12, 13]. This occurs through changes in various policies and policy instruments, such as feed-in-tariffs, quotas, renewable obligations, tax incentives, local content policies, spatial planning instruments, green certificates or the introduction of green public procurement mechanisms [17, 33, 35].

Summary

A geographical political economy (GPE) approach provides a comprehensive perspective on uneven regional development and how broader institutional processes enable and constrain regional industry path development. In this paper, we employ the GPE framework to conduct an extensive historical investigation of industrial development related to the offshore wind power (OWP) sector in Normandy and Southern Denmark, focusing on the role of pre-existing industrial legacies as well as the multi-scalar linkages and multiple connections and interdependencies between actors operating at different spatial scales shaping regional industry paths. Our comparative study is based on principles of deep contextualization to assess how similar processes and path-creation dynamics operate differently across different regional and national contexts [12, 34].

RESEARCH METHOD

Qualitative case study approach

The paper takes a comparative case study approach [32] as prior studies (e.g. [24]) have recognized the utility of a comparative longitudinal approach in understanding the relationship between regional asset development and multi-scalar institutional environment [10]. Crucially, comparative qualitative research is valuable within the GPE approach for uncovering the mechanisms and processes that shape regional path creation processes [2, 23, 24]. In the next section, we explain the data collection and analysis process.

Data collection

Primary data from 26 in-depth semi-structured interviews conducted between October 2018 and February 2020 forms the core of the empirical material. Potential interviewees were identified using the researchers' networks and social media (e.g. LinkedIn), snowballing and through information from organizational websites, media reports and industry and government reports. The informants represented OWP firms, cluster organizations, regional development agencies, industry associations, port authorities and academic researchers specializing in OWP (see Table 1 in Appendix A in the supplemental data online for more details). The interviewees were selected based on different considerations: actor type (e.g. representing government, firm, civil society, university and research); professional function and relevant career background in the OWP industry; knowledge and specialized expertise in the OWP industry; participation in industry networks and associations; seniority in the OWP industry and time availability.

The semi-structured interviews (typically 30–60 minutes with an open-ended interview guide) covered the historical

background, motivations and rationales supporting OWP. The interview guide used for the fieldwork was prepared by having a pre-formulated list of topics to be discussed with the interviewees, followed by a series of open-ended questions to be formed and asked during the interview depending upon the response from the interviewees. Topics focused on understanding the development and modification of different regional assets in the region (including from pre-existing industries), drivers and barriers for OWP, networks and partnerships and policies and regulations. Other important themes covered (albeit varyingly depending on informant type) included firm innovation activities, activities of, e.g. cluster organizations in developing regional cooperation, social opposition to OWP etc. Open-ended interviews helped obtain specialist knowledge from the elite interviewees to contribute to the research themes of the interviews accurately. The open-ended interviews were also beneficial in adapting the flow of the interviews and allowing greater freedom to control the power dynamics throughout the interviews. All interviews were digitally recorded, transcribed and summarized to support the data analysis process.

Different archival data sources supplemented the open-ended semi-structured interviews by providing detailed information on the regional context, including industrial legacies and pre-existing regional assets. Publicly available material, including academic articles, policy documents, industry and consultancy reports, industry magazines, newspaper articles and various websites, was accessed through desktop research (see Appendix B in the supplemental data online for more details). Apart from these data sources, participant observation at various international industry events helped understand private and public actors' sensemaking, strategies and practices in this new industry. Observations were also made at the Port of Esbjerg, guided by the port authorities, which helped gain a first-hand understanding of the complexity of handling the operations related to OWP projects. The archival data sources complemented the data collected and summarized from the semi/structured interviews by corroborating and validating interview information.

Data analysis

After conducting each interview, the main insights were summarized and supplemented with archival data. We then constructed case study narratives for each region, further supported by an event history analysis [34] of key regional (Southern Denmark and Normandy), national (Denmark and France) and supra-national (EU) policy developments (see Fig. 1 in Appendix C and Fig. 2 in Appendix D in the supplemental data online).

The event analysis focused on developing a timeline of the critical events using a process analysis approach that also generated a backdrop for understanding the key phases in the regional path creation process. The data analysis followed an abductive approach where the conceptual framework derived from the existing literature was iteratively validated by juxtaposing it with empirical evidence. More specifically, we used the GPE literature to discuss the regional path creation process using a deductive approach and a data-driven thematic analysis undertaken inductively [36]. The two cases were analysed separately before conducting a cross-case analysis, including regional and national context comparisons. The data analysis was strengthened by using the triangulation approach [34], where the different research team members analysed the two cases individually and compared the various interpretations of the differences between the two cases. In the next section, we present a comparative analysis of the trajectories of the two case studies.

FINDINGS

This section focuses on first explaining the drivers for promoting OWP in Denmark and France, as this provides important context in our analysis of the regional development processes. This is followed by describing the two regions' pre-existing regional assets and historical industrial legacies and how these features conditioned subsequent OWP-related developments. Next, we analyse how the multi-scalar institutional environments influenced the OWP-related industrial trajectories.

The scarcity of onshore sites for additional wind energy deployment and the availability of large and shallow ocean areas with good wind resources was vital to Denmark's early offshore move (PWC, 2018). OWP also started to receive more attention due to increasing public resistance toward onshore wind energy, resulting in already planned projects being cancelled or paused. Further, OWP promised future industrial benefits, job creation and a competitive energy source [37]. In France, combating climate change, creating economic value in terms of job creation, revitalizing existing industrial hubs, promoting local industrial networks and improving cost efficiency for low-cost electricity have been key drivers for OWP development [38].

The French government focused on transforming its energy sector towards a higher share of OWP and developing its industrial capabilities in the global OWP market to improve its international competitiveness [39]. Like the industry in Southern Denmark, the Normandy region also had the presence of an existing maritime sector that provided a basis for OWP activities [60]. In the next section, the different regional assets are discussed.

Regional assets in Southern Denmark and Normandy

The emergence of the OWP industry in Southern Denmark and Normandy benefitted due to the valorization of different interrelated regional assets, i.e. (1) infrastructural and material assets, (2) industrial assets and (3) institutional assets. In addition to these three groups of assets, both regions benefitted from suitable natural resource endowments related to the availability of wind resources and proximity to the project sites in the North Sea.

Infrastructural and material assets

In Southern Denmark, Esbjerg has been a critical harbour area with the fishery, shipbuilding and container shipping industry since the 1970s. During the 1970s and early 1980s, Esbjerg changed its industrial base due to oil and gas exploration opportunities in the Danish part of the North Sea, and a regional offshore oil and gas industry emerged [40].

With the introduction of the offshore O&G industry, the region's industrial structure (dominated by fisheries and shipbuilding) began to change, and the infrastructural assets, notably in the port area, were developed further (Interview 3; Interview 10). Subsequently, the emerging OWP industry in Southern Denmark benefitted from the presence of these infrastructures and material assets. One expert interviewee remarked about the strategic advantages associated with the port in Esbjerg:

'*The port and the geographical location have been a driver in terms of why (…) the offshore hub is here. Well, it is the bridge to the offshore world; it goes through Esbjerg*' (Interview 11).

For the Horns Rev 1 project, the port of Esbjerg and the regional companies offered critical support. As remarked by one expert interviewee about the development of the Horns Rev 1 project:

'*For windmills at the beginning of the 2000s when the Horns Rev 1 was built up and other windmill parks starting, coming up in the North*

Sea and the Horns Rev 2 came in 2009. Esbjerg luckily had enough space at the harbour and the top points. The harbour provided space for the building up the 6 or 7 windmill parks simultaneously' (Interview, 10).

The Port of Esbjerg is a self-governed and municipality-owned port that has played a crucial role in creating a collaborative approach and encouraging learning and experimentation to develop new business models to support further development of the regional OWP industry [41]. The port has played a significant role in providing infrastructure services for the OWP industry in the region [61] by adapting to the increasing needs and demands of the OWP industry and working with project developers and suppliers. The port authority became a front-runner organization in offering different services, such as solving bottlenecks faced by the firms, providing flexible infrastructure in the port area to the other firms, providing continuous operation and service support and adopting a customer-centric business model to meet the needs of the firms using the port services (Interview 7).

Similarly, the Normandy region has benefitted from the presence of suitable infrastructure and material assets. The Port of Normandy has jointly managed the three regional harbours: Cherbourg, Caen-Ouistreham and Dieppe. The Port of Normandy Authority (PNA) developed a regional strategy to support OWP industry activities by initiating large-scale development work on port infrastructure for manufacturing/assembly and logistics. Port of Normandy Authority ensured the development of new additional land and infrastructure and the marketing and commercialization of the Cherbourg and Caen Ouistréham ports. For example, the port of Cherbourg further adapted its existing assets for handling heavy loads, maintenance and component manufacturing (e.g. blades, foundations) as required by firms in OWP [62, 63].

The Channel Port of Dieppe provides a good location as a logistics base for OWP farms and experience with unloading and handling turbine components and maintenance activities. It also offered effective port services (e.g. pilotage, towing, dredging, mooring) and proximity to the specialized maritime business in the Normandy region [64, 65].

Industrial assets

Regarding the industrial assets, the Southern Denmark region benefitted from the presence of supplier firms such as Bladt Industries (offshore substations and foundations), Niels Winther Shipping (port agency services) and Peter Madsen Rederi (seabed preparation for OWP, pipe and cable works, etc.). Additionally, the region has the presence of large multinational consultancy and service providers such as Rambøll and COWI, as well as the certification agency DNV GL [40, 66].

The regional industry received support from specialized maritime and logistics service providers, like Esvagt and Bluewater Shipping, and firms, like A2SEA providing relevant expertise for OWP installations (Interview 3; Interview 5; [41]).

The OWP industry benefitted from the existing O&G industry in designing and installing substations, foundations, cables, operation, maintenance services, logistics and quality and safety standards (Interview 3; Interview 6). Companies like DONG Energy (now Ørsted) recognized the usefulness of transferring knowledge and experience (related to operations, planning, engineering, etc.) from the O&G to OWP. For example, solutions from O&G, such as using two layers of coating to save machinery from corrosion, were effectively transferred to OWP turbines [42].

The OWP industry in Southern Denmark also took advantage of the experiences and assets in Denmark's globally leading domestic onshore wind (turbine) energy industry [40]. Rapid technological advances in wind turbine technology (blades, towers, nacelles, gearboxes, control systems and generators) were essential for the OWP industry in reducing costs and increasing reliability (Interview 6; Interview 8; Interview 9).

Regarding the industrial assets, the Normandy region benefitted from the LM Wind Power factory (blade production) in Cherbourg and the Siemens Gamesa factory (nacelle production) in Le Havre, along with a dedicated installation hub allowing direct load out of wind turbine components to the French OWP plants (Interview 21; Interview 22). One interviewee also mentioned the region's support for the blade factory.

'*We received strong support from the region; we had proposals from different ports to locate our activities. Here it was quite simple they offered location just near the quay so this is simplifying all the logistical aspects*' (Interview 14).

These manufacturing facilities will produce the OWP equipment for future OWP farms, i.e. three Ocean Winds farms at Yeu-Noirmoutier, Dieppe-Le Tréport and the Golfe du Lion [43]. Further, the Pépinière d'Entreprises Energies Renouvelables acting as a business incubator, has supported the industrial SMEs to develop OWP farms [64].

Institutional assets

Regarding institutional assets, the regional government agency, Region Southern Denmark, has strategically supported the OWP industry by enhancing collaboration between large companies and local/regional SMEs (Interview 2). Furthermore, regional actors such as the Esbjerg business development centre supported the regional SMEs to become suppliers for the OWP industry (Interview 5). Industry-supporting organizations were initiated to build strong relationships between the offshore O&G and the OWP industry. Offshore Centre Denmark, which later became Offshore Energy, facilitated knowledge sharing and resource transfer between the industries via seminars and matchmaking events and improved cooperation between the two regional clusters [61, 67]. One of the expert interviewees remarks about the role played by the organization:

'*As a cluster organization, our role is to bridge up with other relevant clusters around the world where Danish companies could collaborate with some interesting partners abroad so that we try and open doors in that way (. . .) we try and facilitate concrete collaborations*.' (Interview 11).

The regional OWP industry benefitted from regional universities such as Aalborg University and the University of Southern Denmark, collaborating with industry on various research and development projects and training the regional workforce (Interview 1; Interview 4).

In France, within the Normandy region, the cluster initiative Normandie Energies played an essential role in working with different renewable energy companies in the region, organizing pilot projects, enhancing communication between regional stakeholders and organizing business fairs to support OWP development. The Normandy and Picardy, the Chamber of Commerce and Industry, a dedicated business incubator for renewable energy, supported the industrial diversification process for accelerating OWP development. The region developed OWP-related knowledge due to a Siemens Gamesa research centre in Rouen focusing on critical areas such as fluid dynamics, aerodynamics, wind energy blades and research projects at Caen University, Le Havre University and Rouen University.

Multi-scalar institutional environment

In this section, we describe the elements of the broader multi-scalar institutional environment shaping the development of

OWP in Southern Denmark and Normandy. Here we focus on the role of the national state in the development of the OWP industry in the two regions by using a variety of policy instruments such as feed-in-tariffs, investment subsidies, tax breaks and loans, grid connection guidelines, renewable obligations (ROs), R&D test facilities, subsidies, public R&D instruments, legal and regulatory frameworks [31, 44, 45]. Specifically, we distinguish between two regions horizontal, vertical and spatial policy instruments [31, 34].

Horizontal policy instruments

Regarding the horizontal policy instruments in Denmark, several initiatives focussed on supporting OWP development. With an executive order from the Danish Minister of the Environment and Energy, two large energy utilities, ELSAM and SEAS, started working towards developing large-scale experimental OWP farms, which resulted in the commissioning of the Vindeby project in 1991. These projects were delivered by Elkraft as compensation when the utility could not deliver an agreed 100 MW onshore wind project made in 1985 [37].

The Danish energy utility DONG Energy (Later became Ørsted) became an integral part of the Danish government policies for developing OWP-related capabilities and was instrumental in installing the Horns Rev 1 project [39, 46]. In 1997, the '750 MW obligation' was placed as a requirement for the utilities to install an additional 750 MW OWP before 2008 [45]. An action plan in 1997 recommended a development program to understand better the technical (including grid-related), economic and environmental impact of large-scale OWP in Denmark. The Danish government also provided considerable support in the form of feed-in tariffs and contracts for difference (CFDs) for supporting the market development of OWP. Later there was also a shift towards more competitive bidding and tendering procedures [12, 47, 57].

Regarding the horizontal policy instruments in France, a number of regulatory instruments have been used to support OWP. For example, the long-term strategic energy objectives are specified in the multi-annual energy plan (PPE), adopted in 2015 after the Paris Agreement as part of the Energy Transition for Green Growth Act. The MEP established a target of reaching the contribution of renewable energy consumption to 23% by 2020 and 33% by 2030. Furthermore, as part of the EU climate policy targets 2030, France adopted a target of 32% renewables in the final energy consumption by 2030. Despite these developments, France's OWP sector has not kept pace with other leading European nations due to regulatory hurdles that project developers and investors have faced over the years during the state-led auction process [51, 68].

Apart from the regulatory initiatives, the policy support for OWP in France was also carried out by initiating OWP pilot projects and using a dual system by combining feed-in tariffs with calls to the tender mechanism. Initial developments focused on the Veulettes-sur-Mer wind farm off the Normandy coast to install a 105-MW pilot project. However, despite the potential, the project faced major setbacks. The French government supported OWP pilot projects between 2000 and 2009 OWP industrial projects (two calls for tenders representing 3700 MW of installed OWP) between 2009 and 2019 and large-scale OWP projects through competitive pricing mechanisms from 2019 onwards [38]. The large-scale OWP projects were exposed to fluctuating electricity prices and offered through a competitive bidding process [48].

The French government launched new tenders for OWP projects located off the coast of Fécamp and Courseulles-Sur-Mer (Normandy), Saint-Brieuc (Brittany) and Saint-Nazaire (Pays de Loire) in 2012. Subsequent tenders were launched for Tréport (Normandy) and near the islands of Yeu and Noirmoutier (Pays de Loire), and another tender was launched for a wind farm located off the coast of Dunkerque (Hauts de France) (CMS, 2019). To address the issues related to public opposition against OWP, The National Commission of Public Debate (CNDP) launched a commission to develop a public participation process for developing OWP farms. To reduce costs, a competitive bidding process was introduced [69]. The French government also streamlined the framework for future OWP tenders and allowed firms to apply for envelope permits, allowing them to adapt to the initial project after securing the necessary approval [70, 71].

The French regions have been involved in regular discussions with the national state for project development and lobby for securing their specific interests to decide upon the future volume of OWP projects and the potential locations (Interview 22). An expert interviewee also remarked:

'*The OWP energy farms are admittedly part of a national policy, but they consider that the regions should be the ones carrying out the projects because they know the territories and are better able to judge what can be done or not.*' (Interview 23).

The regions have attracted foreign direct investments (FDI), invested in the renovation and upgradation of port facilities and harnessed the pre-existing regional assets to support the development of OWP (Interview 13). The regional interests include industrial development, creating regional employment and enhancing the regional industry's competitiveness in OWP [39].

A critical challenge has been related to the nuclear lobby in France, as there has been strong opposition due to the increasing development of OWP in the French energy mix [39]. As remarked by an expert interviewee regarding the regulatory delays:

'*So, if I can say so, somewhat in France, we have not been good in this area. When I look at my British colleagues on the other side of the Channel, who decided five years ago to build a farm, and the farm works now, I tell myself they are much better than we are in this area.*' (Interview 21).

There have also been challenges related to resistance from fishermen, NGOs and citizens, thereby creating challenges for OWP development. Offshore wind energy projects were treated on a case-by-case basis, resulting in long public debates between fishing groups, regional authorities and mayors and permissions for initiating the projects [38, 49].

Spatial policy instruments

Regarding Denmark's supportive spatial policy instruments, the Danish Energy Agency (DEA) was mandated to issue licenses and production approval for OWP projects, including grid connections. The DEA subsequently developed a 'one-stop-shop model' for project developers, which came to be seen as an international planning and consenting benchmark model for the industry. With this model, the DEA granted necessary permits for other ministries, including the Danish Nature Agency, Maritime Authority, Coastal Authority, Agency for Culture and the Ministry of Defence. The Danish TSO (Energinet) was essential in providing priority grid access for OWP [72, 73].

In 2004, the DEA called for tenders for OWP farms at Horns Rev and Rødsand. This followed a broad energy-policy agreement in the Danish parliament that ensured, among other things, the basis for establishing two 200 MW OWP farms [74]. In 2007, the Danish government also released a new policy for identifying potential locations for OWP farms and better strategic planning (Danish Energy Agency, 2017).

Regarding the spatial policy instruments in France, maritime spatial planning involves identifying macro-zones for OWP

development and conducting comprehensive public consultations [39]. The OWP planning process is guided by the European maritime spatial planning directive (introduced in 2014), highlighting the role of supra-national institutional and regulatory frameworks. The French government adopted new regulations and formalized the maritime plan for OWP projects. The legislation on Integrated Management of the Sea and the Coastline was included in the Environment Code (art L 219–1 et seq. Environmental Code). In 2009, the Minister for Energy requested the region's maritime prefects to identify suitable areas for OWP development to launch the call for tenders. In 2016, the French government adopted an administrative litigation concerning OWP projects by adopting a single court of appeal regarding OWP matters.

In 2018, the ESSOC Act brought changes that allowed permits to be modified after their issuance within limits defined by the law for supporting OWP projects. The act also provides that the environmental impact assessment of the projects needs to be made available to the OWP project owners by the Minister of Energy. Before launching competitive bidding procedures for the construction and operation of OWP projects, the Minister of Energy is required to refer to the National Commission for Public Debate. Provisions were also established to organize public debates before the competitive bidding procedures regarding the choice and the location of the potential areas for installing the OWP projects [50].

Vertical policy instruments

Regarding vertical policy instruments, the French government also made OWP turbine manufacturing a part of its industrial policies and invested in R&D to become a leading international player. The French government, moreover, used local content criteria in the first tender round of OWP farms (called 'Patriotisme écologique') to stimulate the domestic supplier industry [75].

In 2018, a new facility was opened in Cherbourg for wind turbine blade manufacturing for the GE Haliade- X12 MW turbine. Building a blade factory was a strategic decision based on the requirements in the earlier tenders. GE wanted a leading role in France's offshore wind energy market and decided to ramp up its supply chain quickly (Interview 14). The government has also been focused on generating local employment by developing the OWP industry and setting a target of 20 000 direct and indirect jobs by 2035 [51]. Due to the infancy of the French OWP market, supply chain developments have, however, been limited.

In Denmark, there has been an emphasis on creating an industrial base to develop the OWP industry. The focus on industrial policy has resulted from initiatives emerging from the anti-nuclear movement and developing an alternative energy plan for creating a low-carbon industrial trajectory. A number of industrial policy instruments were utilized to achieve this vision, such as requesting the fossil fuel incumbent firms to transfer their assets and modify their industrial trajectory, the use of taxes on fossil fuel consumption, long-term and stable market intervention mechanisms to promote wind turbine manufacturing and production, grants for wind turbine manufacturers, subsidies for offshore wind facilities and long-term support for R&D test stations [52].

DISCUSSION

This paper analysed how regional assets and multi-scalar institutional environments have influenced green path creation in Southern Denmark and Normandy, taking a comparative regional and cross-national approach [12]. The preceding case study analysis explored how variation in regional assets and the multi-scalar institutions shaped OWP industry developments of OWP in the two cases. These differences help explain how Southern Denmark became a pioneering region within this fast-growing sector, while developments in Normandy have lagged behind (summarized in Table 1).

Our study emphasizes regional assets' role in green path creation. Those assets must be adapted for OWP, and new assets are also required [27]. Especially Southern Denmark region has successfully redeployed existing regional assets to support OWP and benefitted from the first-mover advantages and an enabling multi-scalar institutional environment since the early 1990s. The regional industry comprises both lead firms and a broad supplier base, built on pre-existing assets from other offshore activities and the domestic solid onshore wind energy industry. Regional actors such as the Port of Esbjerg in Southern Denmark played a critical role in developing the material and infrastructure assets infrastructure [32, 39, 41]. It is also fair to say that OWP-related industry developments in Denmark, at least those related to offshore logistics, have been concentrated around Esbjerg. As such,

Table 1. Contrasting development trajectories in Southern Denmark and Normandy (Based on [12])

Region	Regional assets	Multi-scalar institutional environment	Characteristics of the regional path creation process
Southern Denmark	Substantial pre-existing assets in all categories (infrastructural and material, industrial, institutional) have been further modified and adapted to fit the needs of the OWP industry both domestically and internationally	Mature and stable long-term policy support environment with an adequate level of coordination between the market and industry development at the regional and national level	Deep-rooted holistic industrial development
Normandy	Suitable pre-existing regional assets, even if less broad industrial assets. Some adaptations and modifications in relation to OWP, however mostly underutilized	Constrained multi-scalar institutional environment, lack of long-term policy support and limited coordination between the market and industry development at the regional and national level	Shallow and partial industrial development

Southern Denmark has not suffered from inter-regional competition for investments as resources. Most notably, the national government in Denmark provided a more stable policy environment, market regime and long-term support mechanisms to support OWP compared to France.

Compared with Southern Denmark, the Normandy region is a latecomer region in the OWP industry. While OWP-started developments started with the Veulettes-sur-Mer wind farm, the project faced challenges due to the opposition by local citizens and civic associations regarding the negative impact on coastal landscapes, conflicts between the project developers, fishermen, groups and the offshore administrators over the lack of suitable maritime planning regulations. In the subsequent phases, industry developments related to OWP have been slow, especially due to a constraining multi-scalar institutional environment [38]. There were challenges related to cumbersome negotiations between regional and national authorities over the planning of OWP projects, slow tendering processes, competition with nuclear energy and ongoing resistance against OWP from fishermen and citizens. Challenges related to frequent regulatory adjustments, renegotiation of tariffs and the need for systematic planning processes for the different tenders created significant delays in implementing the OWP projects [39, 49]. Furthermore, the Normandy region also had to compete with other regions in France (e.g. Brittany, Pays de Loire) over scarce national support for the deployment and industrial development of OWP.

CONCLUSION

How regions contribute to the deployment of RE and manage to develop new industrial growth paths is an important topic to energy transitions scholars and practitioners alike. In this paper, we analysed the distinct trajectories of OWP development in Southern Denmark (a pioneering region) and Normandy (France, a latecomer region). As such, the paper contributes to ongoing debates concerning geographically uneven energy transitions and associated opportunities for industry development and value creation [5, 76]. Drawing on a geographical political economy (GPE) approach [11, 12], our analytical framework emphasized the role of regional assets and multi-scalar institutional environments in shaping industrial development trajectories.

Our analysis revealed that Southern Denmark has benefited from a broad range of pre-existing regional assets that have been further adapted to fit the needs of the OWP sector. An enabling multi-scalar institutional environment, including domestic (national-level) policies that supported OWP market development, was crucial for the OWP industry path developments. In contrast, and despite similarities with Southern Denmark with regards to pre-existing assets (as well as good wind resources), industry developments in Normandy have been hindered by a lack of supportive policies, especially in relation to market formation.

These insights point to the need for coordinated policy initiatives that help sustain industrial development over time. This concerns both developing regional assets and addressing shortcomings in policy and institutional environments. The case of Normandy also illustrates the difficult task of balancing the inclusion of stakeholders that may be adversely affected by RE developments (e.g. fishermen, citizens) with the ambition of RE deployment.

The paper has limitations that require reflection and can be addressed in future research. The Varieties of Capitalism (VoC) approach can, for example, be utilized to study how specific national political-economic conditions constrain and facilitate the development of new renewable energy industries in different regional and national contexts [12, 45, 53]. Another alternative perspective would be to combine insights from the technological innovation systems (TIS) literature with economic geography [54] to better account for how technology-specific characteristics influence green regional industry path development. There is also a need for examining more in-depth how lagging or so-called left behind regions [55] can partake in the development of new renewable energy industries in ways that enable more inclusive energy transitions.

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Authors' Contributions

S.J. contributed to conceptualization, original draft writing, writing, review and editing. M.S. contributed to conceptualization, original draft writing, writing, review and editing. T.H. and S.A. contributed to conceptualization, writing, review and editing.

Supplementary Data

Supplementary data are available at *Oxford Open Energy* online.

Conflict of interest

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Data Availability

There are no new data associated with this article.

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