**Article:**
Gibbs, D and Jensen, PD orcid.org/0000-0001-6406-7771 (2022) Chasing after the wind? Green economy strategies, path creation and transitions in the offshore wind industry. Regional Studies, 56 (10). pp. 1671-1682. ISSN 0034-3404

https://doi.org/10.1080/00343404.2021.2000958

Draft Author Version: Accepted for publication in *Regional Studies*, 30th Nov. 2021.

# Chasing after the wind? Green economy strategies, path creation and transitions in the offshore wind industry.

*David Gibbs[1] and Paul D. Jensen[2]*

[1]Department of Geography, Geology and Environment, University of Hull, HU6 7RX, UK.

[2]School of Earth and Environment, University of Leeds, Leeds, LS2 9JT.

Contact details:

d.c.gibbs@associate.hull.ac.uk (Corresponding author)

p.jensen@leeds.ac.uk

## Abstract

There has been a growing interest by both academics and policy makers at the local and regional scales in the development of a green economy to promote both economic development and achieve environmental policy aims. Despite this, we have little evidence as to whether either the economic or environmental aims are being met, nor how local and regional authorities are promoting and developing green economies in their localities. In order to address these issues this paper explores the development of the offshore wind industry in North West Germany, drawing upon sustainability transitions research and path creation literature.

## Keywords

Green Economy, Offshore Wind Industry, Sustainability Transitions, Multi-Level Perspective, Path Creation, Renewable Energy



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

## Introduction

Green economy strategies are increasingly proposed as a solution to both economic and environmental problems at a variety of spatial scales (see for example Labour Party, 2018; European Commission, 2019; Ocasio-Cortez, 2019). Both policy makers and academics have shown a growing interest in the development of a green economy, defined as being "low carbon, resource efficient, and socially inclusive" (UNEP, 2011: 16). At the regional scale, actors have begun to position their locations as leaders in the green economy and as destinations for new forms of investment (Gibbs and O'Neill, 2014). These have been termed 'transition regions' constituting sub-national administrative areas with policies and support mechanisms in place to encourage and develop green industries (Cooke, 2011) and which it is claimed aim to break "out of path dependence upon fossil fuels in production and consumption" (Cooke, 2012: 825). However, we have a limited understanding of the ways in which local and regional governments are developing their green economies and the related institutional and governance shifts that are involved (Grillitsch and Hansen, 2019). For regional studies scholars therefore, it is "an outstanding challenge to understand the opportunities for green growth development at the regional scale" (Capasso et al., 2019: 397). From an academic perspective research into green economic development has drawn on two bodies of literature. The first of these has built on research in evolutionary economic geography to identify green path creation, and the second upon sustainability transitions research at sub-national scales (see for example, Trippl et al, 2020; Coenen et al, 2010). The overarching aim of this paper is therefore to contribute to the call for "greater attention to the geography of green growth processes" (Capasso et al., 2019: 400) and to examine the local and regional impacts of green economic developments. In particular, the paper focuses on three research questions: what is the role of agency in developing green



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

economic development at the regional scale? What are the regional institutional and asset base changes involved? How are such strategies justified and legitimated?

In order to address these questions, the paper focuses upon one green economy sector that has been targeted by local and regional policy makers in recent years, the offshore wind (OSW) industry. In common with other green economy initiatives, much of the rhetoric around OSW has focused on both its supposed environmental (low carbon energy generation) and economic (job generation, inward investment) benefits for regions (Kern et al., 2014; Karlsen, 2018). For example, in Europe, it is argued that the growth of the OSW industry "has been driven by policy goals to reduce greenhouse gas emissions, enhance energy security, and facilitate 'green growth'" (Steen and Hansen, 2018: 196). Empirically this paper examines the development of OSW industry strategies in North West Germany, with a particular focus on Bremerhaven (Bremen) and Cuxhaven (Lower Saxony). Here, strategies to develop an OSW industry through indigenous growth and to attract investment from OSW companies have occurred, primarily aimed at countering long-term economic decline and unemployment.

The structure of the paper is as follows. The next section of the paper outlines the theoretical background to the paper, focusing on research into sustainability transitions and the path creation literature. After an outline of methods used to collect the empirical data, subsequent sections examine strategies to develop the OSW industry in Bremerhaven and Cuxhaven and consider the extent to which economic development expectations have been met. A discussion of the empirical results and a concluding section link the empirical findings back to the theoretical framework and outlines a future research agenda.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

## Sustainability Transitions and Path Creation

One useful perspective from which to investigate the growth of the green economy and thus the OSW industry is provided by sustainability transitions research, in particular the multi-level perspective (MLP) approach (Smith, 2003; Geels, 2005). The MLP identifies three synergistic levels: the socio-technical *landscape*, which encompasses the wider context, and which influences niche and regime dynamics, and includes spatial structures (e.g. regional infrastructure), political ideologies, societal values, beliefs, concerns, the media landscape and macro-economic trends (Geels, 2011); a meso-level of socio-technical *regimes* (such as fossil fuel-based energy systems), that include interconnected systems of existing technologies, institutions, rules, norms and practices (Berkhout et al., 2003); and a micro-level of protected *niches*, which act as test-beds for innovative ideas and technologies and the potential emergence of new socio-technical constellations (such as renewable energy and offshore wind) that have the potential to challenge the existing regime (Späth and Rohracher, 2010).

Sustainability transitions research incorporates accounts of human agency and stresses the importance of institutional drivers and barriers for the emergence of new industries (Capasso et al., 2019). In addition, research has focused on the ways that new technologies gain acceptance and legitimation (MacKinnon et al. 2021; Jolly and Hansen, 2021). The latter concept refers to "the narratives and strategies developed by supporters of emerging technologies and industries" (MacKinnon et al. 2021: 1) and the consonance of an industry with its institutional environment (Jolly and Hansen, 2021). The dynamics of legitimation influence the ability to mobilise resources for new forms of economic development and the acquisition of political influence to enable this (Binz and Gong, 2021). 'Regional imaginaries'



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

can also play a role, referring to the narratives and visions employed by actors to support their strategies for new forms of economic development, and which can act to align these with perceived opportunity spaces (Miorner, 2020). These can draw upon shifts at the landscape level of the MLP, such as the growing importance of climate change and environmental policy to justify green economy policies. For example, Sotarauta and Suvenen (2019) argue that regional policy makers and 'place leaders' in Finland draw upon a 'national mindset' and a shared policy ambition of a green growth agenda to justify creating the conditions for their own green economy initiatives. In this case, "public policies are crucial for place leaders, as they provide a generic direction, a legitimate context in which to operate and some financial support" (Sotarauta and Suvenen, 2019: 1763).

In the specific case of OSW, MacKinnon et al. (2021) identify four legitimation narratives: combating climate change, energy security, cost reduction and creating economic value (e.g., job creation and investment). These are seen as key issues where those advocating OSW developments align their narratives with broader policy agendas to legitimate the development of, and support for, OSW. In particular, economic value creation is a key source of legitimacy in the sector at the regional scale with expectations of green jobs and investment. MacKinnon et al. (2021: 10) argue that the sector's "tendency to create employment in peripheral and maritime regions, which often lack alternative sources of growth and investment, enhances its legitimacy". Sectors can thus gain legitimacy if they are seen as providing solutions to identified problems – this may then translate into policy support, although changes in politics may subsequently close windows of opportunity (Jolly and Hansen, 2021).

However, sustainability transitions research does have shortcomings when exploring green economic development. First, it is largely silent on the particular forms of the green economy that are being developed (Feola, 2020), despite its theoretical focus on the major shifts in socio-economic development required for a more sustainable future (Chatterton, 2016; Sheldrick et al., 2017). Rather, the implicit assumption is that such shifts will contribute positively to both sustainable practices and ecological improvement and that sustainability transitions are "relatively linear and teleological" (Koehler et al., 2019: 3). This view is problematic given that in reality transitions may experience setbacks and encounter resistance (O'Neill and Gibbs, 2020). Moreover, supposedly green industries may have negative environmental impacts (see Gudmunsdottir et al., 2018 for an example). Second, little attention has been paid to *where* transitions are taking place (McCauley and Stephens, 2012). In cases where space *has* been explicitly addressed, the main focus has often been on national scale transitions (Hodson and Marvin, 2010). This lack of spatial context has been recognised as an important shortcoming in transitions research, as inattention to space hinders it from adequately capturing the evolution and development of networks of institutions, entrepreneurs and innovations into stable forms that can challenge and replace existing regimes (Truffer and Coenen, 2012). Sustainability transitions will depend on the interplay of actors, networks and institutions available in some places (and regions) and not others (Raven et al., 2012). Some regions may offer greater opportunity for niches to develop and operate and for the formation and development of green economy activities (Coenen et al., 2010).

One way to address these shortcomings is to combine elements of transitions research with a body of literature around path creation in evolutionary economic geography, which has



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

aimed to explain the establishment and growth of new economic sectors in particular localities (MacKinnon et al., 2019), reflecting calls for greater theoretical pluralism in transitions research (Hopkins et al. 2020). Martin and Sunley's (2006) initial research produced a 'path as process' model which identified five routes to new path creation:

- indigenous path creation
- transplantation (i.e., importation of new firms, technologies and industries)
- diversification (i.e., into related industrial sectors)
- heterogeneity and diversity
- upgrading of existing industries.

While initially the path creation literature saw firms and entrepreneurs as the main sources of new path creation (Dawley et al., 2015), more recent work has called for research to "extend the analytical focus beyond firms as actors and pay more attention to the question of how non-firm actors such as users, universities, intermediaries and policy actors shape new regional industrial path development" (Hassink et al., 2019: 1642). In response, work by Trippl et al. (2020) combined path development research in evolutionary economic geography with a regional innovation systems approach to allow analysis to move beyond a firm-centred approach. This allows a multi-actor approach including institutions, policy actors, support organisations and research bodies, not just locally but also involving broader multi-scale linkages (Jolly and Hansen, 2021).

However, although path development work has focused on the emergence of new industries, "far less attention has been directed toward *green* industrial development and industry emergence processes" and to "how society can move toward sustainability through green path creation (Njors et al., 2020). Green path development has been defined as



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

"industrial development around products, solutions or technologies that 'reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services'" (Sotarauta et al., 2020:2). In common with the critique of more mainstream path development research, Sotarauta and Suvenen (2019: 1763) argue that we need "a better understanding of agency in path development and green growth". In addition, green path development may require modification of the regional asset base, which includes human, institutional and infrastructural assets, brought about by "different types of agency performed by multiple actors at various spatial scales" (Trippl et al. 2020: 192).

In order to address these issues Trippl et al. (2020) proposed four main forms of green path development, by reference to Martin and Sunley's (2006) initial work:

- Path renewal: through adoption of green technologies or more eco-efficient practices in existing industries
- Path diversification: where existing sectors branch out into new green industries, whether related or unrelated
- Path importation: involving green industry new to the region, especially though inflows of non-local firms, assets and knowledge
- Path creation: through the establishment of completely new green industries, for example through spin-offs or green entrepreneurship.

In an overlap with the transitions literature, Simmie (2012) suggests that path creation can occur through the actions of 'knowledgeable agents' initiating new technologies such as OSW in niches that are protected from normal selection criteria. Niche development can therefore be coupled with local path creation and regional development (Essletzbichler,



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

2012). However, as Strambach and Pflitsch (2018: 297) comment "change does not only develop in protected, deliberately created spaces but that regional paths offer actors opportunities to initiate change from within". This is a process of 'strategic coupling' between regional assets and the strategic needs of firms such that "the emergence and development of a new path may be mediated…by the matching of regional assets to the strategic needs of transnational corporations" (Dawley, 2014: 97). There has thus been a growing recognition that path development accounts need to include agency and the actions and interventions by actors beyond firms to create or alter paths, including both intra- and extra-regional resources (Boschma et al. 2017; Hassink et al., 2019; Chen and Hassink, 2020). This can include state actors and public policy (Dawley, 2014), institutional entrepreneurs (Sotarauta and Suvenen, 2018) and place leadership (Grillitsch and Sotarauta, 2020), all of which are important in mobilising power and resources to transform institutions and to stimulate and shape new path development (Miorner, 2020).

Such 'system building' activity therefore plays an important role in both path development *and* transitions research (Binz and Gong, 2021), reflecting a recognition that change "emerges from the actions of multiple actors with different visions and interests" (Bækkelund, 2021: 2). In transitions research, system building involves developing actor support and intermediary organisations, while in the path development literature the focus is more on system reconfiguration, such as through path upgrading or importation (Binz and Gong, 2021). Green development paths can therefore be initiated by firm-level or system-level agency, or a combination of the two (Hassink et al., 2019). Before turning to an examination of how this approach can be used to explain OSW developments in North West Germany, the methods used for this paper are outlined in the next section.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

## Methods

An initial desk-based study and evidence review was conducted for both locations. The authors were also involved in a large-scale research and consultancy project on renewable energy and green path developments for a port in the UK. This involved comparator research with other European locations, including Bremerhaven and Cuxhaven, and comprised a set of informal discussions with 23 personnel and stakeholders of European energy businesses and regional institutions. The authors were also present at site visits, steering group and project board meetings for the project and were able to draw upon discussions at these meetings. Expert insight was also gained from attendance at, and participation in, three workshops on offshore wind and green path development held in the UK, but involving representatives from Bremerhaven, experts from Denmark and the Netherlands and a range of industry and local authority representatives. Based upon the insights gained from this work, subsequently a total of seven interviews were conducted with private and public sector representatives in Bremerhaven and Cuxhaven between November 2017-February 2018 through a mix of face-to-face, telephone and Skype interviews. All interviews were conducted in English and digitally recorded, transcribed and qualitatively analysed to structure analysis themes. Interview transcripts were coded based on themes from the literature, specifically relating to interview responses, but also as a result of themes that emerged during the course of the interviews. Secondary material was also obtained from the web sites of the respondents' organisations and from other material that they forwarded after interview, including internal reports, theses and PowerPoint presentations.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

## Offshore Wind Development in North West Germany

### *Local contexts*

The North Sea coastline in North West Germany is the heartland of the German OSW industry with the main focus for development in the two ports of Bremerhaven and Cuxhaven (Fornahl et al., 2012; Wieczorek et al., 2015). Bremerhaven sits on the mouth of the Weser Estuary and is part of the Land of Bremen, one of Germany's three city-states (Stadtstaaten) – the Free Hanseatic City of Bremen – and comprises the two cities of Bremen and Bremerhaven. Cuxhaven is located on the North Sea coast between the rivers Elbe and Weser and is part of the Land of Lower Saxony (Niedersachsen), the second largest German state (see Figure 1). Bremerhaven has seen a long-term decline in its traditional industries of fishing and shipbuilding, although food and fish processing remains a key sector. The city is an important container port (the fourth largest in Europe) and acts as the main shipping centre for Germany's car industry. Cuxhaven has similarly experienced a weak economic situation following a decline in fishing and associated industries and the closure of a naval base. Both locations have experienced long-term economic decline, with higher than national levels of unemployment (for example, at its peak in 2005 unemployment in Bremerhaven was 26% and 12.8% in Cuxhaven compared to a national rate of 11.7%). More recently, at state level, unemployment rates in 2021 remained higher than the national rate of 4.3%, at 11.3% in Bremen and 6% in Lower Saxony[1]. Bremerhaven in particular has high levels of local poverty and welfare benefit recipients, as well as a negative external image of the city inside Germany.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

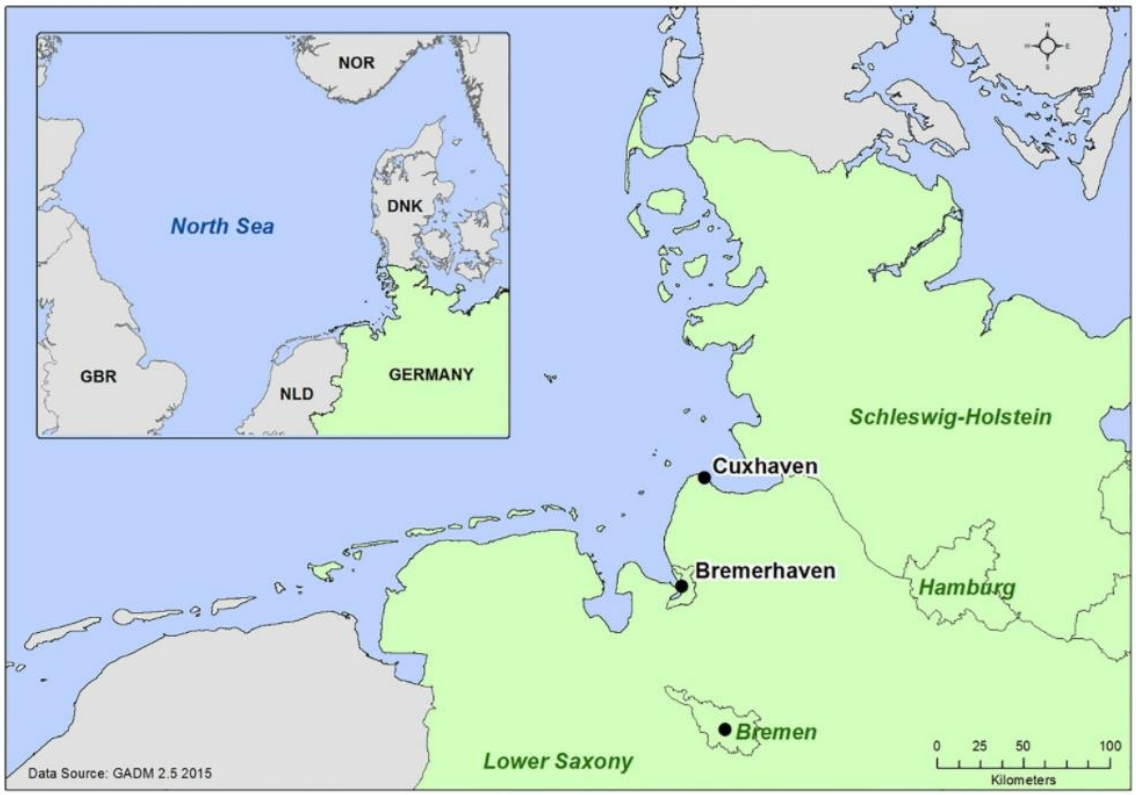


**Figure 1**. Locations of Bremerhaven and Cuxhaven, Germany.

Source: Adapted from Gerber et al. (2016)

***Legitimation for offshore wind development***

In both locations a key factor in legitimating policy towards developing OSW was the perceived opportunity to bring investment and jobs. In 2002 the state of Bremen started to promote itself as a centre for the industry, with a major role for Bremerhaven's economic development company - the Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung (Bremerhaven Society for Investment Promotion and Urban Development) (BIS), funded by the local and state governments to attract in new investors. The stated aim was to become "*Europe's premier location for offshore wind energy projects*" (BIS 2013: 3), with BIS working with businesses, R&D organisations, educational establishments and government to develop "*an integrated plan for the offshore wind energy industry*" (BIS,



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

2012: 1). In Cuxhaven, a similar legitimation approach was developed by the Business Development Agency to enrol other local actors:

> *From the beginning all parties supported offshore wind because we could convince them that it's a good opportunity after the long decline of the fishing industry and our naval base* [which had closed]*. So, at a certain point there was a lot of unemployment and we could convince them that renewable energies, and especially offshore wind, is a very good thing for the town and that's why they were all supportive at the time* (Interview, Cuxhaven Business Development Agency).

Thus, in both locations, a central justification for the development of OSW capacity was primarily as an economic development opportunity, rather than specifically as a *green* form of economic development. As one interviewee remarked "*the point was re-industrialising Bremerhaven*" (Interview, University Academic). As the following sections show, this fed through into the strategies adopted for green path development through the agency of local actors, involving efforts to build on and further develop the local asset base and infrastructure.

### ***Green path development and agency***

#### *Bremerhaven*

Existing locally-based research institutions such as the Alfred-Wegener Institute (AWI) and the Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) had a presence that pre-dated the OSW industry, but they played an important role in attracting initial interest and subsequent investment by the offshore sector. The city is also the



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

headquarters for the Windenergie Agentur Bremerhaven - WAB - (Wind Energy Agency) founded in 2002, which holds exhibitions and conducts sector studies and market analyses for its 400 or so members and has acted as an important networking facilitator (WAB, 2013; BIS, 2014). Bremerhaven's plans for developing an OSW industry were therefore a strategic attempt to build on existing assets, including these research institutions (Interview, University Academic). Initially the policy was a success, with six wind industry original equipment manufacturers (OEMs) locating there in a boom period up to 2009 producing components for the construction and placement of offshore wind turbines, including turbine generators, blades, towers and foundations. Employment reached a peak of around 3,500 jobs in 2014, with BIS (2013: 10) stating that: "*no other location has such a strong cluster of offshore wind energy producers and service providers on all levels along the value-added chain as in Bremerhaven*".

However, although it was thought that the OSW industry would prove to be the solution to mass unemployment in Bremerhaven (Interview, Development Agency), after early success, the sector suffered a decline. An initial success story, WeserWind, a fabricator of turbine foundations, was declared bankrupt in January 2015 as its tripod foundations were superseded by monopiles which were simpler to fabricate and install and proved to be as effective as tripods in deeper offshore waters. Structural change in the industry also saw shifting technology with larger turbines and a reduced number of installations needed as individual turbines rapidly increased from 3-5MW to 8-10MW capacity (Interview, University Academic). The sector was also undergoing consolidation into a smaller number of companies and by 2016 Siemens had an 80% share of the German North Sea offshore wind sector meaning that other companies, such as those located in Bremerhaven, were marginalised. Further closures occurred in Bremerhaven by Power Blades (wind turbine



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

blades) and Senvion, while Adwen, which had suffered from competition from Siemens, was eventually purchased by Siemens-Gamesa[2]. From a peak of 3,500 jobs in 2014 this declined to 1,500 by 2017, although both were well short of the initial projected target of 8,000 jobs.

*Cuxhaven*

Cuxhaven's OSW strategy also began in the early 2000s when the state of Lower Saxony decided that it would also build on local assets and develop the port of Cuxhaven as an OSW industry hub with the aim of fostering economic (re)development and job creation. The investment was intended to be a "*signal to the market that Cuxhaven…would be developed for offshore wind and that it could attract private investment to Cuxhaven for this purpose*" (Interview, Cuxhaven Port). Between 2008-15 Cuxhaven's Offshore Masterplan involved developing an additional 100ha of industrial land and the construction of two offshore terminals (Steitzel, 2016). The local economic development agency, the Agentur für Wirtschaftsförderung (AfW) was an important actor leading the OSW strategy, but there was also continued strong support from the Lower Saxony state government, which invested €250m in infrastructure, plus investment in harbour facilities through Enport, the harbour development company. On completion, the management of the infrastructure remained with the publicly-owned Port Authority. While this investment decision was based on strong interest from the private sector and OSW market signals, there was also an element of public sector-led *"build it and they will come"* (Interview, Port Authority).

However, despite being in negotiations with potential investors from 2007 onwards, Cuxhaven initially had mixed fortunes in attracting offshore wind investors. Between 2007-11 investment came from AMBAU[3] (producing towers and monopile transition pieces) and Cuxhaven Steel Production (foundations), but the port saw the closure of Stabarg Offshore



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

wind, and stagnation between 2012-14 (Stietzel, n.d). Despite these early setbacks through closures, however, the strategy appeared to have been successful following a decision by Siemens in 2015 to locate their nacelle[4] plant in Cuxhaven. The Cuxhaven Offshore Masterplan that had initially identified opportunities to attract the OSW industry, through the agency of state government investment in a heavy load platform and an offshore test site, had seemingly paid off. Indeed, the availability of existing infrastructure was a key factor in Cuxhaven's 'breakthrough' (Stietzel, n.d.) and reflects changes to the regional asset base and infrastructure in both locations.

***Regional asset base and infrastructure***

Bremerhaven's OSW strategy was dealt a major blow by the Siemens decision to locate their new nacelle construction plant in Cuxhaven. Bremerhaven had been Siemens first choice, but this had been dependent on the development of a new terminal – Offshore Terminal Bremerhaven (OTB). The OTB was launched as a project by the state government in 2010 and, with a similar aim to that of Cuxhaven, was intended to provide the infrastructure to position Bremerhaven as a key centre for OSW in Europe. It involved developing 0.5km of heavy load quay and 2-3 new berths and was intended to provide deep water access to avoid the restrictions of water depth and width imposed by the existing lock system in the port (BIS, 2017). This would mean that turbines could be loaded directly onto sea-going vessels, reducing logistics costs. The OTB was planned to have a capacity of up to 160 wind turbines per annum and a completion date of 2016. As part of the overall development plan, the adjacent Luneort/Luneplate industrial estates were designated as "production and assembly areas for the foundation, tower, nacelle and rotorblade production as well as for



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

storage and final assembly" (BIS, 2013: 24). Industry representatives were supportive of the OTB arguing that there was a need to develop local infrastructure: "*we urgently need to expand port capacity, in other words, the OTB, and to open up available space to maintain the city's key role in offshore wind energy*" (Norbert Giese, Repower Systems SE, quoted in BIS, 2012).

However, the OTB plans ran into problems partly due to mistakes in the planning application and also due to opposition and litigation from the environmental NGO Bund für Umwelt und Naturschutz Bremen e.V. (BUND), who argued that the planned site was an important area for biodiversity:

> "*There were so much discussion about this new terminal because it cost a lot of money, €180million and the next problem was next to natural habitat, so we had to discuss with the environmental agencies…we had this industrial area but no suitable port and that was very bad here for Bremerhaven because it meant at the same time* [Siemens were looking] *for industrial sites and we couldn't promise that*" (Interview, BIS).

At the same time the initial legitimation for the OSW strategy and demand for such a facility was subjected to criticism by some local actors. The technological shift within the OSW industry towards larger capacity turbines meant that a reduced number of turbines would be handled by the OTB, calling into question the demand for increased capacity. Politicians in Bremerhaven also became increasingly critical of the lack of Federal support for the industry and called for greater policy clarity, grid expansion and grid connection to encourage investment from the OSW sector[5] (BIS, 2012). Questions were also raised about the scale of the state investment needed given that Bremen had budgetary problems – local



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

politicians were *"saying why don't you finance this privately somehow if it benefits the industry?"* (Interview, University academic).

The delays in approval for Bremerhaven's OTB gave Cuxhaven the opportunity to attract Siemens' investment and to build on its earlier infrastructural development:

> *Siemens was looking for a base port for a long, long time and for a production port. I think we have been in contact with them for…six, seven years…the transport of those massive components overland to Bremen was too complicated, so they were looking for a production site where they could really do everything very close, directly more or less to the quay line…We had everything ready in place here in Cuxhaven. They found that they could use the infrastructure which was already in place and waiting for them*" (Interview, Cuxhaven Business Development Agency).

Thus, Cuxhaven had the advantage of possessing an existing quay as a result of speculative early moves by the State government of Lower Saxony to develop infrastructural assets, whereas a Bremerhaven location depended upon the construction of new infrastructure - "*that was a major point for Siemens, when we come to Cuxhaven we have no legal uncertainties, the harbour is there, the offshore terminal is there. In Bremerhaven we don't even know at what time the terminal will be ready; will there be legal feuds and will there be a lot of uncertainty?*" (Interview, Cuxhaven Business Development Agency).

***Stalled path development?***

The Cuxhaven plant is Siemens first offshore wind plant in Germany and is a 'one stop' production facility for generators, hubs and the back end (cabin) section for direct drive



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

7MW turbines, with capacity for 8MW turbines (Stietzel, 2016). The decision to invest in Cuxhaven had an impact in employment terms in both Cuxhaven itself and in Bremerhaven:

> "*it meant the loss also of labour in the other elements of the value chains that were situated in Bremerhaven. So, after a peak of about 4,000 jobs in Bremerhaven it went down to 3,000 and perhaps 2,000 nowadays. That's one thing. The second thing is, in Cuxhaven it went up. The consequence of the Siemens factory is 1,000 new jobs, so it's about 2,000 there now and perhaps 2,000 in Bremerhaven*" (Interview, University academic).

While Bremerhaven retains a small workforce for OSW servicing and maintenance, this is far short of the original projections of 8,000 jobs or more being created by the sector.

Initially, it appeared that a cluster was developing around the OSW equipment manufacturers in Cuxhaven, with associated job losses in Bremerhaven:

> *One factory that was based in Bremen which is 50 kilometres south of Bremerhaven and 90 kilometres south of Cuxhaven…was a supplier to industries in Bremerhaven, now it's relocated…the main part of its business with 300 jobs to Cuxhaven.* [They] *said we need to be near our market...So you can see that activities directly related to this value chain and which are suppliers for Siemens, they start to locate in Cuxhaven. So the effect goes very much further than the direct 900-1,000 jobs, it's now 1,000-1,500 or even more. And of course these are direct losses in Bremen and Bremerhaven*" (Interview, University academic).



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

However, after this initial success Cuxhaven has struggled to attract additional investment, despite developing an industry park (in a similar strategy to that in Bremerhaven) to facilitate the co-location of suppliers:

> *We* [thought] *that the building up of the supply chain would be faster. So up to now there's one company called North Mark, from Denmark, and…another company they will sign the contract…in the next month…the problem in my opinion was that Siemens give to their supply chain companies only contract for one, two and very rarely for five years and making a large investment as a supplier in the direct vicinity of the Siemens production site means you also have to invest some 10, 15, 20 million Euros…so they need longer term contracts and that was…the obstacle…for smaller companies*" (Interview, Cuxhaven Business Development Agency).

***Discussion***

Both Bremerhaven and Cuxhaven have developed economic development strategies aimed at bringing OSW development to cities which have experienced long term economic decline, high levels of unemployment and the loss of traditional sectors and employers. Green path creation has been conditioned by wider political and economic contexts including national energy policies (in the case of renewable energy strategies), the presence of R&D institutions (in the case of Bremerhaven) and regional scale strategies in both locations (Dawley, 2014; Fornahl et al., 2012). Initially OSW development had supportive landscape and regime conditions through supranational (EU) carbon reduction targets and nationally with ambitious Federal renewable energy targets, subsidies and the phase out of nuclear energy (Wurzel et al., 2019). These played a key role in legitimating local OSW development



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

strategies and provided a window of opportunity for local actors to engage with the strategic needs of global companies. However, this changed in 2014 as Federal policy responded to consumer concerns over the increasing costs, given that the cost of renewables was met by a surcharge on consumers' energy bills (Jonas et al., 2017). The 'strompreisbremse', or energy price break, was aimed at reducing the financial burden of renewables development on Federal expenditure. This commitment to energy cost reduction created uncertainty in the market at this time and led to a suspension of active consenting activities for some renewables technologies, including OSW (MacKinnon et al., 2021). Subsequent Federal policy developments, however, have committed to the 'Energiewende', the plan to make Germany's energy system more efficient and mainly supplied by renewable sources[6].

OSW developments in Bremerhaven and Cuxhaven were initiated by the agency of state policies, but the key local 'system builders' were the local development agencies of BIS and the AfW working in conjunction with other local actors. In Bremerhaven the managing director of BIS has been a leading figure in promoting both OSW and subsequent green economy initiatives illustrating the key role of those system builders or institutional entrepreneurs "who intentionally create, maintain and change system resources that help building, diffusing and further developing new technologies" (Trippl et al., 2019: 12). Key local actors in both cities have thus played an important role in perceiving the opportunities offered by renewable energy and using the perceived economic development benefits to legitimate attempts to initiate strategic coupling between local assets and global corporate demands. In both Bremerhaven and Cuxhaven, the agency of both state and local government actors has been of importance in green path creation through the actions of



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

local intermediaries to facilitate infrastructure investment and changes to the local asset base in both Cuxhaven and Bremerhaven.

System-level agency has been important through public support initiatives driven by national and federal system-level actors (Trippl et al., 2020). A key factor here has been the ways in which "regional and national actors work to attract and embed investment from lead firms and key suppliers" (Dawley et al., 2019: 2). In relation to Martin and Sunley's (2006) 'path as process' model, path creation has occurred through indigenous path creation (at least initially), transplantation (i.e., importation of new firms, technologies and industries) and diversification (i.e., combining existing shipbuilding knowledge and infrastructure with that from OSW inward investment) (Hassink et al., 2019; Chen and Hassink, 2020). Here the "emergence of new green industries through path creation and path importation processes implies the rise of totally new green industries (path creation) or the settlement of green industries that are new to the region (path importation). Path importation results from inflows and anchoring of non-local firms, talent, knowledge and other resources" (Trippl et al., 2019: 7).

However, relying on imported technologies may have limited potential for regional growth (Capasso et al., 2019) as the lack of cluster development in Cuxhaven indicates, and we need to remember "the potential fallibility of inward investment within peripheral regions" (Dawley, 2014: 107). Moreover, the emphasis in the literature is often on positive development paths, with less attention paid to negative outcomes, such as path downgrading or the failed establishment of new industries (Jolly and Hansen, 2021). Negative path development can involve the decline of a regional industry in terms of employment and capital accumulation, as well as adverse impacts on the regional asset



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

base. Where negative path development occurs it can take the form of path contraction, path downgrading and path delocalisation (or a combination of these) (Blazek et al., 2020). There are certainly elements of all three of these outcomes present in both Bremerhaven and Cuxhaven which raises the question of the longer-term viability of the OSW manufacturing sector as a major employer and contributor to the local economy.

While in the early stages of offshore wind development there were a number of potential investors who could have located in Bremerhaven, subsequent market consolidation means this is now down to one or two, so that *"one decision can make or break a region's fortunes"* (Interview, University academic). Indeed, in both Bremerhaven and Cuxhaven employment creation and investment have fallen well short of initial projections, so that the economic outcomes from green industry development in both locations have been limited. This is partly due to structural and technological change (particularly the growth in turbine size), but also a consequence of consolidation in the OSW sector and the dominance of a small number of companies whose investment decisions have played a major role. This meant that Bremerhaven and Cuxhaven ended up competing for the same investments. By 2018, the OSW market had become dominated by a handful of businesses, with 70% of the European market (in respect of total installed GW) held by Siemens-Gamesa alone[7]. Dominance of the market by a small number of businesses is important. Given that Siemens and other OSW companies such as Vestas have long standing contracts with other primary component producers with existing facilities (i.e., foundations, towers), such organisations do not make large investments without having their immediate critical supply chain already in place, and the potential for further developments in Bremerhaven or Cuxhaven through either indigenous path creation or transplantation is limited. For example, the Bremerhaven BIS view was that Siemens can now supply the European market from the Cuxhaven plant



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

and its location in Hull in the UK[8] (where a turbine blade manufacturing plant was established in 2016, Dawley et al., 2019) and that the opportunity to attract other turbine manufacturers had passed (Interview, BIS).

Bremerhaven's early first mover advantage, which was seen as creating a new green industry path for the city, may even have been a disadvantage given later developments in the sector. To some extent, this was seen as part of the process by those involved in promoting economic development locally - "*you also have to know that if you are a forerunner you make mistakes*" (Interview, BIS). Despite the fact that the impact of OSW has been less than expected, Bremerhaven's strategy and that of BIS remains optimistic about the potential for future green path development through the development of a sustainable industrial park as a flagship project (BIS, 2016):

> *Besides the renewable energy from offshore wind…there are other opportunities for Bremerhaven with regard to the energy transition…that's why we are developing… sustainable industrial areas here in Bremerhaven…there are still some industrial sites here that can be developed but we want to develop them in a sustainable way so that there is a good understanding between economy and ecology…we know that in the future more and more companies are asking for this kind of industrial site* (Interview, BIS).

Similarly, Cuxhaven's AfW sees potential in future green path development based around a hydrogen economy, using electricity generated by OSW to convert excess energy into transportable hydrogen[9]. Notably, however, the potential for a green economic transition based on so-called 'green hydrogen', whether in a path renewal or diversification scenario, is itself debated in terms of the resultant delayed climate action and the potential for



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

undesirable technology lock-in (Thomas et al., 2021). This, in effect, is the transitional front-runner potential risk-reward scenario that Bremerhaven faced with its pursuit of an OSW-based green economy.

## Conclusions

This paper has developed new insights into the processes of transition towards green regional economies, through exploring the role of agency by regional actors to bring about transitions. In terms of differing local relations and contexts, both Bremerhaven and Cuxhaven are areas of long-term industrial decline and have sought to reimage themselves as centres for renewable energy, particularly offshore wind, and are examples of a growing number of "places around the world promoting themselves as a hub for low-carbon development, where regional economic fortunes are hitched to becoming an important global locus for low carbon energy" (Bridge et al., 2013: 337). In MLP terms, shifting landscape imperatives around climate change have provided legitimacy and justification for these green economy policies. A supportive environment created through EU and national policies has enabled key actors in local development agencies to justify a green strategy that can be legitimated to other local stakeholders as a solution for unemployment and local regeneration. Local actors have thus drawn upon 'regional imaginaries' of a transformed local economy to justify their strategies and to enrol other actors.

Both local governments and their respective state governments saw the OSW sector as an opportunity to regenerate their localities, alter negative perceptions and reduce unemployment. However, not all actors were willing to be enrolled (cf Jaffee, 2015). As



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

Trippl et al. (2020) outline environmental NGOs and civil society organisations also play a role in green path development which can be both positive (building support, shaping values and beliefs) and negative (opposing the introduction of green technologies). In Bremerhaven, legal objections from an environmental NGO to the construction of Offshore Terminal Bremerhaven led to delays and stalled investment. Thus "initially favourable conditions…[can turn]…into unfavourable ones due to factors 'out of reach' of regional actors, thereby bringing processes of asset modification for green path development to a halt" (Trippl et al., 2020: 193). Such disagreements and local political fragmentation effectively resulted in a failure to modify Bremerhaven's infrastructural asset base. As a consequence OSW investment shifted from Bremerhaven to Cuxhaven where there was little or no opposition and where the relevant infrastructural assets had already been created through the earlier agency of the state government. This may mean little difference for the workforce and firms (given the relatively short commuting distance (43km) between the two cities), but the loss of tax revenue from Bremen to Lower Saxony precludes any wider regional political cooperation which might help to address the issues of competition.

The paper has thus provided new empirical evidence on the role of agency in green economic development, related institutional shifts and changes to the regional asset base and the ways in which attempts at green path development have been legitimated. This highlights the need for more empirical research into green economy transitions at the local and regional scale and the contribution this paper makes to both the transitions and path creation literatures, particularly though the focus on the role of agency and legitimation. Combining path creation with work on transitions has two advantages. First, it helps us understand how and where new green path development occurs and the particular impacts that it may have in



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

host regions. Second, the empirical evidence presented in the paper addresses the observation that "there is a dearth of knowledge about what actors do to create and exploit opportunities in given contexts, why they do so in some places and not in others, and why the effects of such efforts differ between apparently similar places" (Grillitsch and Sotarauta, 2020: 705).

While green economy strategies are increasingly proposed as a solution to both economic and environmental problems, the research presented here has shown that the impact upon the former is so far limited. In both Bremerhaven and Cuxhaven the anticipated job creation, inward investment and supply chain development have all been much lower than anticipated (Fornahl et al., 2012; Capasso et al., 2017), and substantially lower than the (often inflated) claims made by proponents in the early stages of development (Jaffee, 2015). Consolidation of the offshore wind industry and changing technologies (a shift towards larger turbines and IT-enabled monitoring and control systems) (Haakonsson et al., 2020; Jensen et al., 2020) reflect the growing maturity of the OSW industry. As MacKinnon et al. (2021: 10) comment "industry maturity and consolidation makes it more difficult for regions to break into the manufacturing value chain". Combining path creation with sustainability transitions research thus provides us with an approach that better conceptualises "the dynamics of ongoing socio-technical change in a spatial perspective" (Fastenrath and Braun, 2018:340) and allows us to better understand the processes and mechanisms whereby economies undergo transformation. Importantly, the research also illustrates that both path development and transition are not necessarily smooth processes and that apparent initial success can subsequently result in a negative path or stalled transition (Fastenrath and Braun, 2018; O'Neill and Gibbs, 2020).



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

However, the paper has only focused on one element of green economic development and green path creation. From academic, and particularly policy makers', perspectives, there is a general expectation that green economy developments and path creation can result in both positive economic *and* environmental impacts. From the empirical evidence in this paper, green economy strategies in Bremerhaven and Cuxhaven are largely seen as economic development strategies as part of a weak ecological modernisation approach and issues around social and environmental sustainability have received very limited attention. Indeed, notwithstanding the wider societal benefits of the adoption of the manufacture and deployment of renewable energy technologies, evidence of any regional environmental improvements emanating from Cuxhaven or Bremerhaven's courting of the OSW industry, are not clear. To date, we therefore have little empirical evidence whether green path development is resulting in a sustainability transition for improved ecological sustainability (Hickel and Kallis, 2019; Trippl et al., 2019; Njors et al., 2020). Similarly, while sustainability transitions research (by definition) envisages some form of transformation, it too is largely silent on the specific sustainability outcomes that should be developed. There is thus limited evidence as to how green economy initiatives are impacting upon the areas where they are located and we have little understanding of the environmental effects of green restructuring. A key question for a future research agenda is therefore "to what extent are the rise of new green paths and the green renewal of established paths contributing to achieving greater ecological sustainability?" Trippl et al. (2020: 196). This statement is particularly pertinent at the regional scale where the promise of a green economy transition continues to be used to both promote the adoption of a given technology and, indeed, portray them as being a source of long-term local economic recovery and reinvigoration. As



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

such, future research also needs to focus on the unanswered question of which transitions are actually sustainable (Feola, 2020) and the type of green path developments that are needed to in order to adequately address the major global environmental challenges, rather than implicitly assuming that they comprise "low carbon variants of life under capitalism" (Chatterton, 2016: 404).

## Acknowledgements

David Gibbs acknowledges the support of a Regional Studies Association Fellowship Research Grant. Paul Jensen acknowledges the support of Green Port Hull/Regional Growth Fund. Thanks to the three anonymous reviewers and the editor for their helpful and constructive comments and suggestions on an earlier draft of this paper. The usual disclaimers apply.

## References

Bækkelund, N G (2021): Change agency and reproductive agency in the course of industrial path evolution, *Regional Studies*, DOI: 10.1080/00343404.2021.1893291.

Berkhout, F, Smith, A and Stirling, A (2003) Socio-technological regimes and transition contexts, SPRU, University of Sussex.

BIS - Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung (2012), *Offshore Wind Report*. Bremerhaven: Economic Development Agency.

BIS - Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung (2013), *Bremerhaven: More than just a Port for the Offshore Wind Industry*. Bremerhaven: Economic Development Agency.

BIS - Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung (2016), *Mooring in Bremerhaven: Sustainable Business, Future-oriented Growth*. Bremerhaven: Economic Development Agency.

Binz, C and Gong, H (2021) Legitimation dynamics in industrial path development: new-to-the-world versus new-to-the-region industries, *Regional Studies*, DOI: 10.1080/00343404.2020.1861238.

Blažek, J, Květoň, V, Baumgartinger-Seiringer, S and Trippl, M (2020) The dark side of regional industrial path development: towards a typology of trajectories of decline, *European Planning Studies*, 28:8, 1455-1473.

Boschma, R, Coenen, L, Frenken, K and Truffer, B (2017) Towards a theory of regional diversification: combining insights from Evolutionary Economic Geography and Transition Studies, *Regional Studies*, 51:1, 31-45.

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

Capasso, M, Iverson, E J, Klitkou, A and Sandven, T (2017) Empirical research avenues for regional policy elaboration, NIFU Working Paper 2017:15, Oslo: NIFU.

Capasso, M, Hansen, T, Heiberg, J, Klitkou, A and Steen, M (2019) Green growth – A synthesis of scientific findings, *Technological Forecasting and Social Change*, 146, 390-402.

Chatterton, P., (2016) Building transitions to post-capitalist urban commons, *Transactions of The Institute of British Geographers*, 41, 403-415.

Chen, Y and Hassink, R (2020) Multi-scalar knowledge bases for new regional industrial path development: toward a typology, *European Planning Studies*, 28:12, 2489-2507

Coenen, L, Raven, R and Verbong, G (2010) Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages, *Technology in Society*, 32, 295-302.

Cooke, P (2011) Transition regions: Regional-national eco-innovation systems and strategies, *Progress in Planning*, 76, 105-146.

Cooke, P (2012) Transversality and transition: Green innovation and new regional path creation, *European Planning Studies*, 20(5), 817-834.

Dawley, S (2014) Creating new paths? Offshore wind, policy activism, and peripheral region development, *Economic Geography*, 90(1), 91-112.

Dawley, D, MacKinnon, D and Pollock, R (2019) Creating strategic couplings in global production networks: Regional institutions and lead firm investment in the Humber region, UK, *Journal of Economic Geography*, 19(4), 853-872.

Dawley, S, MacKinnon, D, Cumbers, A and Pike, A (2015) Policy activism and regional path creation: The promotion of offshore wind in North East England and Scotland, *Cambridge Journal of Regions, Economy and Society*, 8, 257-272.

Essletzbichler, J (2012) Renewable energy technology and path creation: A multi-scalar approach to energy transition in the UK, *European Planning Studies*, 20(5), 791-816.

European Commission (2019) *The European Green Deal*, COM (2019) 640 Final, European Commission: Brussels.

Fastenrath, S and Braun, B (2018) Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany), *Applied Geography*, 90, 339-349.

Feola, G., (2020) Capitalism in sustainability transitions research: Time for a critical turn? *Environmental Innovations and Societal Transitions,* 35, 241-250.

Fornahl, D, Hassink, R, Klaerding, C, Mossig, I and Schröder, H (2012) From the old path of shipbuilding onto the new path of offshore wind energy? The case of northern Germany, *European Planning Studies*, 20(5), 835-855.

Geels, F W (2005) *Technological Transitions and System Innovations: A Co-evolutionary and Socio-technical Analysis*, Cheltenham: Edward Elgar.

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

Gerber, M, Gauske, A, Müller-Navarra, S and Rosenhagen, G (2016) Categorisation of

meteorological conditions for storm tide episodes in the German Bight, *Meteorologische Zeitschrift*, 25(4), 447-462.

Gibbs, D. and O'Neill, K. (2014) The green economy, sustainability transitions and transition regions: a case study of Boston, *Geografiska Annaler: Series B, Human Geography* 96 (3), 201–216.

Gibbs, D and O'Neill, K (2017) Future green economies and regional development: A research agenda, *Regional Studies*, 51, 161-173.

Grillitsch, M and Hansen, T (2019) Green industry development in different types of regions, *European Planning Studies*, 27(11) 2163-2183.

Grillitsch, M and Sotarauta, M (2020) Trinity of change agency, regional development paths and opportunity spaces, *Progress in Human Geography*, 44(4), 704-723.

Gudmundsdóttir, H, Carton, W, Busch, H and Ramasar, V (2018) Modernist dreams and green sagas: The neoliberal politics of Iceland's renewable energy economy, *Environment and Planning E: Nature and Space*, DOI: 10.1177/2514848618796829.

Haakonsson, S, Kirkegaard, J K and Lema, R (2020) The decomposition of innovation in Europe and China's catch-up in wind power technology: the role of KIBS, *European Planning Studies*, 28:11, 2174-2192.

Hanson, T., and Coenen, L., (2015) The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field, *Environmental Innovation and Societal Transitions*, 17, 92-1089.

Hassink, R, Isaksen, A and Trippl, M (2019) Towards a comprehensive understanding of new regional industrial path development, *Regional Studies*, 53:11, 1636-1645.

Hickel, J and Kallis, G (2019) Is green growth possible? *New Political Economy*, 25(4), 469-486.

Hodson, M., and Marvin, S., (2010) Can cities shape socio-technical transitions and how would we know if they were? *Research Policy*, 39, 477-485.

Hopkins, D, Kester, J, Meelen, T and Schwanen, T (2020) Not more but different: A comment on the transitions research agenda, *Environmental Innovation and Societal Transitions*, 34, 4-6.

Jaffee, D (2015) 'A deeper channel floats all boats': The port economy as urban growth engine, *Environment and Planning A*, 47, 783-800.

Jensen, P, Purnell, P and Velenturf, A (2020) Highlighting the need to embed circular economy in low carbon decommissioning: The case of offshore wind, *Sustainable Production and Consumption*, 24, 266-280.

Jolly, S and Hansen, T (2021): Industry legitimacy: bright and dark phases in regional industry path development, *Regional Studies*, doi.org/10.1080/00343404.2020.1861236.

Jonas, A, Wurzel, R, Monaghan, E and Osthorst, W (2017) Climate change, the green economy and reimagining the city: the case of structurally disadvantaged European maritime port cities, *Die Erde*, 148 (4), 197-211.

Karlsen, A (2018) Framing industrialization of the offshore wind value chain – A discourse approach to an event, *Geoforum*, 88, 148-156.

Kern, F, Smith, A, Shaw, C, Raven, R and Verhees, B (2014) From laggard to leader: Explaining offshore wind developments in the UK, *Energy Policy*, 69, 635-646.

Koehler, J., et al., (2019) An agenda for sustainability transitions research: State of the art and future directions, *Environmental Innovation and Sustainable Transitions*, 31, 1-32.

Labour Party (2018) *The Green Transformation*, Available at www.labour.org.uk/wp-content/uploads/2018/09/The-Green-Transformation-.pdf

McCauley, S M and Stephens, J C (2012) Green energy clusters and socio-technical transitions: Analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA, *Sustainability Science*, 7, 213-225.

MacKinnon, D, Dawley, S, Menzel, M-P, Karlsen, A, Sommer, P, Hansen, G H and Normann, H E (2019) Path creation, global production networks and regional development: A comparative international analysis of the offshore wind sector, *Progress in Planning*, 130, 1-32.

MacKinnon, D, Karlsen, A, Dawley, S, Steen, M, Afewerki, S and Kenzhegaliyeva, A (2021) Legitimation, institutions and regional path creation: a cross-national study of offshore wind, *Regional Studies*, doi.org/10.1080/00343404.2020.1861239.

Martin, R and Sunley, P (2006) Path dependence and regional economic evolution, *Journal of Economic Geography*, 6(4), 395-437.

Miörner, J (2020): Contextualizing agency in new path development: how system selectivity shapes regional reconfiguration capacity, *Regional Studies*, DOI: 10.1080/00343404.2020.1854713.

Njøs, R, Gunnar Sjøtun, S, Jakobsen, S-E and Fløysand, A (2020) Expanding Analyses of Path Creation: Interconnections between Territory and Technology, *Economic Geography*, 96:3, 266-288,

Ocasio-Cortez, A (2019) House Resolution 109 Recognizing the duty of the Federal Government to create a Green New Deal, H.Res. 109, 116th Congress (2019-2020), United States Congress.

O'Neill, K and Gibbs, D (2020) Sustainability transitions and policy dismantling: Zero carbon housing in the UK, *Geoforum*, 108, 119-129.

Raven, R, Schot, J and Berkhout, F (2012) Space and scale in socio-technical transitions, *Environmental Innovation and Societal Transitions*, 4, 63-78.

Schulz-Baldes, M (2014) Towards climate city Bremerhaven – climate change taken serious, Presentation to workshop, June, University of Hull.

Sheldrick, A., Evans, J., and Schliwa, G., (2017) Policy learning and sustainable urban transitions: Mobilising Berlin's cycling renaissance, *Urban Studies*, 54(12), 2739-2762.

Sotarauta, M, and Suvinen, N (2018). Institutional agency and path creation: Institutional path from industrial to knowledge city, in A. Saksen, R. Martin, & M. Trippl (eds.), *New avenues for regional innovation systems – theoretical advances, empirical cases and policy lessons*, New York: Springer, 85-104.

Thomas, N., Sheppard, D. and Hume, N (2021), The Race to Scale Up Green Hydrogen. *Financial Times*, March 8th.

Sotarauta, M and Suvinen, N (2019) Place leadership and the challenge of transformation: policy platforms and innovation ecosystems in promotion of green growth, *European Planning Studies*, 27:9, 1748-1767.

Sotarauta, M, Suvinen, N, Jolly, S and Hansen, T (2020) The many roles of change agency in the game of green path development in the North, *European Urban and Regional Studies*, DOI: 10.1177/0969776420944995.

Steen, M and Hansen, G H (2018) Barriers to Path Creation: The Case of Offshore Wind Power in Norway, *Economic Geography*, 94:2, 188-210.

Stietzel, H-J. (2016), Cuxhaven: Base Port for the Offshore Wind Industry in Germany. Presentation, Port Association of Cuxhaven.

Stietzel, H-J. (No Date), Regionalökonomische Effekte der Ansiedlung von Siemens Wind Power in Cuxhaven. Stadt Cuxhaven.

Simmie, J (2012) Path dependence and new technological path creation in the Danish wind power industry, *European Planning Studies*, 20(5), 753-772.

Smith, A (2003) Transforming technological regimes for sustainable development: a role for alternative technology niches? *Science and Public Policy*, 30(2), 127-135.

Späth, P and Rohracher, H (2010) 'Energy regions': The transformative power of regional discourses on socio-technical futures, *Research Policy*, 39, 449-458.

Strambach, S and Pflitsch, G (2018) Micro-dynamics in regional transition paths to sustainability – Insights from the Augsburg region, *Applied Geography*, 90, 296-307.

Truffer, B and Coenen, L (2012) Environmental innovation and sustainability transitions in regional studies, *Regional Studies*, 46(1), 1-21.

Trippl, M, Baumgaartinger-Seiringer, S, Frangenheim, A, Isaksen, A and Rypestøl, J O (2019) Green path development, asset modification and agency: Towards a systemic integrative

approach, Papers in Economic Geography and Innovation Studies, 2019/01, University of Vienna/Vienna University of Economics and Business/Austrian Academy of Sciences/University of Agder/Kiel University.

Trippl, M, Baumgaartinger-Seiringer, S, Frangenheim, A, Isaksen, A and Rypestøl, J O (2020) Unravelling green regional industrial path development: Regional preconditions, asset modification and agency, *Geoforum*, 111, 189-197.

United Nations Environment Programme (2011) *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication – A Synthesis for Policy Makers*, www.unep.org/greeneconomy.

WAB - Windenergie-Agentur Bremerhaven/Bremen (2013), *WAB: The Network for Wind Energy: All Skills on Board*. Bremerhaven: WAB.

Wieczorek, A J, Hekkert, M, Coenen, L and Harmsen, R (2015) Broadening the national focus in technological innovation system analysis: The case of offshore wind, *Environmental Innovation and Societal Transitions*, 141, 128-148.

Wurzel, R, Moulton, J, Osthorst, W, Mederake, L, Deutz, P and Jonas, A (2019) Climate pioneership and leadership in structurally disadvantaged maritime port cities, *Environmental Politics*, 28(1), 146-166.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958

[1] de.statista.com/statistik/daten/studie/36651/umfrage/arbeitslosenquote-in-deutschland-nach-bundeslaendern/

[2] Siemens merged with the Spanish company Gamesa to form Siemens Gamesa Renewable Energy in 2017.

[3] Acquired by the Chinese company Titan Wind Energy in 2019.

[4] The nacelle part of a wind turbine is on top of the tower and contains the gear box, low- and high-speed shafts, generator, controller, and brake www.energy.gov/eere/wind/inside-wind-turbine.

[5] The OTB development was put on hold by the state government in mid-2019, see https://www.butenunbinnen.de/nachrichten/politik/otb-bremerhaven-sondierungen-100.html

[6] www.iea.org/reports/germany-2020.

[7] offshoreWIND (2018): www.offshorewind.biz/2018/04/23/globaldata-siemens-gamesa-outstrips-vestas/.

[8] Despite initial concerns over the future of the Siemens plant in Hull following Brexit, in 2021 the company announced that it would double its plant size reflecting changing technology demands in the OSW market. www.hullccnews.co.uk/09/08/2021/siemens-gamesa-confirms-expansion-bringing-more-jobs-to-hull/

[9] www.afw-cuxhaven.de/en/sectors/renewable-energy/.



Published version of article available from: https://doi.org/10.1080/00343404.2021.2000958