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From the old path of shipbuilding onto the new path of offshore wind energy? The case of northern Germany

Abstract

Wind energy-related employment has been surging recently in Germany: it rose from 9,200 in 1997 to 90,000 in 2007 and is estimated to be 112,000 in 2020. The industry particularly emerged in coastal, northern Germany. Recently big hopes are particularly set on the offshore wind energy industry. Two recently discussed evolutionary concepts explain the emergence of new industries, such as wind energy, in space in different ways: the windows of locational opportunity concept stresses the locational freedom in the earliest stages of industrial development, whereas path creation emphasises the role of existing industrial development paths, such as shipbuilding, from which new paths, such as wind energy, emerge. The paper aims at analysing whether the new path of offshore wind energy emerged out of existing paths, mainly shipbuilding, in the five states of coastal Germany. It concludes that shipbuilding only indirectly affected the emergence of the new development path of offshore the wind energy industry in northern Germany.

1. Introduction

After the Second World War the shipbuilding industry has become the core manufacturing industry in northern Germany¹. Several yard crises starting in the 1980s have led to pressures to restructure the regional economy. Against this background, big hopes have been set on the booming offshore wind energy sector as new impetus for regional employment and economic growth. Schamp (2000, p. 136), though, has pointed out that technologically determined industry cycles are not the only explanation for the decline and renewal in old industrial areas. Not only industries' age, but also institutional tissues, sclerotic networks, institutional persistence and other lock-in effects have to be broken up in order to use the potential of new technologies and to master the challenges of industrial restructuring.

The success and regional embeddedness of a new industry such as the offshore wind energy is affected by a combination of factors (Martin & Sunley, 2010; Storper, 2011; Boschma & Frenken, 2011). In addition to the motivation of decisive actors and market opportunities, it is particularly affected by specific capabilities which can differ from region to region due to varying regional conditions. This paper will particularly focus on the role of these regionally specific conditions related to the previously dominating shipbuilding industry in explaining the genesis of the offshore wind energy development path in the five states of northern Germany (Lower Saxony, Bremen, Hamburg, Schleswig-Holstein and Mecklenburg-Vorpommern). Do traditional shipbuilding companies invest in the new business fields of offshore wind energy? Which expertise,

competences, skills and routines of former yard workers and engineers can be recombined and used in offshore wind energy? At which points in the development path and how did regional industrial policy in the five regional states (*Länder*) intervene in the restructuring process? Does the existing infrastructure constitute an important locational advantage in supporting the emergence of the offshore wind energy in the different states of northern Germany? Or are exogenous factors more important, such as the attraction of energy companies or key actors from outside the region, to explain the emergence of the industry in the regions? Overall, to what extent is the emerging development path of offshore wind energy in northern Germany related to the decline of the shipbuilding industry? Can we speak of tight relations with many commonalities or can we explain the emergence of the industry better by new impetuses and new windows of opportunity?

The perception of a smooth restructuring from a declining core industry into a newly emerging growth industry, however, can also be the result of wishful thinking of regional economic promoters or local politicians. A handful newspaper articles about individual shipbuilding companies which were saved from bankruptcy due to offshore wind energy orders or easily made correlations between yards and offshore terminals might hide that shipbuilding-related regional-specific conditions are in fact not very relevant to offshore wind energy. Perhaps other triggering events have been much more significant. These might include the establishment or relocation of a core company, newly developed product innovations, specific policy measures as a reaction to the yard crises or the activities of new actors in the regional institutional environment and their effective promotion of offshore wind energy (Brenner & Fornahl, 2006).

Northern Germany can be seen as an appropriate research area to tackle these questions, as in this region we can find both the declining shipbuilding industry as well as a relatively high density of research institutes and companies in offshore wind energy (see for instance IWR, 2008). The main sources for the empirical part of this research consist of both primary data collected through 17 in-depth interviews with the main actors in the states of northern Germany, such as the leading offshore wind energy companies, suppliers, shipbuilding companies, cluster managers, officials of industry associations and officials in state ministries, as well as secondary data in the form of annual reports, strategy papers and other statistics and reports. The first six interviews in Lower Saxony and Bremen took place in March 2010, whereas in August 2010 another eleven followed in Schleswig-Holstein, Hamburg and Mecklenburg-Vorpommern.

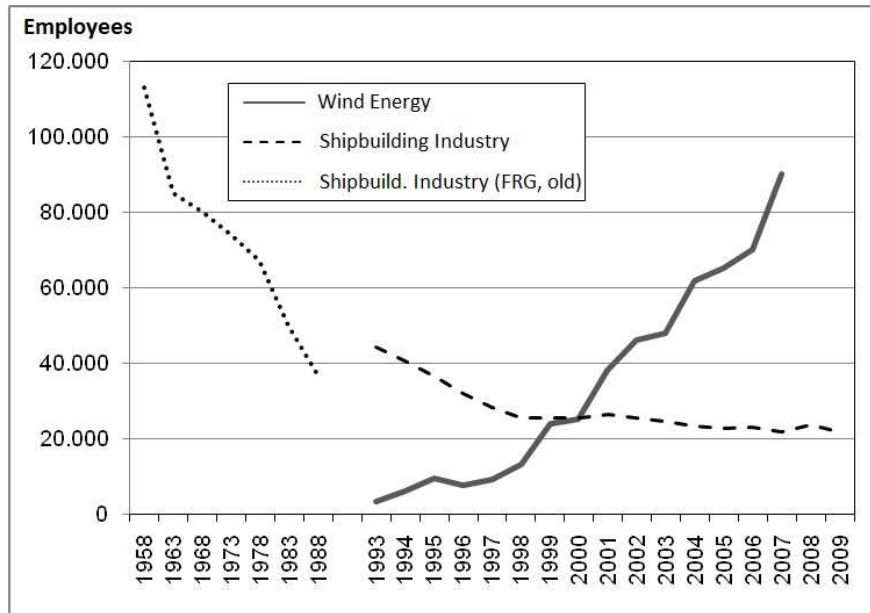
The paper is structured as follows. In the next section the decline in shipbuilding and emergence of the offshore wind energy cluster is further described. In the following section 3 the theoretical foundations of this paper based on path dependence and path creation are introduced, which have recently been much discussed in economic geography (see for instance Martin & Sunley, 2006 and Martin, 2010). Section 4 will then present the empirical analysis of the relationship between the emerging offshore wind energy clusters and the declining shipbuilding industry in the different states of northern Germany. Section 5 will summarise and conclude the paper.

2. Offshore wind energy as the great white hope after the yard crises

In the 1950s the shipbuilding industry in the northern part of former West Germany went through a real boom. Despite heavy war-related damages the industry boomed mainly due to tax reductions and favourable loans in order to reconstruct the trade fleet. The world-wide intensification of trade relations generated strong demand for large trade merchant vessels and hence the employment increased up to 113,000 in 1958 (200,000 if one would include suppliers); the lion's share was employed in the coastal areas of West Germany. West Germany's world market share in merchant shipbuilding reached its peak in 1956 with 17%. At that time it was the third biggest shipbuilding nation in the world, after Japan and Great Britain (Nuhn, 1990; Giese et al., 2011).

In the 1960s business cycles started to show first ups and downs and the first bankruptcies and mergers and acquisitions of small and medium-sized yards took place. A dramatic decline started at the end of the 1970s. In 1978 West Germany's world market share in merchant shipbuilding had dropped to only 2.1%. Despite strong support by the federal and state governments only 59% of the production capacities were used in 1979 (Nuhn, 1990). Although East Germany's shipbuilding located in the state of Mecklenburg-Vorpommern was added to total employment in shipbuilding after reunification in 1990, the dramatic decline in yard employment steadily continued to the mere 22,000 employment currently (VSM, 2010, p. 65) (Figure 1). Large traditional shipyards, such as Bremer Vulkan, which employed over 5,000 workers in the 1970s, as well as many small and medium-sized yards, had to give up in the 1990s. The main reasons for this strong decline in the shipbuilding industry were seen in the strongly developing international competition in East Asia, the delay in necessary restructuring of the product range partly caused by state subsidies, relatively high production costs due to high wages and material costs, as well as currency disadvantages (strong D-Mark) (see Eich-Born, 2005; Nuhn, 1998, p. 318; Eich-Born & Hassink, 2005, Hassink & Shin, 2005; Giese et al., 2011, Tholen & Ludwig, 2005; Kramm, 1980). Currently about 22.000 people are employed in German shipyards whereby almost a third (6.724) is located in Niedersachsen, followed by Mecklenburg-Vorpommern (4.916), Schleswig-Holstein (4.565), Hamburg (2.565) and Bremen (1.443) (VSM, 2009).

Figure 1: Development of the employment in the shipbuilding (1958-2009) as well as wind energy industry (1993-2007) in Germany



Source: Nuhn (1998, p. 321) as well as annual reports of the German Shipbuilding and Ocean Industries Association and the German Wind Energy Association (BWE).

Since a couple of years big hopes are set on the booming offshore wind energy industry in northern Germany. According to the German Wind Energy Association (BWE) only 9,200 persons were employed in planning and construction of wind farms in 1997, whereas about ten years later the number has increased to approximately 90,000 (Figure 1). Until 2020 the total number of employees is expected to be 112,000. These positive future expectations are mainly due to the strong expansion of the number of offshore wind farms. After finishing the construction of the first offshore wind farm, Alpha Ventus, 45 km north of Borkum in the North Sea, in November 2009, further investments in infrastructure is expected in three areas.

First, together with neighbouring countries billions will be invested in the grid network on the bottom of the North Sea². Secondly, investments will be made in the extension of existing harbours with special terminals for shipping the extremely heavy and huge components of offshore wind farms. In immediate vicinity to these harbours industrial estates are planned to provide wind energy companies with manufacturing premises. The investments for the new offshore harbour of Bremerhaven, to ship annually between 110 and 160 installations, are for instance estimated between 170 and 200 million euro (Weser Kurier, 2010b). About 80 million euro will be invested in the harbour of Cuxhaven (Lower Saxony), whereas other investments are planned to extend the harbours of Emden (Lower Saxony), Brunsbüttel, Husum and the county-port of Rendsburg (all in Schleswig-Holstein). Originally a port for reloading, Rendsburg now invests in extending industrial estates close by to become a heavy duty harbour in 2011. The area called Neuer Hafen Kiel-Canal is advertised for heavy weight productions of traditional machine

building and explicitly geared to producing and assembling components of the wind energy industry. Since 2003, there have also been heavy investments in the ports infrastructure of Rostock (Mecklenburg-Vorpommern), however, reasons other than the emerging offshore industry are mainly considered responsible for this development.

Thirdly, private money as well as public grants will be invested in the extension of the research infrastructure. In Lower Saxony and Bremen, for instance, the universities of Bremen, Hanover and Oldenburg, as well as the Fraunhofer Institute for Wind Energy and Energy System (IWES) have joined forces under the name ForWind, in order to cover all wind energy related research in the north-western part of Germany. In Schleswig-Holstein a similar initiative was set up under the name CEwind. In Bremerhaven, in particular, the networking between firms has been boosted by the establishment of the Wind Energy Agency Bremerhaven/Bremen (WAB). In Husum, Schleswig-Holstein, it is Windcomm and in Mecklenburg-Vorpommern there is a similar organisation called Wind Energy Network. An additional network organisation is Germanwind – the wind energy cluster in northwest Germany, which has meanwhile 150 companies and institutes as members. All in all, offshore wind energy already is a strong regional pillar in large parts of northern Germany, particularly in the area around Bremen, on which large hopes are set to compensate for the huge job losses related to the yard crises and to trigger strong economic growth in the future (Zeit, 2010). The question is, however, how did it emerge? And can its origin be explained by theories on the origin of new development paths?

3. Conceptual framework: explaining the origin of new development paths

Path dependence-related ideas have already been developed in Carl Menger's analysis of institutional emergence in 1883 as well as in Thorstein Veblen's concept of cumulative causation in the evolution of habits and conventions (1898). It was only in the 1980s, however, when path dependence received much more attention, particularly due to the work by Paul David and Brian Arthur (Martin & Sunley 2006, p. 397). In their work they opposed neoclassical assumptions and explained multiple equilibria and market inefficiencies with the help of path dependence (for instance Arthur, 1988 and 1994; David, 1993; Crouch & Farrell, 2004, p. 8-10).

A path dependent process is characterised by non-ergodicity. This term, which has been adopted from the theory of stochastic systems, means that actors or systems which are subject to path dependence cannot free themselves from effects of past events (David, 1993, p. 29; Martin & Sunley, 2006, p. 399). Path dependence is not the same as inertia or persistence effects, it refers instead to the limitation of options for current decisions, as they are strongly related to events and experiences made in the past (North, 2005, p. 52). At the same time, current decisions are dependent on the current and contingent context, so that the concept of path dependence can be clearly distinguished from historical determinism (Bathelt & Glückler, 2002, p. 27 ff).

A perspective of path dependence can contribute to understanding and analysing the origin of the offshore wind energy industry in northern Germany in the context of the region's industrial restructuring problems. In order to do so, the following two questions need to be first tackled at the theoretical level:

- a) As far as there are only limited relations with the shipbuilding industry, the question about the origin of a new development path needs to be dealt with, which will be done in section 3.1.
- b) If there is a large variety of relations, it needs to be clarified how the development path of the traditional core industry can be transferred and how inertia which caused the decline of the shipbuilding industry can be de-locked (see section 3.2).

3.1 On the origin of new development paths

In the literature often existing development paths are investigated, whereas the question of the actual origin of a new path is not much dealt with (Hirsch & Gillespie, 2001, p. 72, 84; MacKinnon et al., 2009, p. 143; Crouch & Farrell, 2004, p. 7). Basically three different viewpoints can be distinguished on the origin of new development paths. The causes of a new path are firstly seen in chance, secondly a mix of chance and limiting conditions or thirdly deliberate and dedicated behaviour of economic actors. The first viewpoint, that the origin of new development paths is a matter of pure chance, does not need a further theoretical elaboration. The second viewpoint is often backed by the theory of windows of locational opportunity, which is used in evolutionary economic geography (Martin & Sunley, 2006). According to that theory innovative enterprises of new industries do not have yet specific locational preferences in the early stages of development. They shape their entrepreneurial environment largely themselves and therefore have large degrees of freedom concerning their choice of location. In these early stages of development, therefore, the windows of locational opportunity are relatively open and hence existing locational patterns can be changed. Chance and small events determine where the first entrepreneurs in a new industry will locate. Also regions outside of existing economic centres get a chance to generate or attract pioneer entrepreneurs as long as certain unspecified framework conditions and basic requirements are in place (Storper & Walker, 1989, p. 70-92; Boschma, 1997, p. 15 f.; Bathelt & Glückler, 2003; Mossig, 2006, p. 58ff.; Dorenkamp & Mossig, 2010). According to Boschma and Frenken (2006, p. 290) "... regional conditions may play a generic and rather unimportant role at the start of a new sector, such as providing generic knowledge and skills, functions that are often equally well provided in many other regions". The third viewpoint criticises the strong emphasis on chance and the lacking integration of actor and behavioural theories in the concept of path dependence (Garud & Karnøe, 2001). According to them new development paths are created by strategic actions of actors who deliberately differ themselves from existing social rules and technologies. According to this viewpoint the location of pioneer entrepreneurs as seed-beds of a new development cannot be explained by chance and small events, but is strongly related to existing experience, knowledge, capabilities and contacts, which the entrepreneur carries with him from previous development paths.

The question therefore is when do we speak of a truly new path and when of a change of an existing path? According to Karnøe and Garud (1995, cited in Rao and Singh 2001, p. 243 f.) a new path is created by a sudden break with the past and hence a sudden break with existing technologies, products and organisational forms, which implies new future expectations. They do not speak of an incremental adaptation process over a long period of time in which the different elements of a path are gradually changed by the actions and experiments of the actors, which could be characterised as an on-path-change.

Accordingly it needs to be clarified which triggering events lead to such path breaking change. In contrast to the above-mentioned small events (see also Hirsch & Gillespie, 2001, p. 72; Jovanović, 2009, p. 71), we need a much stronger driving force in order to break through an established path (David, 1993, p. 39). Technological breakthroughs are often mentioned as such driving forces in the economic geography literature, in line with the Long Wave Theory and neo-Schumpeterian approaches (Boschma & Lambooy, 1999, p. 421; Boschma, 1997, p. 13) and the model of industrial pathways of Storper and Walker (1989). We therefore need to check whether the offshore wind energy can be regarded as such a technological breakthrough or as an incremental change.

Martin and Sunley (2010) summarise the discussion on the different opinions on the origin of new path development with four quadrants in a matrix (see Table 1). They state (Martin & Sunley, 2010, p. 79, 80): “while the classic model of path dependence is rooted in quadrant 4, more recent work in economic geography has begun to move closer to positions in quadrants 2 and 1, and has put much more emphasis on the re-use and transfer of resources and competences”.

(Martin 2010, p. 19) states with regard to the links between old and new paths: “... new paths may be latent in old ones, or spin out from existing ones ... resources and competences acquired and used in previous and existing paths of technological and industrial activity may be recombined to form the basis of purposeful entrepreneurial deviations into new paths ... preconditions, and the resources associated with them, are often place specific, shaped by the characteristics of previous local economic developments ... the local inherited knowledge and skill base of an industry can form the basis of the rise of related new local paths of industrial and technological activity. And local spin-off firms can use the routines and competences inherited from their parent firms to launch new products and processes”.

Table 1: Varieties of Path Creation

	Origins of New Path of Development	
Place and Path Effects	<i>Deliberate and Intentional</i>	<i>Chance and Accidental</i>

<i>Enabling new paths</i>	1. Agents search for opportunities, re-use resources, transfer competences as basis of new growth	2. Agents gain assets and experience, but accidents and events trigger new path
<i>Constraining to existing path</i>	3. Designed interventions to break path or switch location to overcome lock-in	4. Unpredictable external shocks and random events break old trajectory and launch new path

Source: Martin and Sunley 2010, p. 80

Bathelt and Boggs (2003, p. 256 f.), however, emphasise that it is not sufficient to just focus on technological discontinuities as explanation for the destruction or emergence of development paths. They stress that also externally caused strong crises have the potential to break through the path dependence of economic development (MacKinnon et al., 2009, p. 143; Bassanini & Dosi, 2001, p. 50; Jovanović, 2009, p. 13). Moreover, specific political support measures potentially have the power to break through existing paths. Particularly those policy-makers who are not themselves part of the old development path (e.g. the local administration) are able to decrease incentives to follow the old path or increase incentives to change towards a new development path. This might, for example, be achieved by legislations positively or negatively affecting the market conditions under which the different regimes are operating.

In addition to the question whether an old path needs to be broken through to create a new one, we also need to think about factors affecting the development process of a new path in a positive way. Four factors can be mentioned (see also Brenner & Fornahl, 2006, in the context of clusters). First, the current market conditions and forecasts need to be sufficiently positive, so that entrepreneurs are willing to enter this market. Secondly, long-term stable characteristics of a region (such as its coastal location) do play a role and thirdly varying local conditions such as human capital, networks and public research establishments. Fourthly, there need to be triggering events leading to an actual realisation of the regional and industrial potentials, such as the location of a core company or new industry policy initiatives.

Building upon the current literature on the origin of new development paths, we now need to examine whether the yard crisis in northern Germany can be regarded as a path breaking event and whether this event has been the core impetus for the new development path of the offshore wind energy industry. We will analyse which combination of deliberate actions, regional-specific conditions, triggering events as well as geographical conditions has played a role here.

Alternatively chance and small events might play a role as is postulated in the theory of windows of locational opportunity. They need to be interpreted as independent of the traditional shipbuilding development path and as behaviour that is not deliberately focused on establishing an offshore wind energy cluster.

After having dealt with the origin of new development paths from a theoretical perspective, we will now elaborate more on the mechanisms leading to a break-through of existing development paths and a successful further development of the newly created path.

3.2 De-locking of development paths

In order to realise a link between the two development paths (shipbuilding and offshore wind energy), the new industry needs to be able to free itself from the declining core industry. Sclerosis is regarded as an important reason for not successfully coping with the yard crisis in northern Germany, and many other old industrial areas for that matter (Hassink, 2010). State subsidies for the yards in West Germany, for instance, led to conserving traditional products and hence a delaying of necessary restructuring into new, high-value added special products. State subsidies were used to “winter” crises until the next boom. This strategy led to sclerosis of production and network structures leading to a negative lock-in (Kern & Schumann 1990, p. 305ff.).

A large part of the literature on lock-ins discusses the factors leading to a negative locking in of development paths and thinks about strategies on how to prevent this (for instance Grabher, 1993; Hassink, 2005, 2010; Cowan & Gunby, 1996; Boschma, 2004). Relatively little has been written on how regions can manage to free themselves from such a lock-in situation. Concerning de-locking most economic geographers have until now emphasised the technological level of this process. In addition to technologies, heterogeneity, on the one hand, and transplantation through the import of novelties from outside the action radius of the company, on the other hand, is useful to discuss in relation to de-locking (Martin & Sunley, 2006, p. 121-123).

Heterogeneity as a first de-locking mechanism is a relatively new research area. In evolutionary economics heterogeneity is mainly discussed at the micro-level of individual firms as a driving force in selection processes (Rigby & Essletzbichler, 1997, p. 270). Frenken et al. (2007) have recently stressed the meaning of heterogeneity of different mutually related industries in a region with the term related variety. They particularly emphasise positive effects of knowledge spill-overs, risk reduction and labour market stability. Heterogeneity, however, does not seem to be very relevant for our research question, that is the relation between the two development paths shipbuilding and offshore wind energy industry.

The decisive impulses for the emergence of offshore wind energy might also have come from external actors to the industry. This leads us to the second de-locking mechanism, namely transplantation. Knowledge acquisition, learning, innovativeness and hence competitiveness of

firms nowadays does not only depend on intra-organisational resources, but increasingly on extra-organisational resources (Boschma, 2004, p. 1004; van den Bosch et al., 1999, p. 552; Song et al., 2003, p. 351 f.; Bierly et al., 2009; p. 481 f.; Martin & Sunley, 2006, p. 422). In order to break through sclerotic development paths it does not suffice to recognise external relevant knowledge, what is also needed is the capability in firms to synthesise newly acquired knowledge with existing knowledge stocks which is in turn dependent on so-called absorptive capacities in firms (Zahra & George, 2002, p. 185; Phene & Almeida, 2008, p. 902). Transplantation is seen as an important de-locking mechanism, due to the learning processes that take place through the exchange with actors from other institutional contexts. Learning processes as such, however, have controversial effects, as they are both path dependent and path breaking at the same time (Crouch & Farrell, 2004, p. 26 f., p. 34 f.; Martin & Sunley, 2006, p. 422 f.). In the empirical part of this paper we will clarify the contribution of transplantation of external knowledge to the breakthrough of the development path of the shipbuilding industry and the emergence of the offshore wind energy cluster. In this case probably not only know-how transfer has been relevant, but also the transfer of external capital.

4. Determinants of the genesis of the offshore wind energy in northern Germany

In the following sections, the origin and development path of the offshore wind energy cluster in northern Germany will be described and interpreted with the help of the above-described theoretical elaborations.

4.1 Local conditions affecting the offshore wind energy industry

Two shipbuilding-related local factors can be distinguished which have positively affected the location of offshore wind energy companies in northern Germany.

First, the available infrastructure (for example, large dedicated quay premises, production halls, harbour facilities, heavy lift terminals etc.) has been a favourable location factor for offshore wind energy companies. Large premises and production halls are needed for the production, storage and pre-assembly of offshore components, such as 60 meter long rotor blades. Some large quaysides of bankrupt shipyards were made available for these purposes; although small adaptations to the specific requirements of the offshore wind energy companies were necessary. AMBAU Stahl- und Anlagenbau for instance is located on premises of the former Vulkan yard in Bremen Nord and WeserWind GmbH Offshore Construction Georgsmarienhütte at a former yard in Bremerhaven.

Secondly, the locally available human capital played a positive role. Regional competences in firms and workers are available in steel construction (for instance welding and assembling of large components), electronics in autonomous systems, maritime logistics and the handling of heavy

weight components. Most yards used to have relatively small shares of in-house production, which has led to an increase in the necessary competences in co-ordination and logistics, competences which can also be used in the offshore wind energy industry. Due to the yard crises parts of these human resources have been made redundant and could be used in the offshore sector.

WeserWind GmbH Offshore Construction Georgsmarienhütte, for instance, has employed workers from SSW Transfergesellschaft, a job intermediary agency founded after the bankruptcy of Werft SSW Schichau Seebeck Shipyard. SIAG Schaaf Industrie AG has taken over a large part of the yard workers of TKMS Nordseewerke in Emden. Other shipyards in Schleswig-Holstein and Mecklenburg-Vorpommern, however, substantially rely or plan to rely on existing competences and specialized in-house training for building installation ships and transformation platforms required for the wind energy sector. At the same time, however, the pool of workers is limited as some yard workers moved to other regions or have been retired before the offshore wind energy industry started to emerge. During the last years, the number of retraining and additional training courses for offshore activities has increased, both in the craft and academic fields. In Schleswig-Holstein some public and private institutions such as Glücksburg Consulting Group are engaged in retraining personnel from related sectors of the onshore and maritime industry. However, there are also further potentials for improving the training infrastructure in Schleswig-Holstein, particularly for offshore service technicians. Past training courses on safety were, for instance, offered in Esbjerg in Denmark. Although many former yard workers have found a job in the offshore wind industry, interviewees stressed that the capabilities and competences could also have come from another industry than shipbuilding. A basic, high-quality craft education is sufficient for employees to be retrained into specific qualification requirements of the offshore wind industry. Although regions with yards have some favourable local conditions, similar conditions could have been found in other regions with different industrial structures. Human capital as such therefore cannot be seen as sufficient evidence for new path creation out of established paths.

The direct access to open sea due to the availability of deep-water seaports has been an essential factor contributing to the emergence of both the shipbuilding and offshore wind energy industry in northern Germany. Transportation costs are much higher in alternative locations without a direct access to open sea, particularly due to heavy weight components, such as foundations and piles. In order to save transportation costs, producers of both offshore and export-oriented onshore components therefore prefer waterfront locations along the sea or large rivers, such as the Rhine and Elbe. Supply, repair and maintenance of the wind farms in the North Sea and Baltic Sea will also be co-ordinated and started in the offshore wind energy seaports. All in all, sea access as a local condition is favourable to both industries; the shipbuilding industry did positively but rather indirectly affect the emergence of the offshore wind energy industry because of this.

In addition to the favourable local conditions which has been partly created by the shipbuilding industry in the past (waterfront premises, heavy lift facilities, for instance), dedicated actions by policy-makers and companies have been more recently undertaken to improve local conditions

even more. Concerning actions by policy-makers, the city state of Bremen has been the first in northern Germany and started its offshore wind energy support policy in 2001. This policy consists of R&D and investment support schemes, as well as support for networks and offshore-oriented infrastructure. It made for instance dedicated premises available for offshore activities and invested in the adaptation of seaport infrastructure to offshore activities. Concerning network activities, informal meetings started in 2001, first primarily with research institutes, later on with support for lobby activities and public relations. This led to the establishment of the Wind Energy Agency Bremerhaven/Bremen e.V. (WAB) in 2004. Since the offshore wind energy industry is still relatively small and regional policy-makers in this area started to support the industry relatively early, tight personal networks could be built up between policy-makers, public administrators and company managers. Due to the early policy involvement, as well as the broad political support by several administrative departments, a visible, positive sign was given to potential investors in the Bremen region. A strong dedication to this industry by regional policy-makers in Bremen was conveyed to companies willing to relocate their offshore activities or to companies planning to set up an offshore daughter. This political dedication and the favourable local conditions actually led to the location and relocation of some offshore wind energy companies to the Bremen region who came from outside the region. Company interviewees positively report about the leeway they have in the Bremen region to change local conditions into favourable ones to the offshore wind energy industry. Schleswig-Holstein and Mecklenburg-Vorpommern, in contrast, have reacted much later and could hence not be as successful as the Bremen region in attracting offshore wind energy companies from outside. Only since 2009 the wind energy sector has become a prioritized field of economic development in Schleswig (Windcomm, 2010; Kieler Nachrichten, 2010). For offshore wind energy there is no specific support programme yet, but individual initiatives, such as CEwind, are supported from the overall Future Programme Economy.

The policy support measures, however, have been carried out separately from the yard crisis. Although policy-makers have been looking for alternative industries to compensate for the job losses in shipbuilding already since the 1990s in all northern states (push factor), the heaviest job losses took place decades ago (in West Germany), much earlier than the emergence of the offshore wind energy industry. Moreover, offshore is not the only alternative industry selected by policy-makers; there is also support for a couple of other industries, such as the tourism industry and the creative industry (Dirksmeier, 2009; Haller et al., 2003).

Also offshore wind-related public research activities are largely separated from the traditional development path of shipbuilding. They mainly emerged out of existing research institutes outside of shipbuilding-related research, such as the Fraunhofer Institute for Wind Energy and Energy System (IWES) in Bremerhaven or the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Bremen or research activities in (onshore-) wind energy companies. Initially these research activities were not focused on offshore or did take place in an un-coordinated way. In order to improve this situation and to bundle offshore research activities, the research and coordination agency at the Hochschule Bremerhaven (fk-wind) was established in

2003. Moreover, new institutes in Bremen were set up that particularly focus on offshore-related research. According to a study on renewable energy in Germany, the Rhine-Ruhr-Region and Bremen/Bremerhaven are both the main centres on wind energy research in Germany (IWR, 2008). In addition to research, also a bachelor and master study on wind energy technology have been established at the Bremerhaven University of Applied Sciences. In Schleswig-Holstein, similar initiatives have been started since 2005, such as CEwind and the master programme of wind engineering. Launched by the University of Applied Science of Kiel and the University of Applied Science of Flensburg in 2008/09 a tailor-made course targeting emerging market demands has been designed. In Mecklenburg-Vorpommern similar master programmes will run from 2011 onwards at the University of Rostock.

Another indicator for the emergence of a new path separated from the traditional development path of shipbuilding is the origin of some offshore wind energy companies. Some companies for instance developed out of the onshore wind energy, of plastic processing and the offshore oil and gas industries. Investments in new competences are necessary, also in onshore wind energy companies, as offshore has its specific requirements concerning corrosion protection, maintenance intervals, specific services, as well as specific installation and maintenance logistics. Moreover, some equipment such as pile driving hammers and pipes need to be customized to specific demands and can often not be re-utilized for other projects or be produced in series. Offshore project solutions therefore have to be individually designed in line with specific industrial requirements and expertise.

The financial sector has been sceptical vis-à-vis investments in offshore wind farms, particularly at the early stages of development; in contrast to onshore wind farms, both investments sums and equity ratio are higher and the industry first had to prove itself. Also, as procedures of building transformation platforms, hammers and installation ships are not standardised yet, the calculation of risks is claimed to be too vague for supporting huge investment decisions. Until the yard crisis investing in shipbuilding was a safer bet for banks. As a reaction to this sceptical attitude of the banks, experienced onshore product developers (f.e. wpd, prokon or Energiekontor) saved financing the first project by selling loans, a strategy also used in the shipbuilding sector to finance large projects. In the wind energy sector, ship yards therefore appear to be integrated into the value chain rather as provider of capital than technical constructors and producers of installation ships. More recently, however, large energy concerns, such as Eon, EnBW and RWE, investment funds as well as banks increasingly started to invest in offshore projects, as it has got easier to calculate returns on investments due to the Renewable Energy Sources Act (EEG) and to forecast wind yields.

As with banks, the industry had to prove itself vis-à-vis potential suppliers in order to be able to meet the demand for specific supplies and components in the region. In some cases networks and competences could be used that emerged out of the shipbuilding industry.

4.2 Market incentives as driving force of the industrial development path

The growing market has played a key role in developing the offshore wind energy industry. Important factors have been the grid connection duty, the Renewable Energy Sources Act (EEG) in 2004, an increasing environment consciousness, the Infrastructure Planning Acceleration Act, oil price increases, climate protection agreements and increasing doubts vis-à-vis nuclear energy, as well as the High Tech Strategy of the federal government. The latter has proclaimed the area of climate protection, resource protection and energy as the leading future market in 2006. This has led to, first, a stronger support for R&D in wind energy and positive effects on the supply side. Secondly, this has also positively influenced the demand side. Moreover, increasing feasibility and risk calculation of offshore wind farm projects have been made possible due to the long-term stability of the feed-in-tariffs at 15 cent/kWh for 12 till 20 years. These positive framework conditions could hardly be affected by industrial and/or regional actors, apart from some lobbying activities for instance to influence the EEG Act. Nevertheless the industry did not emerge by chance, but its emergence is the logical consequence of a series of events, starting already with the oil crises in the 1970s, and deliberate actions to change societal, ecological, economic and political framework conditions. Despite these positive framework conditions, there have been several uncertainties. It took much longer to open the first test farm, alpha ventus, which was already approved in 2001 but started only in 2009. The interviewees confirmed that it is particularly the long-term stability of the feed-in-tariffs at 15 cent/kWh, which was agreed upon in 2009, that significantly reduced economic uncertainty.

4.3 On the origin of leading offshore wind energy companies

It is not only in times of crises that companies, such as shipbuilding companies, look for new business areas. The motivation behind this searching behaviour can be seen in positive and negative effects of displacement (Mossig, 2000). In order to cope with the yard crisis, offshore wind energy was not in the focus of the shipbuilding companies in their search for alternative business areas. Other areas were tested to find out whether existing competences could be transferred in a profitable way. Only a few exceptional shipyards considered offshore wind energy as an alternative business area and hence contributed to the endogenous emergence of offshore wind energy in the region: Husumer Schiffswerft, FR. Fassmer (Berne) and Abeking & Rasmussen in Lemwerder. In some cases, such as Abeking & Rasmussen, there were competences available in the area of fibre-reinforced composites at the end of the 1980s, for which new applications were sought. Among several alternative new application fields, such as chassis of electric cars, rotor blades for wind farms proved to be the most successful one. A similar case is the yard FR. Fassmer, which also has competences in fibre-reinforced composites and uses this competence for among others producing spinners and nacelles for the offshore wind energy industry. Also the Husum shipyard entered the wind energy business due to the decline in shipbuilding at the end of the 1980s. This did, however, not prevent them from bankruptcy, after which the wind farm part of the company was taken over by Jacobs Energie GmbH in 2000. Out of the merger with pro+pro

and BWU the company was then renamed into RePower Systems. However, most yards, such as SSW Schichau Seebeck Shipyard in Bremerhaven (2009), TKMS Nordseewerke in Emden (2010), HDW in Kiel, Schleswig-Holstein (2010) and Nordic Yards in Wismar, Mecklenburg-Vorpommern (2010) have only recently started this step into offshore wind energy. They are mainly pushed into it because of threatening bankruptcy as a consequence of the negative prospects in shipbuilding. There are several examples in which German shipyards have competed and lost orders to Korean and Polish shipbuilders to build special ships and platforms (see also Zeit, 2010). Hence, the majority of yards only entered the new market after it has taken off already for some time, mainly because of push factors (declining prospects in core business) and regarding Schleswig-Holstein because of close market observation and learning from entrepreneurial pioneers in Niedersachsen and Bremen.

Of the yards that managed to enter the offshore business, only a part of them produces components in-house. Another part confines itself to the renting out of infrastructure (halls, premises, quays etc.) to producing firms. Constructing offshore towers, as strived for by some yards, is relatively easy compared to the production of other components. Competition, however, is much stronger in this market segment than in other segments, such as rotor blades. Overall, we can observe that out of the five large system offshore engineering companies, Siemens Wind Power, Vestas, Bard Group, Areva/Multibrud and RePower Systems, only RePower Systems has some roots in shipbuilding (one of the four companies out of which it has emerged stems from shipbuilding).³

Among the main components manufacturers, some emerged out of large companies in other industries diversifying into this new business field. Examples are steel construction (AMBAU Stahl- und Anlagebau, Georgsmarienhütte Holding and for some time Thyssen Krupp Stahl Service Center), construction (Züblin AG) and logistics services (Beluga-Hochtief Offshore). Others (Menck, EEW), as previously mentioned, started off in producing hammers and pipes for the offshore oil and gas industries before entering the wind energy market. Since 2000, many of these large companies have been setting up subsidiaries in the coastal regions of Germany to serve the newly emerging market. In addition to these firms, some newly founded firms could establish themselves on the market, particularly in niches of new challenges, such as offshore specification, 5 MW installations) (one example is Multibrud as the manufacturer of nacelles). During the last years, expansion and diversification took place through take-overs of local firms by national and international companies, such as AN Wind Energie taken over by Siemens Wind Power, Multibrud taken over by Areva (France) or RePower by Suzlon (India). This has also led to an increase in investment sums in new offshore wind farm complexes.

Hamburg has an interesting position in the offshore wind energy industry in northern Germany. Here we find neither production nor component manufacturers, but instead the offshore wind energy R&D and planning divisions of the large energy concerns (Eon, RWE, Vattenfall, EnBW and GE). To some extent it can be regarded as the brain port of offshore wind energy in northern

Germany. A specialisation within the value chain is also a possibility for Husum in Schleswig-Holstein in order to strengthen its position. The port facilities are on the one hand too small for attracting heavy weight component and pile manufactures. On the other hand, however the sea access and waterfront infrastructure is argued to be sufficiently large for service and maintenance vessels serving the offshore farms in the North Sea. Some interviewees in Schleswig-Holstein therefore see large potentials for their mainland and island based ports (e.g. Helgoland, Hörnum) in the niche market of maintenance and repair although assembly and production of heavy weight components is also considered in the region's offshore strategy, e.g. for Rendsburg and Kiel (Windcomm, 2010). Others, however, are more sceptical, as they point out that competitors in repair and service from the UK, Denmark, Norway and the Netherlands are more experienced, as their markets developed much earlier. Moreover, large maintenance and repair orders are only expected from approximately 2020 onwards, as during the first six years wind farm producers are obliged to take care of the maintenance and repair themselves.

All in all, we find *relatively few originally newly established firms*, if so in the service sector or other fringe areas, which have low entry barriers due to low investment sums required compared to other parts of the offshore industry. The archetypical spin-off processes leading to a clustering process are thus under-represented in the case of the offshore wind energy industry (Bünstorf & Fornahl, 2009; Mossig, 2000). However, despite an apparent lack of spin-offs some interview partners are optimistic about future industrial locations in the German regions. Market demands for heavy weight components such as foundations, piles, towers and transformation platforms are predicted to increase fundamentally which facilitates ship yards, and others, to potentially entry the wind energy market. SIAG in Emden may be a good example in this respect as it specialized in steelwork and has currently taken on the production of generators and piles.

5. Conclusions

During the last ten years, the offshore wind energy industry emerged as a new industry in northern Germany. The industry is still in its early development phase and hence could not yet unfold its full regional economic effects. Nevertheless, the industry is currently already a significant economic sector in the region of Bremen/Bremerhaven and to a lesser extent in the Husum region in Schleswig-Holstein and Rostock in Mecklenburg-Vorpommern. Since the current production capacities are much lower than the aims set by the European governments concerning renewable energies in general and offshore wind energy in particular, further employment growth can be expected in the future.

The core question of this paper was focused on the conditions und which the development path of this industry emerged and the role of the declining shipbuilding industry herein. The overall results show that primarily onshore firms or firms of other industries have diversified into offshore wind energy. Only a few offshore wind energy firms have their roots in shipbuilding. The shipbuilding industry and the yard crises only indirectly affected two explanatory factors. First, the access to

seaports is a basic locational condition for both offshore wind energy production and shipbuilding. This is a common location factor, not a factor that is transferred from the old to the new industry. Secondly, the yard crises and shipbuilding decline generated a push factor for companies and policy-makers to look for new market areas. The shipbuilding industry could provide human capital and competences, as well as specific infrastructure, which both could be well used by the new offshore wind energy industry. These effects, however, are of an indirect nature, as there was a time lag of several years between decline of the shipbuilding industry, on the one hand, and the emergence of the offshore wind energy industry, on the other hand. An important pull factor unrelated to the shipbuilding industry is the long-term stability of the feed-in-tariffs at 15 cent/kWh, which has led to strong growth dynamics.

Building on existing regional conditions, policy-makers in Bremen have deliberately tried to change framework conditions. Further positive signals for the offshore wind energy industry have been the first relocations of firms into the northern region, as well as the extension of scientific expertise in offshore wind energy in the region. The path therefore has been created by a combination of one triggering event (positive market development) and favourable regional conditions in northern Germany, which in turn result from the sea location and the history of the region, on which dedicated actions particularly by the Bremen regional policy-makers have built upon. One isolated factor would probably not have led to the development of the offshore wind energy industry in the region.

Although the shipbuilding industry only had indirect effects on the emergence of this new development path, interestingly, feedback forces work from the new to the old shipbuilding industry. Some yards for instance have received new orders to build special ships for offshore wind farms or currently plan to produce installation, service and maintenance ships. Examples of these yards are the Lloyd Werft in Bremerhaven, Abeking & Rasmussen in Lemwerder, Diedrich Oldersum in Moormerland, Cassens Werft in Emden, the Mützelfeldwerft in Cuxhaven, HDW in Kiel and Nordic Yards in Wismar. Additional positive effects can be observed if ship maintenance and all other necessary services needed for installing, maintaining and repairing offshore wind farms are located in one home seaport. Particularly in this business area, large hopes and expectations can be seen among policy-makers for positive regional economic multiplier effects to shipbuilders and other maritime service industries. It is particularly in Schleswig-Holstein where big hopes are set on this niche market (Windcomm, 2010).

Thus shipbuilding only has indirect effects on the emergence of this new path; new impulses are more important as explanatory factor. However, after the establishment of the offshore wind energy industry, de-locking of shipbuilding activities can be observed. The established companies and regional networks were pushed to reconfigure themselves by several forces, such as new technological, marketing and sales challenges, new network partners and the transplantation of external knowledge into the region. This has had two consequences. First, it has led to a revitalisation of the special ships business fields of many yards. Secondly, other yards which lacked

a division of special ships entered straight away into the offshore wind energy business. Both phenomena have slowed down the decline of the shipbuilding development path.

The emerging development path is still in its early stage and the industry also faces several risks and challenges with respect to regulation, financing, grid infrastructure and (storage) technologies. Further stable incentive-oriented framework conditions, such as the extension of the EEG law, are essential to the long-term development of the offshore wind energy industry in northern Germany. Quite the contrary, the extension of nuclear power which conflicts with previous political agreements is expected to weaken investments in offshore wind energy. Also, Germany's strict environmental laws (e.g. regarding the regulation of underwater pile-driving sound, nature and landscape protection) as well as long-term political procedures of permitting wind farms are argued to delay investments. The financial crisis in 2008, for example, has severely threatened the financial security of wind farm projects in Germany but also gave rise to think of alternative investment strategies such as state guarantees (*Staatsbürgschaften*) (Spiegel, 2010). Moreover, to reach the stage of a stable offshore wind energy cluster, a critical mass of activities and self-reinforcing processes are necessary concerning for instance human capital, co-operations and spin-offs, which could lead to a further acceleration of growth (Brenner & Fornahl, 2006). Currently the regions in northern Germany, as well as other regions along the North Sea in the UK, the Netherlands, Denmark and Norway compete with each other; stable clusters are not established yet. In order to support the regions in northern Germany further, more investments in infrastructure in general and in offshore terminals in particular are necessary. It might make sense, to focus that support on the most promising locations in north-western Germany (Bremen, Lower Saxony). However, since also within federal Germany, the northern regional states compete with each other, it is likely that there will be no strong concentration of support for one area.

End notes

¹ Northern Germany consists of the states of Lower Saxony, Schleswig-Holstein and Mecklenburg-Vorpommern, as well as the city states of Bremen and Hamburg.

² The costs are estimated at no less than 30 billion Euro, so that from 2020 onwards large parts of Europe can be provided with electricity powered by wind, solar and wave power works from the North Sea grid (Weser Kurier, 2010a).

³ Germanwind's study of the 40 core companies in the offshore wind energy cluster comes to similar results.

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