Resource transfer between two Danish offshore energy clusters

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Torben Damgaard, Mads Bruun Ingstrup and Mia Dahl Mikkelsen:

Resource transfer between two Danish offshore energy clusters

Marts 2013

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Resource transfer between two Danish offshore energy clusters

Torben Damgaard, Mads Bruun Ingstrup & Mia Dahl Mikkelsen
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1. Abstract

The aim of this report is to describe and analyse the transfer of firm resources between two offshore energy clusters located around the city of Esbjerg in Denmark, and to discuss what elements to consider in such complex resource transfer processes. This is relevant theoretically as well as practically as resource transfer between clusters may influence, positively or negatively, the developmental process of clusters and their firms, including the emergence of cluster externalities. The report contains a case study, developed from April 2012 to September 2012, that demonstrates how and by whom different kinds of firm resources are transferred between a mature offshore oil and gas cluster and an emerging offshore wind energy cluster.

The report is part of the project Offshore Energy which is financed by the Regional Growth Forum of Southern Denmark and the European Regional Fund. It targets stakeholders in the offshore energy industry as well as policy makers and researchers with interest in resource transfer between clusters.

The main findings of the case study underlying this report are summarized in the five points listed below:

1. The transfer of firm resources between the emerging offshore wind energy cluster and the mature oil and gas cluster takes place at three levels; at the individual level, at the single firm level, and at the firm network level.

2. Both tangible and intangible firm resources are transferred directly and indirectly between the two offshore energy clusters.

3. The transfer of firm resources between the two offshore energy clusters fostered several innovations and new ways of thinking regarding foundation designs, supply philosophies, and service and maintenance related to offshore oil and gas projects and especially to offshore wind energy projects.
4. The transfer of firm resources is mostly one-directional between the offshore energy clusters, meaning that resources have been transferred mainly from the mature cluster of offshore oil and gas to the emerging cluster of offshore wind energy.

5. The learning based upon the resource transfer was in more cases achieved through the process of learning by failure. Very often errors occur because the resources transferred have not been customized to the new business area and business logic in which they are to be used. Errors also occur because resources have been transferred without discussing the need and relevance which typically leads to over-engineering and increased complexity.

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2. Context

In 1971, Denmark was the first country to discover oil in the North Sea, and today a significant percentage of the Danish energy supply originates from oil and gas reserves in the North Sea (Maersk Oil, 2010). However, since oil reserves are declining, other sources of energy are exploited in order to remain self-sufficient with energy (Danish Energy Agency, 2012). In relation to this, the Danish Parliament in 2012 decided that 35 percent of the Danish energy supply must stem from renewable energy sources in 2020, and 50 percent of the electricity must come from wind energy alone (Danish Ministry of Climate, Energy and Building, 2012), and with an increased level of the production taking place offshore.

This focus on offshore energy originates from a development that goes back to the 1960s where the Danish firm A. P. Møller applied for the right to drill for oil in the Danish part of the North Sea. Two years later, the firm received an exclusive 50 years authorization even though it had no prior experience in oil exploration or drilling at that time (Maersk Oil, 2010). In order to overcome this challenge, A. P. Møller founded the Danish Underground Consortium together with Gulf Oil and Shell, and in the early 1970s they found the first oil reserve about 200 kilometres west of the coast of Esbjerg in the North Sea (Maersk Oil, 2010). Since then, 19 other fields have been found in Danish waters (Offshore Center Denmark, 2009), and their effect on the oil production from 1987 to 2011 is illustrated in Figure 1.

Figure 1: Historical development of the offshore oil production in Denmark

![Fig. 3.3 Production of oil and sales gas 1987-2011](source: Danish Energy Agency (2012))
In the last 21 years and alongside the offshore oil and gas activities, wind energy farms onshore and offshore have been put into operation. At first, wind turbines were placed at windy locations on land and near the coast, but in 1991 the first wind farm was set into production in the North Sea (Offshore Center Denmark, 2012). Today, 12 wind farms are in operation in Danish waters and additional four are under planning or construction. Figure 2 gives an overview of the development in the production of offshore wind energy compared to that of onshore wind energy, including their combined share of the total electricity supply in Denmark.

Figure 2: Development of offshore and onshore wind energy production in Denmark

![Graph showing the development of offshore and onshore wind energy production in Denmark](Source: Danish Energy Agency (2009))

These different offshore activities have given birth to an offshore oil and gas cluster and an offshore wind energy cluster around the city of Esbjerg, and the actors in these clusters share, to a great extent, many of the same challenges of working offshore in relation to for example weather conditions, corrosion, and supply possibilities. Moreover, the clusters are embedded in a larger regional innovation system of interconnected firms, specialized suppliers, service providers and associated institutions, and they are being facilitated by the Offshore Center Denmark, which is a cluster secretariat located in Esbjerg. The centre was established in 2003 in order to support the clusters in becoming more competitive as well as to organize activities targeting actors from the entire national value chain related to both green offshore and oil and gas offshore.
One of the key characteristics of the two offshore energy clusters is that they are dominated by national and international branch firms that have many relationships outside the clusters, but in order to stimulate the cooperation inside the clusters between these branch firms and the local small and medium-sized firms, the Offshore Center Denmark and its staffed cluster facilitators coordinate different projects ranging from technical projects to projects with a broader scope such as education and regional development. In these types of projects, the Offshore Center Denmark assists with administration, fundraising, and background studies, and they promote interaction and knowledge exchange between the cluster actors including making sure that potential actors in related industries outside the clusters are involved if needed. As examples to illustrate activities initiated by the Offshore Center Denmark are designing and building a prototype of a mono tower for drilling oil and gas at inaccessible locations and a project focusing on the development of safety tracking equipment for personnel working at drilling rigs.
3. Concepts

3.1 The concept of clusters
This report is based on Michael Porter’s cluster definition. In the report, clusters are therefore regarded as “geographic concentrations of interconnected firms, specialized suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also cooperate” (Porter, 2000, p. 16). This definition emphasizes that firms are the driving actors in clusters and that there is a coexistence of corporation and competition within clusters.

3.2 The concept of resources and resource transfer
Resources are here seen as cluster assets coordinated or controlled by different cluster actors such as firms, knowledge institutions, government bodies, and individuals. According to De Wit and Meyer (2010), who follow a resource-based view (Barney, 1991; Penrose, 1958; Wernerfelt, 1984), resources are commonly divided into tangible and intangible resources. See Figure 3 for an overview.

Figure 3: Tangible and intangible resources

<table>
<thead>
<tr>
<th>Tangible resources</th>
<th>Intangible resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>Relationships</td>
</tr>
<tr>
<td>Buildings</td>
<td>Reputation</td>
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<tr>
<td>Materials</td>
<td>Knowledge</td>
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<tr>
<td>Technology</td>
<td>Capabilities</td>
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<tr>
<td>Money</td>
<td>Attitudes</td>
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</tbody>
</table>

Source: Based on De Wit and Meyer (2010)

Tangible resources refer to all means which are physically observable within clusters such as land, buildings, materials, technology, and money. In contrast, intangible resources refer to all means which are not physically observable including relational resources and competences held by the actors of clusters. Furthermore, relational resources refer to the assets of clusters which result from the social relationships and interactions of the cluster actors while competences refer to the knowledge, capabilities, and business attitudes held within clusters. In the wake of this, these resources can be shared or transferred when they are handed over from an actor in one cluster to an actor located in another cluster.
4. Key questions of the study

This study is built around four key questions (see Figure 4) that are inspired and deduced from the problems and challenges related to the actors working within the two Esbjerg-based offshore energy clusters as well as from reports and studies of the offshore energy industry.

Figure 4: The four key questions of the study

The first source of inspiration behind the above questions relates to the actors operating in the two offshore energy clusters located around Esbjerg. They have had an interest in discussing how the clusters can learn from each other, and especially how the knowledge and know-how already obtained in the mature offshore oil and gas cluster can be transferred to the emerging offshore wind energy cluster. In particular, there has been a request for investigating the practical considerations of how to do it and what benefits would arise by doing it seen from a business development- and technical perspective.
The other source of inspiration derives from previous studies and reports such as “Udvikling og omstilling i vindmølleindustrien” by Poul Houman Andersen and Ina Drejer, “Værdikædeanalyse af offshore olie- og gassektoren i Danmark” by Oxford Research, and the Power Cluster Initiative “The Northern European Competence Network for Offshore Wind Energy” that all point to the large potential for offshore wind energy and the need for the offshore wind energy industry, including the offshore wind energy cluster located around Esbjerg, to become more competitive and industrialized. In the wake of the location of both a mature offshore oil and gas cluster and an emerging offshore wind energy cluster around Esbjerg, it raises the question of how these clusters can learn from each other, including how resources can be transferred between them in a learning cycle so as to meet the challenges of competitiveness and industrialization related to the offshore wind energy industry. This is of interest to the single case of the offshore energy clusters located around Esbjerg, but also on a more generic level as it becomes a discussion to which extent resource transfer between clusters can speed up the process of cluster development and cluster competitiveness.

Please turn to Appendix 1 for an explanation of how these key questions have been used methodically in the study.
5. The case of resource transfer between two offshore energy clusters

5.1 What kinds of resources are transferred between the clusters?
This section lists the types of firm resources (but not exhaustive) which are transferred between the two offshore energy clusters located around Esbjerg. The findings are presented with respect to the resource categories introduced by de Wit and Meyer (2010); tangible and intangible resources, in Chapter 3.

5.1.1 Tangible resources
Within the category of tangible resources examples of resource transfer between the clusters were found within all five resource types: land, buildings, materials, technology, and money. Further details are stressed below.

5.1.1.1 Land
According to the Port Director at the Port of Esbjerg, Ole Ingrisch, wharf areas are great examples of small pieces of land which have been transferred between the clusters. Not many years ago, the wharf areas were rented mainly by firms from the offshore oil and gas cluster. Today, offshore wind energy firms rent them as well. Still more areas are leased by firms from the offshore wind energy cluster, and more services are rented for offshore wind activities than for offshore oil and gas activities. Sometimes wharf areas are used for unloading offshore windmills while in other cases they are used by oil and gas supply vessels.

5.1.1.2 Buildings
Port buildings are leased by firms from both clusters. Examples of such firms are Dong Energy, Semco Maritime, Ocean Team Scandinavian, Ramboll, and Bureau Veritas. Common for these firms is that they have allocated parts of their buildings originally used for oil and gas activities to activities regarding offshore wind.

5.1.1.3 Materials
Port cranes, construction bolts, supply vessels, coding systems, scaffoldings, foundation constructions, and helicopters are examples of materials that are transferred across cluster boundaries.
• **The case of port cranes**
  According to the Port Director at the Port of Esbjerg, Ole Ingrisch, port cranes are rented by firms from both clusters. He states that “sometimes cranes are used for lifting oil and gas pipes and sometimes they are used for lifting wind turbines” (Interview 6, 00:04:45). This case of the port cranes illustrates how the port offers the same resources to both clusters and acts as a cross-cluster resource portal.

• **The case of supply vessels**
  According to the E&P Director at Maersk Oil, Jens Peter Riber, the clusters and the firms included in the clusters compete for supply vessels, which is a rare resource. In the wake of this, the Chief at Offshore Management at Dong Energy, Claus Christensen, said that in 2009 Dong Energy acquired the vessel and installation firm A2SEA for that very same reason. They simply bought and thereby internalized the resource they needed. To illustrate the competition regarding supply vessels Jens Peter Riber states that on several occasions Maersk Oil has been overbid by Dong Energy when trying to lease supply vessels for offshore operations.

• **The case of construction bolts**
  Despite the fact that the offshore oil and gas cluster for many years used long bolts in offshore constructions, short bolts were used in offshore wind constructions at the beginning. According to Søren Juel Petersen, Business Development Manager at Rambøll, several structures have fallen apart simply because the bolts were not strong enough to hold them together. Because of these incidents, the offshore wind energy cluster and its firms have adapted the idea about using long bolt in offshore constructions. This illustrates how the lack of resource transfer can promote failures.

• **The case of paint systems**
  Paint systems used for protection of offshore constructions are another example of a material that has been tried transferred from the offshore oil and gas cluster to the offshore wind energy cluster. Hempel offers several paint systems for offshore constructions, but the first designers of offshore wind energy farms in Denmark did not follow the general practices and rules of painting used in the offshore oil and gas industry, as Søren Juel Petersen, Business Development Manager at Rambøll, explains. In three or four offshore wind farm projects, only
one layer of coding was applied which resulted in corrosion on the constructions which then had to be handled and re-certified.

- **The case of scaffolding**
  Even though scaffolds have been designed and constructed for several years within the offshore oil and gas industry, new scaffolds were designed and constructed for the offshore wind industry. According to the E&P Director at Maersk Oil, Jens Peter Riber, the new scaffolds however showed to be too thin and unstable and they had to be redesigned and reconstructed in accordance within those of the offshore oil and gas industry.

- **The case of construction materials**
  The interviewees agree on the fact that materials used in foundation constructions are transferred between the two offshore energy clusters. Among those is the Chief at Offshore Management at Dong Energy, Claus Christensen, who also tells that the wind mills used offshore share many similarities with those onshore, even though they have gone through several adaption based upon experiences from the offshore oil and gas industry. He explains the latter by the fact that “the two industries become still more identical and therefore it becomes still more relevant to look at solutions developed by the offshore oil and gas industry. We are moving out on deeper waters and therefore we will have to choose some of the solutions that have been developed by the offshore oil and gas industry, as they have many years of experience in deep water operations” (Interview 4, 00:45:59). The Port Director of Esbjerg Port, Ole Ingrisch, uses a similar explanation. He states that “the offshore oil and gas industry has a long experience in using materials which can withstand the offshore conditions” (Interview 6, 00:07:15).

  In order to be more specific on what has actually been transferred, Claus Christensen says that “the jacket is a clear example of a product that has been directly transferred from the offshore oil and gas cluster, while the monopile, which is a foundation construction, has been advanced by the offshore oil and gas cluster before its transfer” (Interview 4, 00:50:49).

  Claus Christensen is sure that more examples of resource transfer between the clusters are to come in the future as the circumstances under which the offshore wind constructions will be
placed will be more similar to the circumstances of which oil and gas constructions are situated. Until now, the Danish offshore wind farms have been located in rather shallow water. However, in the future, more farms will be located in deeper water. Until 2010, two types of foundations have been used for offshore wind farms in Denmark: monopiles and gravity foundations. A monopile is a long steel tube which is nailed into the seabed. A gravity foundation is a heavy base structure counting a couple of thousand tons. Such a foundation is either made of concrete (which is most common) or steel. The gravity foundation technique is similar to the one that is used in bridge constructions and very well-known. Both foundation types are designed for water depths below 25 meter, also called shallow water (Offshore Center Denmark, 2010).

However, despite the fact that offshore wind farms in the future will be located in deeper waters and that the circumstances under which the offshore wind constructions will be placed will be more similar to the circumstances of which oil and gas constructions are situated, there will be a need for great adjustments and awareness of differences when transferring resources across the clusters. The case of Horns Rev 2 explains why. Last year, it was discovered that the foundation constructions of the Horns Rev 2 offshore wind farm were miss-constructed as they have not been adjusted to the constructions of windmills. As a result, the foundations began to crumble as the windmills started to swayed. According to Søren Juel Petersen, Business Development Manager at the offshore wind division at Rambøll, Horns Rev 2 is not the only offshore wind farm suffering from foundation problems. He estimates that about 80-90 percent of all Danish offshore wind farms suffer from crumbling foundations. Even though he agrees with Claus Christensen from Dong Energy regarding the future aspects of resource transfer between the two offshore energy clusters, he estimates that as the offshore wind energy cluster matures it will seek its resources more from previous offshore wind projects and to a lesser degree from projects run in the offshore oil and gas cluster.

5.1.1.4 Technology
According to the Business Development Manager at the offshore wind division at Rambøll, Søren Juel Petersen, technology has been transferred between the clusters. He explains how a specialized form of calculation technology developed in the offshore wind division at Rambøll has been transferred to the offshore oil and gas division at Rambøll. The calculation technology helps designing offshore projects.
5.1.1.5 Money
The Chief at Offshore Management at Dong Energy, Claus Christensen, specified that Statoil has invested in offshore wind farms in order to obtain, among other things, a green profile. The case illustrates how money originally earned by an offshore oil and gas firm is transferred to one or more firms within the offshore wind energy industry. Moreover, it is assumed that money flows across cluster boundaries in relation to trade and transactions.

5.1.2 Intangible resources

5.1.2.1 Relational resources
The study showed that several sets of relationships exceeded cluster boundaries. For example in the case of Dong Energy working with Rambøll, Semco Maritime and the Port of Esbjerg in both clusters. The fact that the actor set-up in the relationships is identical points to the fact that more relationships between the actors have been transferred between the clusters.

5.1.2.2 Competences
According to the Managing Director at Offshore Center Denmark, Peter Blach, competences such as knowledge and experience within foundation design, foundation materials, logistics, installation, service and maintenance, quality, safety, and security are transferred between the clusters. The Director at the Port of Esbjerg, Ole Ingrisch, specifies that standards are transferred within the areas of quality, safety, and security. As an example, Rambøll is required to follow specific standards given by the certification firm Det Norske Veritas when designing constructions for, among others, MT Højgaard and Dong Energy. These standards seek to maintain high standards of quality. Moreover, project design competences have also been transferred between the clusters mainly through individuals moving from one job to another.
5.2 How and by whom are resources transferred between the clusters?
This section describes how and by whom firm resources are transferred between the two offshore energy clusters. Overall, the study shows that resources are transferred at three levels; at the individual level, at the single firm level, and at the firm network level.

According to the Chief at Offshore Management at Dong Energy, Claus Christensen, in the beginning of the offshore wind energy cluster’s development, resources were mainly transferred by individuals changing jobs from the offshore oil and gas cluster to the offshore wind energy cluster. But as the market for offshore wind energy began to rise and it became profitable for firms to enter the market, more resources were transferred by firms. Today, the greatest amount of resources is transferred by firms.

5.2.1 Movement of individuals
When individuals change jobs across cluster boundaries, they become inter-cluster resource transmitters as they carry resources with them across cluster borders. The Chief at Offshore Management at Dong Energy, Claus Christensen, gives four examples of individuals who have switched jobs from firms in the offshore oil and gas cluster to firms in the offshore wind energy cluster. Among those are himself, the Chief Sales Officer at A2SEA, Kaj Lindvig, who changed job from Semco Maritime to A2SEA, the Senior Manager of Harbour & Transport Logistics at Dong Energy, Bjarne Sloth Jacobsen, who switched job from Semco Maritime to Siemens Wind Power and then to Dong Energy, and the Senior Specialist at Siemens Wind Power, Jesper Møller, who changed job from Semco Maritime to Siemens Wind Power.

- The case of Claus Christensen, Dong Energy
  Claus Christensen, the Chief at Offshore Management at Dong Energy, started his career at Maersk Oil. A couple of years later, he changed his job for a job at Siemens Wind Power. Today he is the Chief at Offshore Management at Dong Energy. The case of Claus Christensen exemplifies how resources such as knowledge and skills are transferred between the clusters through the movement of an individual.
The case of Kaj Lindvig, A2SEA

Another example is Kaj Lindvig, the Chief Sales Officer at A2SEA. He started his career at Semco Maritime where he worked on oil and gas projects. After a few years, he changed his job at Semco Maritime for a job at A2SEA as Chief Sales Officer. His knowledge on and experience with maritime challenges in the North Sea is now used in relation to A2SEA’s maritime transport and installation of turbine components.

Several of the interviewees pointed to the fact that it is attractive to get a job within the industry of renewable energy due to its environmental and sustainable image, and they seem to agree on the fact that the sub-contractors in the two clusters lose workers to the main contractors such as Dong Energy and Siemens Wind Power as they offer more lucrative employment conditions than those of the smaller sub-contractors. However, according to the Innovation Manager at Semco Maritime, Søren Juel Nielsen, engineers also move because of new interesting job opportunities and technical challenges.

5.2.2 Single cluster firms

The case of Rambøll

Rambøll is a great example of a single firm transferring resources across cluster borders. Rambøll originally served contractors from the offshore oil and gas cluster such as Maersk Oil and Dong Energy, but when the cluster of offshore wind energy started increasing, the firm began to serve contractors from this cluster as well. Søren Juel Petersen, Business Development Manager at Rambøll, clarifies that based on knowledge and technology developed for offshore oil and gas projects, the firm began to develop competences and gain experience within offshore wind energy projects. Engineers on offshore oil and gas projects were used for offshore wind energy projects as well. Today the assignments within offshore oil and gas and offshore wind energy are divided into two distinct divisions at Rambøll. Knowledge, manpower, and technologies are, however, still shared between them. In fact, it is often the same engineers who design structures for oil and gas drilling rigs and transformer platforms for offshore wind energy farms.
Other examples of the transfer from offshore oil and gas projects to offshore wind energy projects are safety and maintenance philosophies as well as the experience of what it takes to operate in offshore conditions. Also lessons learned about what kind of material and coding systems to use in offshore conditions exemplify resources transferred to offshore wind energy projects.

- The case of the Port of Esbjerg

The Port of Esbjerg is another example of a single firm linking the two offshore energy clusters. As mentioned earlier, the Port of Esbjerg provides the same core services to the two clusters, namely infrastructure. In this context, infrastructure covers roads, wharf areas, water depths, cranes, electricity, and labour. However, the services are used for different purposes within the two clusters. In the case of the offshore oil and gas cluster, wharf areas are used by supply vessels, while in the case of the offshore wind energy cluster, wharf areas are used to disembarkation of wind turbines. In the same manner, cranes are used for lifting wind turbines, but they are also used for lifting oil and gas pipelines. To the offshore oil and gas activities the port also offers jack-up facilities, areas for trailer cities when drilling rigs are being renovated, and manufacturing facilities. The port originally served the fishing industry. Then, as the fishing industry declined and the offshore oil and gas activities increased, services were adapted to the offshore industry. Today, offshore wind energy firms buy most of the services at the port.

Other examples of resources transferred through single firms were found within the firms of Semco Maritime and Blue Water Shipping. According to Peter Blach from the Offshore Center Denmark and Birgit Bech Jensen from the Green Offshore Center, a number of firms have business activities in both offshore energy clusters and act as resource transmitters across the clusters.
5.3 Resource relationships between the cluster actors

- **The case of Rambøll and MT Højgaard**
  The case of Rambøll and MT Højgaard illustrates how resources are transferred between the clusters via relationships among cluster firms. Over the years Rambøll designed several construction projects for the Danish construction firm MT Højgaard. Knowledge acquired on previous offshore oil and gas projects regarding how foundation constructions have to be designed in order to meet the standards of the offshore industry is transferred from Rambøll to MT Højgaard.

- **The case of Dong Energy and Semco Maritime**
  The case of Semco Maritime and Dong Energy is another example of how resources are transferred between the clusters via relationships between cluster firms. During an interview Innovation Manager at Semco Maritime, Søren Juel Nielsen, tells that Semco Maritime supplies Dong Energy with constructions to both offshore oil and gas projects and offshore wind energy projects.

- **The case of Semco Maritime and University of Aalborg**
  According to Innovation Manager at Semco Maritime, Søren Juel Nielsen, knowledge held within graduates is transferred from the University of Aalborg in Esbjerg to Semco Maritime when Semco Maritime recruits graduates. At the same time specific knowledge on offshore tasks are transferred from Semco Maritime to the University of Aalborg in Esbjerg.
6. Conclusive discussion

The aim of this report was to describe and analyse the transfer of firm resources between two offshore energy clusters located around the city of Esbjerg in Denmark, as well as to discuss what elements to consider in such complex resource transfer processes.

The different examples regarding transfer of tangible and intangible firm resource between the emerging offshore wind energy cluster and the mature oil and gas cluster have made it evident that the resource transfer takes place at three levels; at the individual level, at the single firm level, and at the firm network level. At the individual level, firm resources are often transferred when people change jobs across cluster boundaries and thereby become inter-cluster resource transmitters. At the single firm level, the resource transfer takes place internally within one firm when it for example transfers and adapts resources used in the offshore oil and gas cluster in order to use the very same resources in the offshore wind energy cluster. Finally, at the firm network level firm resources are transferred through relationships between the cluster firms. Following this categorization, firms that wish to develop through the experiences in other clusters need to address all three levels. This has implications on how to recruit new personnel, how to improve employee competencies and how to invest in new resources.

In addition, the case study shows that both tangible and intangible resources can be transferred directly and indirectly like in the situation of transferring technology and knowledge related to foundation designs, foundation materials and service and maintenance, as well as regarding competencies and capabilities within installing, safety, security, quality, catering, logistics, and certification of different offshore energy activities. This distinction of direct and indirect transfer of tangible and intangible firm resources is illustrated in Figure 5.
The transfer of firm resources between the two offshore energy clusters fostered several innovations and new ways of thinking regarding foundation designs, supply philosophies, and service and maintenance of offshore oil and gas projects and especially of offshore wind energy projects. However, the learning process was in more cases achieved through the process of learning by failure, for example in the case of paint systems and construction bolts. In continuation of this, the findings from this study emphasize that very often errors occur because firms mistakenly use resources from the offshore oil and gas cluster which have not been customized and adapted to the business area and business logic of the offshore wind energy cluster and vice versa. Errors also occur because resources have been transferred without discussing the need and relevance which typically leads to over-engineering and increased complexity.

Finally, according to Damgaard et al. (2012) resource transfer between clusters often has mutual and reinforcing upgrading effects on the clusters involved. However, in the case of the two investigated offshore energy clusters this is not the exact case. The examples of resource transfer mentioned in Chapter 5 emphasize that the learning process so far mostly has been one-directional, meaning that resources mainly have been transferred from the mature cluster of offshore oil and gas to the emerging cluster of offshore wind energy. A single example of the opposite is given by the Business Development Manager at the offshore wind division at Rambøll, Søren Juel Petersen, who states that a specialized form of calculation technology used for offshore wind energy projects has been transferred to offshore oil and gas projects. In relation to this, Senior Manager at Maersk Oil, Jens Peter Riber, believes that over time and when the emerging offshore wind energy cluster matures, the cluster of offshore oil and gas will take more advantage of the resources from the
offshore wind energy cluster. This ambition of learning across clusters points to the fact that firms must invest in relationships with other firms in order to gain access to new and innovative tangible and intangible resources. Resources gained in one cluster can be transferred to other clusters, but cluster dynamics will influence how different firms can benefit from these resources and when.
7. References


Appendix 1: Research method

To meet the purpose of investigating the resource transfer taking place between the two offshore energy clusters located around the city of Esbjerg, a single case study recognizing the on-going resource transfer as unit of analysis was made (Yin, 2003). The case study method was chosen as research strategy as it allows researchers to alternate between theoretical and empirical knowledge during the research process (Yin, 2003), and because it provides researchers with the opportunity to explore the phenomenon of interest in its natural context (Johnston et al., 1999). A case study can either be descriptive, explorative, or explanatory (Yin, 2003). In this situation, the case study primarily had an explorative and descriptive design aiming at shedding light on questions such as how and by whom different firm resources are transferred between the two offshore energy clusters and what kinds of consequences relates to that.

The data for the case study was collected in three chronological steps from April 2012 to September 2012. First, in order to understand the context of the two offshore energy clusters, interviews were made with their respective cluster facilitators (step 1). Then interviews with firms either located in one of the clusters or in both were carried out in order to uncover how firm resources were transferred between the clusters (step 2). Finally, a focus group interview was held in order to discuss, challenge, and validate data from the previous interviews (step 3). Figure 6 shows the data collection process step by step.

Figure 6: The data collection process
The personal interviews

A personal interview can be defined as a planned conversation, led by a moderator, on a topic of mutual interest by the participants (Kvale, 1997). Personal interviews were carried out with two cluster facilitators at step 1 and with eight representatives from firms in the clusters in step 2. The interviews with the facilitators were explorative, took on average 35 minutes (see Appendix 5), and were based on a semi-structured interview guide (see Appendix 2). During the interviews, the facilitators were asked to point out leading firms within each of the two clusters and explain the broader context of the cluster, including its history, location, and activities.

The cluster firms aimed at the interviews in step 2 were selected on the basis of a snowball method which was used to untangle the network of actors within the clusters and to provide insight into how the cluster firms were interconnected. The snowball process was based on three selection criteria:

1. Lead firms and broker firms within each of the clusters had to be represented in the interviews
2. Suppliers or subcontractors engaged in both clusters had to be represented in the interviews
3. The firms selected had to embody different business segments within the two clusters

The persons participating on behalf of the firms were asked to nominate other firms which were evaluated on the basis of the selection criteria. The process continued until a sufficient basis for understanding resource transfer between the two offshore energy clusters was found. Figure 7 shows the participants selected for the personal interviews.

Figure 7: Participants selected for the personal interviews

<table>
<thead>
<tr>
<th>Date</th>
<th>Name of interviewee</th>
<th>Position of interviewee</th>
<th>Organisation of interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>07.05.2012</td>
<td>Birgit Bech Jensen</td>
<td>Business Consultant</td>
<td>Eshbjerg Business Development Centre</td>
</tr>
<tr>
<td></td>
<td>Anders Bræstrup</td>
<td>Development Consultant</td>
<td>Region of Southern Denmark</td>
</tr>
<tr>
<td>16.05.2012</td>
<td>Peter Blach</td>
<td>Managing Director</td>
<td>Offshore Center Denmark</td>
</tr>
<tr>
<td>21.05.2012</td>
<td>Søren Juel Nielsen</td>
<td>Innovation Manager</td>
<td>Semco Maritime</td>
</tr>
<tr>
<td>21.05.2012</td>
<td>Claus Christensen</td>
<td>Chief of Offshore Management</td>
<td>Dong Energy</td>
</tr>
<tr>
<td>22.05.2012</td>
<td>Kaj Lindvig</td>
<td>Chief Sales Officer</td>
<td>A2SEA</td>
</tr>
<tr>
<td>24.05.2012</td>
<td>Ole Ingrisch</td>
<td>Managing Director</td>
<td>Port of Esbjerg</td>
</tr>
<tr>
<td>29.05.2012</td>
<td>Jesper Møller</td>
<td>Senior Specialist</td>
<td>Siemens Wind Power</td>
</tr>
<tr>
<td>31.05.2012</td>
<td>Jacob Kjærgaard</td>
<td>Business Development Manager</td>
<td>Blue Water Shipping</td>
</tr>
</tbody>
</table>
The interviews with the firms were explorative and based on a semi-structured interview guide (see Appendix 3), which evolved along the process of making the interviews. On average, the interviews took 45 minutes and they were recorded and later summarized in extended interview memos.

During the interviews, the cluster firms were questioned in depth about their business activities and business partners in order to find out how and by whom firm resources were transferred between the two offshore energy clusters. The interviewees were also questioned about specific cooperation projects in order to uncover the process and effects of the resource transfer.

**The focus group interview**

A focus group interview is "a discussion conducted by a trained moderator among a small group of participants in an unstructured and natural manner" (Malhotra and Birks, 2006, p. 182). The moderator sets the purpose of the interview, questions and probes the participants, and handles the process of discussion.

The participants were selected on the basis of two criteria:

1. They had to be one of the key representatives to the offshore activities in the firms
2. The firm of the participants had to be active in one of the clusters and preferably in both

However, in relation to the selection criteria listed above, a number of relevant actors were discharged, as they might be too leading or agenda-setting for the group discussion. Figure 8 lists the chosen participants in the focus group interview.

**Figure 8: Participants selected for the focus group interview**

<table>
<thead>
<tr>
<th>Date</th>
<th>Name of interviewee</th>
<th>Position of interviewee</th>
<th>Organisation of interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.08.2012</td>
<td>Søren Juel Nielsen</td>
<td>Innovation Manager</td>
<td>Semco Maritime</td>
</tr>
<tr>
<td></td>
<td>Claus Christensen</td>
<td>Chief of Offshore Management</td>
<td>Dong Energy</td>
</tr>
<tr>
<td></td>
<td>Ole Ingrisch</td>
<td>Managing Director</td>
<td>Port of Esbjerg</td>
</tr>
</tbody>
</table>
The focus group interview was semi-structured, based on an interview guide (see Appendix 4) and lasted 2 hours (see Appendix 5). It was recorded and then later transcribed.
Appendix 2: Interview guide for cluster facilitators

- At which year was the cluster established?
- Which milestones have there been in the history of the cluster?
- Which industries do the activities of the cluster concern?
- How many actors participate in the cluster?
- Where is 50 percent or more of the actors participating in the cluster located?
  - The North Denmark region
  - The Central Denmark Region
  - Region of Southern Denmark
  - Region Zealand
  - The Capital Region of Denmark
- How many of the participating actors of the cluster are:
  - Government institutions
  - Knowledge and educational institutions
  - Firms
  - Non-profit organizations
  - Others
- How many of the firms in the cluster are:
  - Micro firms (0-9 employees)
  - Small firms (10-49 employees)
  - Medium-sized firms (50-99 employees)
  - Large firms (100+ employees)
- How many people are employed in the cluster?
- Which firms constitute the core of the cluster?
- Which type of actor is the dynamo in the cluster?
  - Micro, small and medium-sized firms
  - One or few large hub firms and their suppliers
  - Branch firms
  - Government institutions
  - Knowledge and educational institutions
  - Non-profit organizations
• Others

- About which activities do the actors of the cluster cooperate?
  - Research and development
  - Purchase
  - Production
  - Recruitment and labour
  - Logistics
  - Sales and marketing
  - Others

- About which resources do the actors of the cluster cooperate?
  - Materials
  - Products and services
  - Production technologies
  - Labour
  - Knowledge and competences
  - Others

- What does the offshore oil and gas cluster have in common with the offshore wind energy cluster?
  - Actors
  - Activities
  - Resources

- Which resources are transferred between the offshore oil and gas cluster and the offshore wind energy cluster?
  - Money
  - Materials
  - Products and services
  - Labour
  - Production facilities
  - Research and development activities
  - Technology
  - Knowledge, information, and know-how
  - Others
• Who transfers resources between the offshore oil and gas cluster and the offshore wind energy cluster?
  o Multinational firms
  o Micro firms
  o Small firms
  o Medium-sized firms
  o Individuals
  o Government institutions
  o Knowledge and educational institutions
  o Non-profit organizations
  o Others

• How are resources between the offshore oil and gas cluster and the offshore wind energy cluster transferred?
  o Professional relationships
  o Personal/Social relationships
  o Cluster organizations
  o Trade organizations
  o Others

• What are the implications of the resource transfer between the offshore oil and gas cluster and the offshore wind energy cluster?
  o Avoid lock-in
  o Cluster upgrading
  o Increased competitiveness and innovation
  o Others
Appendix 3: Interview guide for cluster firms

About the interviewee
• For how long have you been employed in this firm?
• For how long have you been in the industry of the firm?

About the firm
• When was the firm established?
• Which milestones have there been in the history of the firm?
• How many people are employed in the firm?
• What does the firm do?
• Does the firm operate in both the offshore oil and gas cluster and the offshore wind energy cluster?

About the oil and gas cluster
• When did the firm enter the business area of oil and gas and why?
• What does the firm do in relation to the offshore oil and gas cluster?
  o Which type of products does the firm deliver to the offshore oil and gas cluster?
  o In which activities is the firm involved at the offshore oil and gas cluster?
  o With whom does the firm cooperate in the offshore oil and gas cluster?
  o Which type of resources does the firm put into play in these activities in the offshore oil and gas cluster?
    - Materials
    - Products and services
    - Technology
    - Labour
    - Competences
    - Knowledge, information, and know-how
    - Relational resources

About the offshore wind energy cluster
• When did the firm enter the business area of wind energy and why?
• What does the firm do in relation to the offshore wind energy cluster?
  o Which type of products does the firm deliver to the offshore wind energy cluster?
  o In which activities is the firm involved at the offshore wind energy cluster?
  o With whom does the firm cooperate in the offshore wind energy cluster?
  o Which type of resources does the firm put into play in these activities in the offshore wind energy cluster?
    - Materials
    - Products and services
    - Technology
    - Labour
    - Competences
    - Knowledge, information, and know-how
    - Relational resources

Similarities and differences between the offshore oil and gas cluster and the offshore wind energy cluster
• Are there similarities in relation to the products, market segments, cooperation projects, cooperation partners, and use of resources in the offshore oil and gas cluster and the offshore wind energy cluster?
  o Products and services
  o Market segments
  o Activities and cooperation projects
  o Cooperation partners
  o Resources
• Are there differences in relation to the products, market segments, cooperation projects, cooperation partners, and use of resources in the offshore oil and gas cluster and the offshore wind energy cluster?
  o Products and services
  o Market segments
  o Activities and cooperation projects
  o Cooperation partners
  o Resources
Cooperation projects and joint activities

- Can you please mention a specific cooperation project taking place in the offshore oil and gas cluster or the offshore wind energy cluster?
- When was the cooperation project carried through?
- Who was involved in the cooperation project?
- Which resources were used in the cooperation project and why?
  - Materials
  - Products and services
  - Technology
  - Labour
  - Competences
  - Knowledge, information, and know-how
  - Relational resources
- Which implications did the cooperation project have for your firm and the other project partners?
Appendix 4: Interview guide for focus group interview

- Introduction
- Presentation of the workshop participants
- To what degree have you been involved or heard about resource transfer between the offshore oil and gas cluster and the offshore wind energy cluster?
- Which resources have been transferred between the offshore oil and gas cluster and the offshore wind energy cluster?
- By who and how have the firm resources between the offshore oil and gas cluster and the offshore wind energy cluster been transferred?
- Which kinds of implications have there been in the wake of the resource transfer between the offshore oil and gas cluster and the offshore wind energy cluster?
### Appendix 5: List of interviews

<table>
<thead>
<tr>
<th>Number</th>
<th>Date</th>
<th>Name of interviewee</th>
<th>Organisation of interviewee</th>
<th>Length of interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>07.05.2012</td>
<td>Birgit Bech Jensen Anders Bræstrup</td>
<td>Esbjerg Business Development Centre Region of Southern Denmark</td>
<td>00:42:38</td>
</tr>
<tr>
<td>2</td>
<td>16.05.2012</td>
<td>Peter Blach</td>
<td>Offshore Center Denmark</td>
<td>00:26:18</td>
</tr>
<tr>
<td>3</td>
<td>21.05.2012</td>
<td>Søren Juel Nielsen</td>
<td>Semco Maritime</td>
<td>00:38:59</td>
</tr>
<tr>
<td>4</td>
<td>21.05.2012</td>
<td>Claus Christensen</td>
<td>Dong Energy</td>
<td>01:21:26</td>
</tr>
<tr>
<td>5</td>
<td>22.05.2012</td>
<td>Kaj Lindvig</td>
<td>A2SEA</td>
<td>00:41:24</td>
</tr>
<tr>
<td>6</td>
<td>24.05.2012</td>
<td>Ole Ingrisch</td>
<td>Port of Esbjerg</td>
<td>00:20:15</td>
</tr>
<tr>
<td>7</td>
<td>29.05.2012</td>
<td>Jesper Møller</td>
<td>Siemens Wind Power</td>
<td>00:52:22</td>
</tr>
<tr>
<td>8</td>
<td>31.05.2012</td>
<td>Jacob Kjærgaard</td>
<td>Blue Water Shipping</td>
<td>00:58:45</td>
</tr>
<tr>
<td>9</td>
<td>05.06.2012</td>
<td>Jens Peter Riber</td>
<td>Maersk Oil</td>
<td>Not recorded</td>
</tr>
<tr>
<td>10</td>
<td>19.06.2012</td>
<td>Søren Juel Petersen</td>
<td>Rambøll</td>
<td>01:06:49</td>
</tr>
<tr>
<td>11</td>
<td>13.08.2012</td>
<td>Anders Sloth Claus Christensen Klaus Andersen Ole Ingrisch Peter Worck Nielsen Svend Ole Madsen Søren Juel Nielsen Søren Stougaard Tove Brink</td>
<td>Ocean Team Scandinavia Dong Energy Rambøll Port of Esbjerg Bureau Veritas University of Southern Denmark Semco Maritime Blue Water Shipping University of Southern Denmark</td>
<td>02:03:47</td>
</tr>
</tbody>
</table>