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Pushing Offshore Wind Energy Regions

Challenging offshore wind: guiding experiences from the North Sea region

Final Report - June 2007

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Interreg North Sea Region

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Executive summary

Challenging offshore wind: guiding experiences from the North Sea region discusses the major challenges and opportunities in the exploitation of the offshore wind potential in the North Sea region. This report is based on 6 themes: *planning practices, grid issues, environmental impact, project management and finances, stakeholder involvement* and *regional economies.* For five North Sea countries (Denmark, Germany, The Netherlands, Belgium and the United Kingdom) these themes are discussed. These discussions result in opportunities, strengths and weaknesses per country. Table 1 shows the main strengths and weaknesses of the various countries. In order to fully understand the content of this table and the recommendations, the reader is strongly advised to read the specific chapters in this report.

	Main strengths	Main weaknesses
Denmark	Direct and stable government involvement *One stop shop* approach A lot of experience in offshore wind	Ports not suitable for installation next generation turbines Uncertain long-term prospect for offshore wind energy
Germany	Consistent financial support Extensive stakeholder consultation	Complicated bureaucratic setting Time consuming licence procedures Few suitable cable routes
The Netherlands	Broad range of stakeholders involved Good ports for logistics, construction and servicing Growing institutional belief in wind energy	Instable government involvement Time consuming implementation procedures
Belgium	Consents have a high level of freedom Regional partners in the consortium lead to employment in the region	No specific requirements for offshore wind farms taken into account during location selection No long-term perspective on offshore wind energy
United Kingdom	Stable side conitions for the market Room for technological changes	Grid connection possibilities are limited Poor onshore infrstructure

Table 1. Comparison of the POWER countries.

The strengths and weaknesses mentioned in the table lead to recommendations and challenges for the different countries. In *Denmark* turbines were used that were not finished testing. This gave problems during operation. Recent experiences show this will not happen again. A long-term prospect on offshore wind energy gives the market more certainty. It is essential that the Danish government establishes such a prospect. Another challenge for Denmark is the use of shared offshore grid infrastructure. Denmark, being one of the countries with an early experience

in offshore wind energy, can play a leading role in adjusting operation and maintenance strategies. This experience should be used to standardize Environmental Impact Assessment requirements for the North Sea region.

German wind farms are planned far from the coast in deep waters, resulting in a poor ratio between investment and reimbursement. The next generation 5 MW turbines can improve this ratio. Because suitable cable routes crossing the Wadden Sea are rare, a shared cable infrastructure is a solution. German government should actively support the realisation of this infrastructure. Different governmental bodies judge proposed cable routes and proposed project sites. This leads to time consuming procedures. Institutional changes should be explored to shorten implementation procedures.

In *The Netherlands*, a secure and stable policy perspective is crucial in making a successful and structural growth of offshore wind activities possible. A long-term perspective, in which a gradual growth of capacity is adapted to financial support regulation, should be established. Most importantly, the policy framework must be stable over time. In order to benefit from learning effects and to keep financial support at a reasonably low level a step-by-step approach has to be adopted.

A strategic perspective on offshore wind energy should be developed in *Belgium*. Developers are less hesitant when there is a strategic outlook. This perspective should include policy targets, grid reinforcement requirements, financial support, environmental impact and a flexible consent regime. In Belgium projects are, like in Germany, located relatively far from the coast. The use of next generation turbines is crucial to increase financial security and feasibility.

In the *United Kingdom*, the main challenge is reinforcement of the onshore grid infrastructure. Setting up a durable economic relationship with other regions in the North Sea is another challenge. The East of England region, being a forerunner in offshore wind energy, can be at the forefront of such developments.

Guiding principles

The recommendations and challenges for the different countries have common grounds. These common grounds are the basis for the generic guiding principles for a successful exploitation of the offshore wind potential.

Planning practices: A stable and structural policy framework is very important for a young industry to mature. A gradual growth of capacity installed allows the market to fully benefit from technological innovations and allows the government to reduce financial support. Countries should strive for one single regulatory regime and legislative framework applicable to both territorial waters and the Economic Exclusive Zone.

Grid issues: The use of common offshore cables and onshore connection facilities should be encouraged on national or even transnational level. A Trans European perspective, embedded in a Trans European regulatory framework on power exchange, is necessary to allow the future development of transnational cable routes and cross-border grid connections. Existing and future

interconnection cables between the countries surrounding the North Sea may be used to connect offshore wind farms with the onshore grid.

Environmental impact: The results of the first monitoring programmes must be used to reconsider EIA standards and requirements. Furthermore, a transnational Strategic Environmental Assessment for the North Sea should be established in order to combine minimal environmental damage with an efficient use of resources on a European level. Such a transnational SEA creates a strategic perspective that unites all stakeholders in the world of offshore wind.

Project management and finances: Onshore testing and assembling is crucial and should not be rushed, as offshore work is generally up to 5 times more expensive. To reduce insecurities to the market, governments need to provide structural and stable support adjusted to a country's strategic perspective on offshore wind industry in general. Although in general the costs for a project differ up to 20 percent between an EPC- or Multicontracting approach, the actual choice is depends on the capability of a consortium to manage processes and to bear risks.

Stakeholder involvement: Various licence procedures during the realisation of projects ensure extensive stakeholder involvement. Public participation, consultation and information allow a more fact-oriented discussion. Cooperative-ownership is mentioned frequently to increase public involvement and acceptance. In order to be successful, the reimbursement rates of such initiatives need to be rather high and initial investments relatively low. This can be achieved by initiatives that are relatively small-scale and close to the coastline. A media strategy has to focus on providing extensive information during the actual building process and operation.

Regional economics: Offshore wind energy offers a considerable opportunity for North Sea regions to create or safeguard a substantial number of jobs. Employment is generated during the construction period of the wind farms, while operation and maintenance of wind farms create a long term though limited amount of employment. None of the regions is completely self sufficient in serving the whole offshore wind supply chain for its forecast level of development. Together the regions can deliver a fully capable Trans European supply chain, capable of supporting projects in the North Sea region and developments elsewhere in the world. Such a supply chain offers a unique opportunity to use and enlarge the market potential in the region. The parts on Regional economics are mainly based on the Transnational Offshore Wind Supply Chain Study by POWER's work package on regional economics.

Strategic collaborative perspective

What this study calls for (and what is repeatedly confirmed in the recommendations and guiding principles) is cooperation and fine-tuning amongst the members of the North Sea region. To do so, a strategic cross-border outlook on offshore wind energy should be established. Ideally, a strategic cross-border outlook is closely related to a Trans European energy infrastructure perspective and the implementation of a transnational Strategic Environmental Assessment for the North Sea. When this transnational SEA incorporates non-environmental issues relevant to offshore wind energy, this brings spatial planning in the North Sea on a higher level. The countries should work together to make it possible to develop offshore wind energy in the North

Sea on another level. Looking at the offshore wind energy industry, the supply chains in the different POWER regions perform best when complementary. In this way, a fully capable supply chain will be established. Again, transnational cooperation and international fine-tuning is the key to a successful and prosperous exploitation of the offshore wind energy potential.

Table of contents

1. Introduction

The virtue of this work is that it relies on studying the experiences of 8 offshore projects; it relies on the first comprehensive case study research in the North Sea region, conducted in 5 countries. The development of offshore wind energy is at different stages in these countries. Germany and Belgium are still awaiting the first wind farm to be built, whilst Denmark and the United Kingdom are gradually deploying their potential. In The Netherlands, the first wind farm became operational end of 2006. The 8 wind farms studied in this research are shown in figure 1. Developments in the offshore wind energy sector take place rapidly. As a consequence, information runs out of date quickly. The case studies on which this report relies, were carried out end of 2005. The content of this report is based on the state of affairs January 2007.

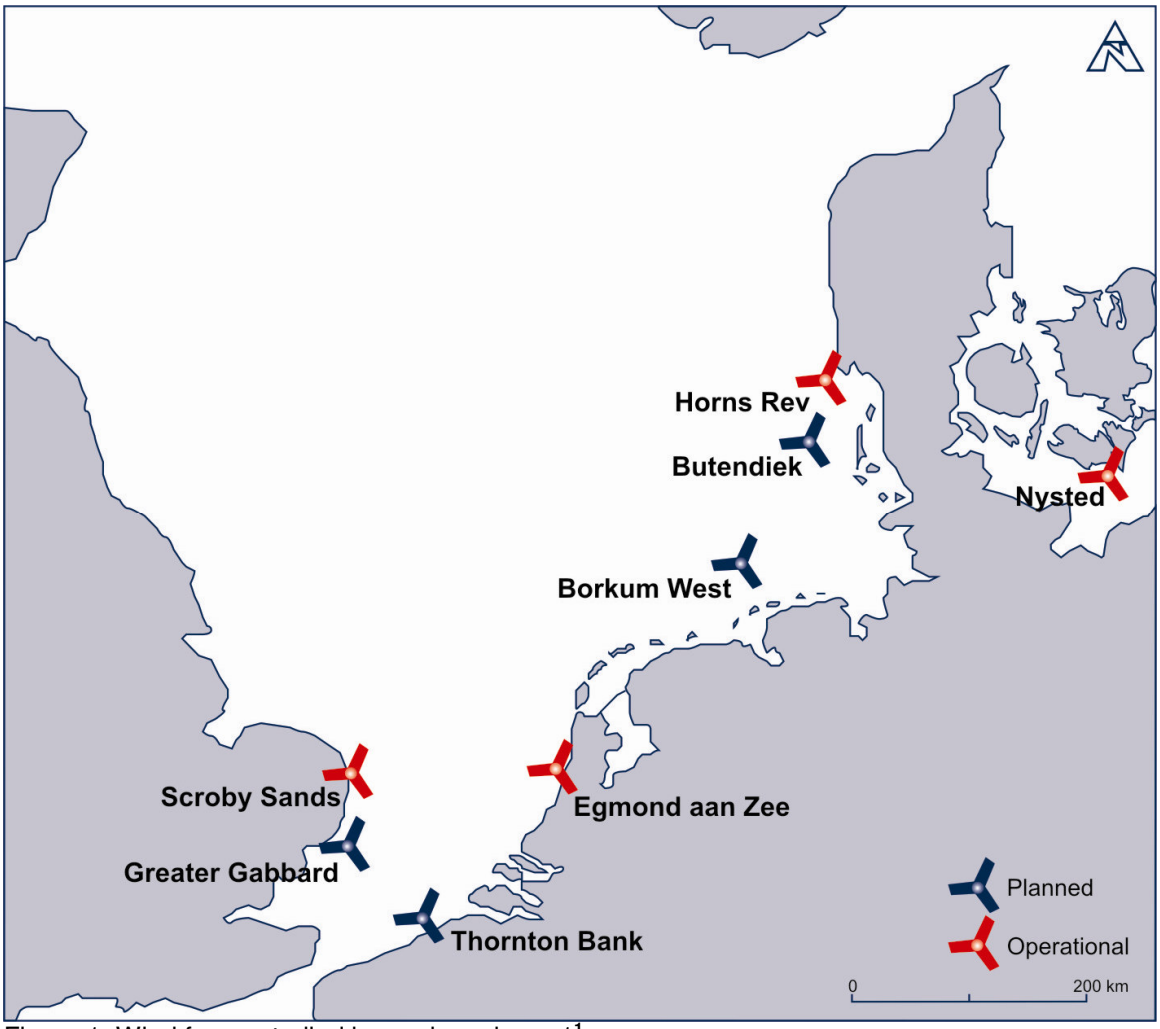


Figure 1. Wind farms studied by work package 1[1].

[1] Source: Tamara Kaspers, University of Groningen.

1.1 Research design

The report and the recommendations are structured according to 6 thematic issues which reflect the main current debates and challenges concerning offshore wind energy[2]. For each country, these issues are considered, resulting in *country-specific recommendations* and *challenges*, and – more general – *guiding principles*. In figure 2 the research design is depicted.

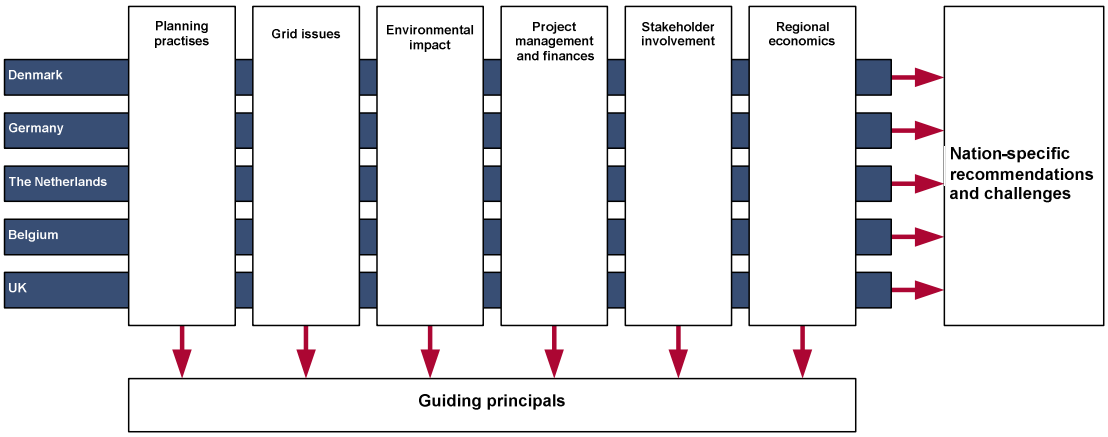


Figure 2. Research design of *Challenging offshore wind: guiding experiences from the North Sea region*.

As a consequence of the fact that the development of offshore wind is at a different stage in each country, the scope of this report's recommendations and guiding principles differs (for instance, there simply is more experience concerning consent procedures than concerning operation and maintenance). With respect to the country-specific recommendations, this should not be considered a problem; these recommendations are bound to fit the country-specific state of affairs. However, the guiding principles run the risk of being based on information disproportionately focused on certain aspects.

Some of the debates are characterized by country-specific issues (e.g. financial support mechanisms or project management). Others occur – to a high degree – in all countries likewise (e.g. strategic investments in electricity grids). Again, this possibly limits the general applicability of the recommendations.

At the same time, the relevance of the

WHAT *CHALLENGING OFFSHORE WIND* IS

This report is addressed to all of those concerned with offshore wind energy in the North Sea region. It calls for institutional capacity building in the field of offshore wind energy. Whether we think about the issues of grid connection, financial support, environmental impact, spatial planning or project management, this document presents a concerted, trans-national approach between regions, between member states, and between government and industry, as the way forward.

The goal of this concerted approach is supporting the full exploitation of the wind energy potential. This report itself is a fine example of such an approach, as its realization has involved partners from throughout the region.

Being part of the POWER project, *Challenging offshore wind* is developed alongside other research reports and tools. The reader is invited to consider the reports on supply chain management in the North Sea region, on information and decisions support tools, and on skills development. All reports are available at www.offshore-power.net.

[2] See for example EWEA (2005).

recommendations and guiding principles depends on the reader's background. In general, the content will prove to be relevant to those seeking information about current issues related to offshore wind energy, especially in combination with the other documents and studies published trough the POWER project. Addressing the bottlenecks in the deployment of the offshore wind energy potential is expected to raise awareness amongst all those involved; and awareness is the first step towards improvement.

More specifically, the recommendations and challenges in *Challenging offshore wind* are addressed directly to policy makers at national and European level. In this view, the report can serve as input to establishing the so-called Action Plan to initiate European policy for wind power. This Action Plan has been called for in the *Copenhagen strategy on offshore wind deployment*[3].

1.2 Outlining the themes

Before discussing country-specific experiences and recommendations, a brief introduction to the thematic distinctions is given, to prevent misconceptions. Planning an offshore wind farm entails a wide range of activities and parties involved. A distinction can be made between the planning process conducted by government (i.e. spatial planning, several policy fields) or the project planning by the project developer[4]. The former is discussed under the heading *planning practices* and comprises consent procedures, governmental involvement and spatial planning issues. The distinction between *tender-based* policies and the so-called *first come first served* principle will be a major point of debate here. The latter (i.e. project planning by the project developer) will be discussed at the *project management and finances*.

HOW TO READ THIS DOCUMENT?

Chapter 1 provides a short introduction to this report and the research design. The different themes used in the following chapters will be introduced.

In the chapters 2 – 6 the countries in the North Sea region are discussed, based on 6 thematic issues. Country specific recommendations are given. Boxes present the main recommendations of each section.

In chapter 7, so-called guiding principles are established. The guiding principles form the core of this document. They are derived from experiences in the North Sea region.

In chapter 8 possible prospects for offshore wind energy development in the North Sea region are discussed.

Grid issues not only addresses grid connection facilities and the internal electric infrastructure of an offshore wind farm. Attention is also paid to the necessary reinforcements of the onshore grid. Should the government undertake the grid connection or is this a developer's responsibility? The answer to this question has far-reaching consequences, especially on the financial level. Note that this discussion does not comprise considerations or difficulties of a true technological nature.

The *environmental impact* of wind farms on the marine environment is repetitive point of consideration. Substantial environmental impact analyses are conducted prior to awarding consents. Although direct harmful consequences on the environment of current offshore projects are not found yet, it is commonly agreed upon that current, comprehensive knowledge falls short[5]. Here, the focus will be on the use of EIAs and SEAs in planning offshore wind farms. An

[3] This strategy was adopted at the European policy seminar on offshore wind power, Copenhagen, 27th October 2005. See DEA (2005).
[4] In former work package 1 documents the following distinction was used: pre-project planning and project planning.
[5] COD (2005a; 2005c).

Environmental Impact Assessment has to be conducted in all countries studied before a permit for an offshore wind farm is given. In a Strategic Environmental Assessment the cumulative environmental impacts of offshore wind energy are looked at in a broader perspective on offshore spatial developments.

Project management and finances focuses on the developer's point of view in project planning. Project and risk management will be discussed. The experiences with on the one hand multi-contracting and on the other hand EPC turnkey contracting[6] will structure the debate.

The way in which third parties, NGOs, pressure or interest groups and other related actors are involved in the decision making process is discussed at in the sections *stakeholder involvement*. Besides communication strategies to inform the broad public, attention is paid to community initiatives and compensation strategies.

Finally, *Regional economics* is dedicated to the potential of the offshore industry to the regional economy. The content of these sections is established in cooperation with POWER's work package on economic and supply chain development, and are primarily based on POWER's *Transnational Supply Chain Study.* In this research four regions have been studied, Denmark, Kop van Noord-Holland in The Netherlands, Schleswig-Holstein & Bremerhaven/Niedersachen in Germany and East of England in the United Kingdom. Main topic in these sections is the supply chain for offshore wind energy.

FOR A COMPLETE INSIGHT

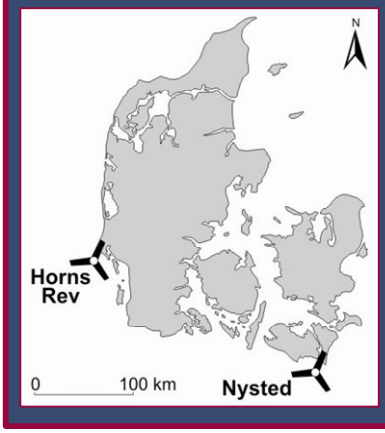
For a complete insight in the research matters the reader might turn to other POWER products. Especially the *Quick scan: state of affairs of offshore wind energy projects in the North Sea region* and *Case study: European offshore wind farms – a survey to analyse experiences and lessons learned by developers of offshore wind farms,* might be of interest. Furthermore the *Transnational Offshore Wind Supply Chain Study* conducted by POWER's work package on Regional Economics might be of interest. All documents are available at www.offshore-power.net.

[6] The latter abbreviation stands for engineering, procurement and construction.

2. Denmark

Traditionally, Denmark has been at the forefront of offshore wind developments worldwide. Experiences from the operation of Horns Rev and Nysted and the development of Horns Rev II and Rødsand II prove to be extremely useful for other projects.

DENMARK



Wind farms studied

Horns Rev

Owner: Vattenfall Group (60%) and DONG Energy (40%)
Turbines: Vestas V80 – 2 MW
Capacity: 160 MW
Operational since July 2003
www.hornsrev.dk

Nysted

Owner: DONG Energy (80%) and E.ON Sweden (20%)
Turbines: Bonus A/S – 2,3 MW
Capacity: 165,6 MW
Operational since January 2004
uk.nystedhavmoellepark.dk

Recent developments

8 offshore wind farms have been built in Denmark, of which 6 are relatively small. The total capacity is 423 MW.

2 wind farms are planned to be built. The Rødsand II wind farm, with a capacity of 200 MW, will be commissioned in 2010. The Horns Rev II wind farm will also have a capacity of 200 MW. This wind farm will be commissioned in 2009.

2.1 Planning practices

For the Danish offshore wind industry to mature the strong and stable governmental support has been, and still is, very important.

The consistency and broad consensus in Danish politics regarding offshore wind energy proved to be fertile soil for the offshore wind industry to mature[7]. The strong governmental support has been essential to the offshore market. The 1997 Offshore Wind Turbine Action Plan for Danish Waters[8], in which strategic areas were designated, clearly set the rules of the game. The recent tenders for Horns Rev II and Rødsand II again have shown that direct government involvement and direction-setting is beneficial, to both developers and government. In this approach, financial considerations (i.e. the level of support by financial regulations) can become a decisive factor in awarding exclusive development rights. The fact that exclusive rights are granted at an early stage reduces investment risks to both developers and government. Altogether, the *one stop shop* approach, the considerable government involvement and backup and the stable rules of the game, as well as the well-developed national wind market and the Danish predilection to exploiting the wind energy potential, have been supportive factors.

[7] See Krohn (2002), Zeelenberg (2006b).
[8] Utilities and Energy Agency (1997).

2.2 Grid issues

Grid connection solutions can best be judged in a broader view on regional grid developments or reinforcements.

The local conditions of the existing electricity grid were major considerations in designating strategic areas in the 1997 Action Plan. However, the Nysted case showed that considerable reinforcements had to be done. These were executed in a comprehensive programme that comprised reinforcements of the complete transmission network of Lolland, Falster and parts of Zealand. This comprehensive approach made investments more secure and feasible. It is advisable to assess grid connection solutions in a broader view on regional grid developments or reinforcements.

Figure 3. Horns Rev wind farm[9]

2.3 Environmental impact

EIA standards should be redefined based on results of the Danish monitoring programme.

Involvement of different stakeholders in an environmental monitoring programme contributes to the exchange and validity of data, experiences and insights.

Notwithstanding the virtue of the extensive environmental investigations conducted for Horns Rev and Nysted[10], it is expected that in the upcoming years the requirements for these investigations can be reconsidered. The final results of the Danish monitoring programme have been be presented November 2006. These results can be the starting point of redefining EIA standards[11]. The standards should preferably be redefined on an European level. The use of GIS based data storage in order to improve data exchange in the North Sea region should be encouraged, as well as the use of COD alike databases[12]. The presence of several stakeholders like Greenpeace, WWF and the Danish Society for Conservation of Nature in the environmental monitoring programmes can contribute significantly to the exchange and validity of data, experiences and insights.

[9] © DONG energy.
[10] See respectively www.hornsrev.dk and uk.nystedhavmoellepark.dk.
[11] See http://www.trippus.se/eventus/eventus_cat.asp?EventusCat_ID=622.
[12] See www.offshorewindenergy.org.

2.4 Project management and finances

When projects are commisioned using a multi-contracting approach the developer should have sufficient management capacity and knowledge.

A full testing programme should be executed before the start of offshore construction works.

Denmark's two largest projects, Horns Rev and Nysted, have been commissioned using a multi-contracting approach. A clear benefit of this approach is the reduction of costs, as the developer can manage risks actively. On the whole, the alternative, EPC contracting, is estimated to be 20% more expensive[13]. However, multi-contracting poses serious requirements to the developer and project organisation. Risks are shared among different contractors and the developing consortium. Risk sharing between the different parties should be managed by the developer. Therefore, the developer should have sufficient management capacity and knowledge. Technically highly detailed tender documents must be prepared and interface management and risk assessment are crucial. Therefore, it is recommended that e.g. the developer has access to contractors' design and quality control processes.

It is recommended that a full testing programme is executed, prior to the beginning of offshore construction works. This programme should include a fully equipped, full-size model for practical onshore testing, as well as pre-testing of the blades for an extensive period of time. In general, offshore works must be reduced to a minimum during installation and construction works. Assembly and final checks should be performed onshore. Therefore, harbour logistics require significant attention.

2.5 Stakeholder involvement

An early involvement of stakeholders supports a more fact-oriented discussion.

Several public hearings were organized during the planning phases of both Horns Rev and Nysted. It is generally accepted that early involvement of stakeholders supports a more fact-oriented discussion. Conflicts of different utilizations or opposing opinions can be prevented. For the case of Denmark though, the societal preference to wind energy should be noted. Because the general public supports the use of (offshore) wind energy, it is recommended to continue to explore the possibilities of cooperatively owned wind farms, like Middelgrunden and Samsø[14].

2.6 Regional economics

When new wind farms get built, using next generation turbines, further improvement of the Danish ports is worthwhile.

The early experience with offshore wind energy in Denmark has let to a fully established offshore wind supply chain in Denmark, particularly well developed in the project design and management fields. Another strength of the region is the presence of key industry players. The region is world leader for turbine installation.

In Denmark there are only a few suitable ports for construction and maintenance of the offshore

[13] Gerdes et al. (2006).
[14] See Olesen (2002).

wind farms. The available ports have been suitable so far, but when new developments start to take off further improvements would be worthwhile. There are only two projects of 200 MW planned to be installed in 2009/2010, resulting in an uncertain long-term prospect[15].

The already operational Horns Rev wind farm has little impact on local employment. The impact is limited to the operation of a control room onshore, the staff for operation and maintenance of the wind turbines and for transport to the wind farm site[16].

The Esjberg harbour was used during the construction of the wind farm, but will not be used this intensely in the following phases. As long as only a limited number of turbine installations is expected for a harbour, wind farm installation will be a secondary-priority business[17].

2.7 Challenges

The fact that Denmark is currently at the forefront of offshore wind energy developments in Europe, does not imply that no challenges are present. One of these challenges can be the use of shared infrastructure, especially the offshore grid infrastructure. Not only the upcoming extensions of Nysted and Horns Rev might well benefit from such attempts; exploring these possibilities reaffirms Denmark's leading role.

Furthermore, the country can play a leading role in adjusting operation and maintenance strategies. Maintenance after several years of full operation demands different and possibly challenging strategies, with which the offshore industry needs to cope.

On project management level, it is clear that interface and work package management require maximum attention. Furthermore, standardizing EIA requirements for the North Sea region is a new challenge that can be dealt with in the Danish experiences.

The Danish harbours will not be sufficient to serve the construction of new offshore wind energy developments making use of next generation turbines. The Danish government should decide if the Danish harbours will be improved or if foreign harbours will be used in future.

When a prospect for offshore wind energy beyond 2010 is developed, market uncertainty may be prevented.

Main challenges for Denmark

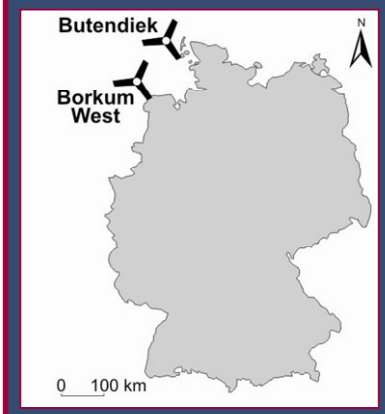
- Explore the possibilities for shared grid infrastructure;
- Use experience to adjust operation and maintenance strategies;
- Use experience to standardize EIA requirements;
- A prospect for offshore wind energy beyond 2010 should be developed.

[15] Douglas-Westwood Ltd. (2006).
[16] Gerdes et al. (2006).
[17] Gerdes et al. (2006).

3. Germany

Although expectations have been remarkably high in Germany it took a long time before the first offshore wind farms were fully commissioned. The main explanations to this seem to be the complicated bureaucratic setting, difficult conditions for offshore wind farms (far offshore and in deep waters), technological challenges in the development of multi-megawatt turbines and the presence of extensive nature protection areas along the German coastline. At the moment though, Nördlicher Grund and the first phase of the Borkum West Wind Farm are fully consented. This means the wind farm, the cables in the EEZ and the cables in the 12 nm zone are consented[18].

GERMANY



Wind farms studied

Borkum West

Developer: Prokon Nord Energie-systeme
Turbines: 5 MW, miscellaneous manufacturers
Capacity: 60 MW consented, 1040 MW in final phase
Expected to become operational in 2012
www.prokonnord.de

Butendiek

Developer: OSB Offshore-Bürger-Windpark Butendiek Gmbh & Co. KG
Turbines: Vestas – 3 MW
Capacity: 240 MW
Expected to become operational in 2008
www.butendiek.de

Recent developments

Two German offshore wind farms are consented. One of these is the Borkum West wind farm. The first phase of the wind farm, 60 MW, is consented. The Butendiek wind farm itself is approved, but the cables are not consented yet.

There are 27 project proposals in the EEZ. These proposals are currently considered by the BSH.

3.1 Planning practices

The *Länder* and Federal authorities should act coordinated during licensing procedures.

The SEA currently executed should consider different applications comprehensively.

Apart from two pilot projects in the territorial waters of Lower Saxony, 27 project proposals in the EEZ are currently handled by the BSH, the German Federal Maritime and Hydrographic Agency[19]. A trilateral agreement between Denmark, The Netherlands and Germany prohibites wind farms in the Wadden Sea. As a result of this strict nature conservation regimes, project developers have been forced to seek suitable sites outside the Wadden Sea. Because of the possible impact on tourism on the islands, these sites had to be far from the coast, in the EEZ. Here, a fundamental institutional complication becomes apparent: in the EEZ and territorial waters, different governmental bodies hold autonomous power, respectively the Federal Agency and the *Länder*. As a consequence the proposed cable route and proposed project site in the EEZ are licensed combined by the BSH. The cable route in the territorial waters is judged separately by the *Länder*. It seems recommendable to strive for coordinated action by the *Länder*

[18] Dena (2006).
[19] The reader must notice that the two pilot projects still are not commissioned. For an overview, see Gerdes et al. (2006) and Dena (2005).

and Federal authorities[20]. Taking the institutional settings in other countries into account, strengthening BSH's position could be considered.

The entire process to obtain the necessary licenses is time consuming[21]. Developers have to cope with insecurities for a relatively long period. For the case of Borkum West, the project developer itself was responsible for designing the investigation programme compulsory to the licence procedure. The standards for EIA programmes were only issued in 2003. It is generally acknowledged that smoothening licence procedures encourage market developments.

The Strategic Environmental Assessment, currently executed by BSH, can be determinative to the deployment of the wind energy potential. If possible, EIA standards should be redefined according to the SEA findings. Furthermore, the SEA should allow BSH to consider applications in a comprehensive manner, instead of on a case by case basis.

3.2 Grid issues

Future extensions and projects should be anticipated when cable infrastructure is developed.

Resulting from the presence of coastal nature protection areas and the tourism interests, the project initiatives are located relatively far off the coast. As a consequence, grid connection problems are twofold. Firstly, electricity losses are considerable and maintenance costs will be relatively high, pressurizing a project's financial feasibility. The most likely solution to this might be anticipating the next generation turbines, presumably 5 MW or more, to become fully operational. The new *Infrastrukturplanungsbeschleunigungsgesetz* was implemented in December 2006. This legislation makes grid operators responsible for providing a grid connection. This means the costs for project developers will be approximately 30% lower. The losses between transformer platform and shore are also for the grid developers.

Secondly, suitable cable routes crossing the Wadden Sea are rare. Until now, only one route has been designated, crossing the isle of Nordeney. For this specific case, local authorities hold strong objections, referring to unknown environmental consequences of the cables crossing ecologically vulnerable areas. This means for each extension new permits have to be issued. Since the projects that are expected to use this cable route might well be developed in several phases, this leads to an opaque situation for developers, frustrating offshore developments[22]. Shared cable infrastructure, possibly anticipating requirements of future projects is a solution to this. If private investors are not willing to provide this, German authorities should explore possibilities to support this facility. The new law may also improve this situation.

When project studies are prepared for future projects in the German North Sea, shared us of cable routes and grid infrastructure should be considered at an early stage. In this way the feasibility of projects is increased.

[20] See also DEWI (2006).
[21] COD (2005b).
[22] Gerdes et al. (2006).

3.3 Environmental impact

Research should be carried out considering the impacts of wind farms built in deep waters and the environmental impact of shared cable infratsructure.

German offshore wind farms face two challenges with respect to environmental issues. Firstly, the fact that proposed wind farms will be built in deep waters (compared to operational wind farms in the North Sea region) requires specific environmental data to be gathered. Secondly, the environmental impact of shared cable infrastructure or clustered cables is unknown and might prove to be valuable in future. For both challenges Germany plays a leading role in the North Sea region, as long as the problems are dealt with strongly.

3.4 Project management and finances

To make sure financial support stays consistent, the amount of possible upcoming applications should be anticipated.

For cooperative ownership to succeed the investment costs of a wind farm must be relatively low.

Although cooperative ownership of offshore wind farms is encouraged generally, it does not seem to fit the German offshore case. The main reason to this is that the relatively high investments cost for German offshore farms have put major constraints on the financing schemes[23]. Besides, the Butendiek case clearly shows the difficulties that come along with the project management of a cooperatively owned wind farm. Therefore, cooperative ownership is recommended only concerning relatively small projects.

Figure 4. Test drilling at the Butendiek site[24].

The poor ratio between project costs and reimbursements has proven to be a major burden on

[23] See the Butendiek case study in Gerdes et al. (2006).
[24] © OSB – Offshore – Bürger - Windpark Butendiek GmbH & Co. KG.

offshore developments. Related to this, it is advised to develop a project in several phases (i.e. pilot phase and extension phase)[25]. However, this might be counter effective, since starting investments in infrastructure might run the risk of becoming unfavourable when only small capacities are installed. License procedures for both farm and grid connection should take anticipated extensions into account. Because of the new law considering the provision of grid connection, distance to the shore is not as relevant anymore.

Financial support to exploiting offshore wind energy, arranged in the so-called *Erneuerbare Energien Gesetz (EEG)*, has proven to be consistent. Provided for a period of 20 years, it is a reliable condition to project developers. However, in order to prevent developments that occurred in The Netherlands[26] to take place, it is recommended to anticipate the number and amount of possible upcoming applications, in order to maintain the regulation.

3.5 Stakeholder involvement

Stakeholder involvement should be continued after license procedures. A media strategy that focuses on providing extensive information during the actual building process and operation is beneficial.

In general, the public opinion with respect to offshore wind energy is favourable. Onshore experiences contribute to this. However, objections by several interest groups should be monitored closely. It is recommended to take public support one step further and to continue exploring the possibilities to develop small-scale, cooperatively owned offshore wind farms.

During the license procedures, extensive stakeholder consultation has been arranged. It is advisable to continue the stakeholder involvement by means of an adequate media strategy when the first offshore farm is built.

3.6 Regional economics

German ports should focus on supporting the next generation offshore wind energy technologies.

The onshore wind energy supply chain in Germany is well established. The core strength of the region is turbine manufacturing. It is expected that offshore wind in the German regions will fully emerge only when the next generation wind turbines become widely available. Because the technical conditions of suitable sites are difficult (being deep water and far offshore) many of the proposed wind farms will only be realized when using these new techniques.

The strengths of the German supply chain are mainly centred on the development and procurement phases. Because there are few German contractors available to undertake large-scale work, the offshore installation is expected to be a weak area. The German ports are not yet fully capable of supporting future wind industry.

The long-term prospects for Germany are excellent, but in the short and mid term future the industry has a lot to overcome[27]. Cooperatively owned wind farms like Butendiek keep most of the economic benefits during operation in the region.

[25] A comparable strategy is adopted to the Belgian project Thornton Bank.
[26] See next chapter or Zeelenberg (2006b).
[27] Douglas-Westwood Ltd. (2006).

3.7 Challenges

The introduction of the next generation 5 MW turbines is expected to be a key factor for the development to the German offshore market. These turbines, if successfully deployed, can improve the ratio between investments and reimbursement. Therefore, one of the biggest challenges for the German market is bringing into use the next generation turbines and the infrastructure that comes along with it. Adequate test facilities are crucial to this; the region of Bremerhaven plays a key role here. Because offshore wind farms in Germany are planned in areas with great water depths new methods for foundation are required.

Especially given the exemplary Nordeney problems, the government should play a leading role in the development and usage of shared electricity facilities. Possibilities should be considered to designate and construct a cable route through the German Wadden Sea for several wind farms[28].

Alongside these efforts, institutional changes should be explored. The possibility of overruling decisions made by *Länder* by federal authorities (e.g. for the case of grid connections) should be considered. Harmonisation of regulatory frameworks in the EEZ and territorial waters, as well as coordinated policy action with respect to offshore wind, should be striven for. Different governmental bodies can also work together more coordinated, by introducing a *one-stop-shop* approach.

Main challenges for Germany

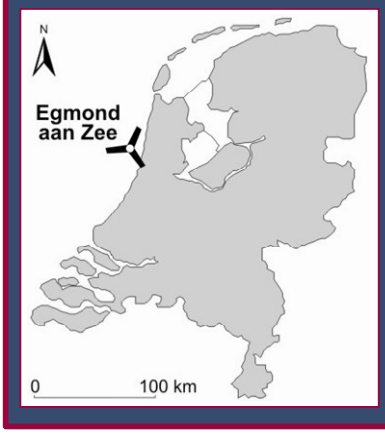
- Bringing into use next generation turbines to improve the ratio between investment and reimursement;
- A shared cable route for several wind farms trough the Wadden Sea has to be considered;
- The current institutional setting has to be changed to make procedures less difficult.

[28] The construction of hollow tubes, awaiting future projects, is a solution to this.

4. The Netherlands

Current practices in The Netherlands are characterized by two developments. The Offshore Wind Farm Egmond aan Zee is operational since December 2006 and a new wind farm, the Q7 wind farm, is under construction. Secondly, numerous new project initiatives have been submitted. These new initiatives have fuelled the political discussion with respect to the planning and support of offshore wind energy.

THE NETHERLANDS



Wind farm studied

Offshore wind farm Egmond aan Zee (OWEZ)

Owner: NoordzeeWind
Turbines: Vestas V90 – 3 MW
Capacity: 108 MW
Operational since December 2006
www.noordzeewind.nl

Recent developments

The building of the second Dutch offshore wind farm is started in 2006. This is the 120 MW Q7 wind farm.

The Ministry of Transport, Public Works and Water Management is handling 65 project proposals at the moment. The financial support for these initiatives is unknown.

4.1 Planning practices

Instead of the current *first come, first served* principle, Dutch policy should aim for a gradual growth that allows to fully benefit from learning effects.

Policies concerning offshore wind have changed dramatically over the past few years. This has had a remarkable result: no less than 65[29] project proposals have been submitted in the last year, when the new policy regime became effective. Despite the clear benefits of the tender procedure in combination with the KPD procedure executed for OWEZ[30], the Dutch government chose to switch to a *first come, first served* regime. Question marks are over the handling of the current flow of initiatives, actually expressed by both ministries[31]. Developers can get a permit to build a wind farm, but it is uncertain what happens after this. The number of permits granted is not related to the amount of financial support. It is not clear if developers can get financial support and how applications for financial support will be judged. There is only a limited amount of financial support available and no rules for selection of applications are available[32].

Several studies have shown that offshore wind energy can be financially feasible on a relatively short term[33]. Keeping this in mind, a step-by-step approach in the upcoming years, allowing only a few new projects to be built, is expected to be beneficial, in order to fully benefit from learning

[29] Status January 24 2007.
[30] See Zeelenberg (2006b) and the case studies by Gerdes et al. (2006).
[31] Roggenkamp en Van Beuge (2005), Zeelenberg (2006a).
[32] See Van der Kloet (2006)
[33] Van der Eijk (2005), Verrips and De Vries (2005), Verrips et al. (2005).

effects and to keep financial support at a reasonably low level. A strategic environmental assessment could be at the heart of this approach, executed within the broader framework of the Integrated Management Plan North Sea 2015.

4.2 Grid issues

The possibilities for transnational grid connections should be explored.

Several studies have explored future investments in grid infrastructure[34]. Up to 3000 MW offshore capacity can be connected without significant grid reinforcements. The most feasible Dutch connection points are Velsen (used for offshore wind farm Egmond aan Zee and Q7) and the Port of Rotterdam. Depending on the number of projects realized in the near future, the use of shared cable routes, infrastructure and offshore substations becomes economically and technically viable. If shared use of infrastructure facilities is considered or possible, this requires a more direct involvement of government concerned and the TSO.

Given the lengthy implementation procedures, the strategic outlook for the grid reinforcements to allow integration of 6000 MW should be an ongoing process. Alongside this strategic outlook, possibilities of transnational grid connections and the connection of future wind farms to international interconnections (e.g. electricity cables between England and The Netherlands), might be worthwhile exploring.

4.3 Environmental impact

Results of monitoring and evaluation programmes should be used to reduce and adjust the amount and type of information on environmental impact that is requested from applicants.

The majority of the findings of the Monitoring and Evaluation Programme (MEP), executed at the Egmond aan Zee wind farm are public. The outcomes of the programme will be used to adjust the standards for future EIAs. If possible, the amount and nature of information that must be provided by applicants should be reduced. In this respect, international exchange of research outcomes with regard to environmental impact enhances decision-making[35].

Several different environmental compensation plans have been executed successfully at the Egmond aan Zee project. The use of environmental compensation and a SEA-like framework can contribute significantly to offshore wind development in the upcoming years.

4.4 Project management and finances

Financial support regulations should stay stable and structural in order to provide the developers certainty.

Given the specific nature and requisites of commissioning and building an offshore wind farm, NoordzeeWind had no real other option then to use a turnkey EPC construction. Contrary to e.g. its Danish counterparts, NoordzeeWind did not dispose of sufficient management capacity and knowledge to be able to pursue a multi-contracting approach. Depending on market

[34] Hondebrink et al. (2004), Eleveld et al. (2005), ECN (2004).
[35] COD (2005a).

developments, other project management structures may be considered in future projects[36]. The media strategy deliberately focused on the building phase; a media strategy was expected to be the most effective when preparatory works physically started. For now, it seems the general public opinion is in favour of the project.

To offshore wind farm Egmond aan Zee, financial support by the government has been crucial. Fixed feed-in tariffs prove to be an effective instrument. Stable and structural presence of financial support regulations appears to be more important than the actual shape of the regulation.

4.5 Stakeholder involvement

In future projects, public consultation rounds should be held to make sure a broad range of stakeholders is involved in the decision-making. This may prevent delay further on in the process.

As a result of the extensive public consultation rounds a broad range of stakeholders have been involved in decision-making regarding Offshore wind farm Egmond aan Zee. Environmental pressure groups successfully stipulated the execution of environmental compensation plans. Regarding the upcoming project proposals, it is recommendable to arrange similar participation opportunities. The media strategy of the developer focuses on the period during building and operation. During the construction phase the website of the developer gave information about the new wind farm and the monitoring and evaluation programme that is carried out. After the wind farm became operational an information pillar on the beach was installed.

Figure 5. Building an offshore wind farm[37].

Compared to e.g. the United Kingdom, the offshore industry and R&D institutes do not have a

[36] Given the status of the project, little is to say about project management details or possible recommendations.
[37] © Shell.

longstanding tradition of close cooperation and capacity building. Only recently, the We@Sea consortium has united partners from industry, finances, energy sector, R&D, universities and interest groups[38]. The development of the offshore wind energy market benefits from the presence and the research agenda of this platform. It enhances knowledge exchange and supports capacity building in the Dutch offshore world.

4.6 Regional economics

Capabilities in cabling and foundation manufacturing have to be kept up to date to make it possible to support future international offshore wind projects.

A strength of the Dutch region is the presence of good ports for logistics, construction and servicing. These ports also give a high capability to associated activities, such as transport and pre-assembly. The offshore installation area is an area targeted for growth. Although the country is not home to any turbine manufacturer, The Netherlands has specific capabilities in cabling and foundation manufacturing. These capabilities have been well proven, with Dutch companies supplying many international offshore wind projects to date.

The policy on offshore wind in The Netherlands is frequently changing, resulting in uncertain market conditions. Regarding the high level of interest in the market, long-term future developments are likely.

4.7 Challenges

Fine-tuning different policy fields is the main challenge for The Netherlands. Spatial and environmental policies, financial regulations and consent procedures to have developed rather independently in the last years. Stable side conditions are crucial to a successful and structural growth of offshore wind activities. The market asks for secure and stable policy perspectives, subordinate to the actual type of policy approach adopted. This goes for the current permit and EIA regulations under the Public Works Act, as well as financial support by means of the feed-in tariffs, provided by the Ministry of Economic Affairs.

Establishing a 10-15 years perspective by reconsidering current policy goals, in which a gradual growth of capacity is adapted to financial support regulations is advised. The use of shared offshore infrastructure facilities should be considered as a part of this approach. This requires a more pro-active governing, directing offshore wind developments. Both MEP and COD outcomes should be used to re-establish EIA standards. The use and added value of executing a Strategic Environmental Assessment given current circumstances (i.e. over 60 new project proposals) might be doubted. Whilst the potential benefits are commonly agreed upon, a *one stop shop procedure* is not fully implemented yet.

Main challenges for The Netherlands

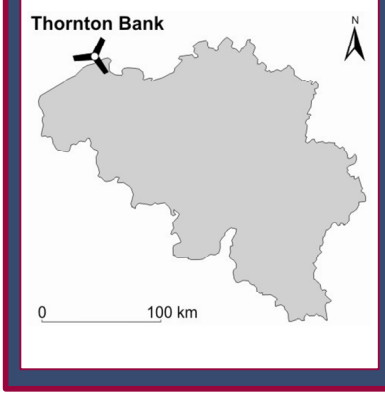
- Secure and stable policy perspectives in which different policy fields are united have to be developed;
- More pro-active governing is necessary to establish a 10-15 years perspective for offshore wind. In this perspective a gradual growth of capacity can be adjusted to financial support regulations;
- A fully implemented *one-stop-shop* approach is beneficial.

[38] See www.we-at-sea.org.

5. Belgium

The Belgian offshore wind energy practices are confined to one project: Thornton Bank. Only recently two new initiatives (Eldepasco and Belwind) were granted a domain concession.

BELGIUM



Wind farm studied

Thornton Bank

Owner: C-Power NV
Turbines: Repower – 5 MW
Capacity: 300 MW in final phase
Final phase expected to become operational in 2010
www.c-power.be

Recent developments

Eldepasco and Belwind are two consortiums planning to built an offshore wind farm, of 216 and 330 MW. Both have a domain concession, but need an authorisation and permit from the Minister of Environmental Affairs. Both initiatives are located in the so-called wind energy zone.

5.1 Planning practices

When deciding upon a zoning plan for offshore wind energy, requirements for offshore wind farms should be taken into account.

Whether or not to build a wind farm in phases should be a decision made by the project developer.

In order to make clear which investments have to be done by the federal government, a long term policy perspective on offshore wind energy has to be established.

The Belgian government has agreed upon a zoning plan, restricting offshore wind farms to the wind energy zone. This wind energy zone is an area including three sandbanks, the Thornton Bank, the Bligh Bank and a bank without a name. The choice for the location of the Thornton Bank wind farm is based on the fact that it is relatively far away from the coast and not used for other activities[38]. The specific requirements for wind farms have not been taken into account deliberately. As a consequence, the Thornton Bank project is located unfortunately: distance to the coast is far and soil conditions are challenging[39].

Another factor impedes the progress of the Thornton Bank project. To fully investigate environmental impact, federal government demands that the wind farm will be developed in two stages. Especially during the pilot phase, investment costs per kWh produced will be high. These high costs thwart the project's progress. It is advised to leave the decision whether to build a pilot phase prior to building the complete farm to the project developer (C-Power).

Despite the strategic outlook that was performed in order to sketch future developments and

[38] COD (2005b).
[39] See the Thornton Bank case study in Gerdes et al. (2006).

related policy requirements with respect to offshore wind energy[40], Belgian policy lacks an unambiguous perspective. It is unclear if and how the 2010 policy goals will be met. In order to pursue one of the scenarios from this strategic outlook, several investments need to be done by the federal government or Flemish region. Therefore, it is essential that offshore wind energy policy provides a long-term perspective. This perspective should include a strategic outlook regarding financial support[41].

5.2 Grid issues

Federal government should explore and assess the necessary grid improvements.

The possibility of shared cable infrastructure should be explored.

For Thornton Bank, no significant onshore grid reinforcements are necessary. However, future projects require increased grid capacity. It is most likely that Oostende and Seabruges will provide grid connection facilities[42]. In order to ensure the progress of the recently initiated Eldepasco project and other future projects, it is advised that the federal government assesses the necessary grid improvements.

Given the fact that offshore wind farms in Belgium are located far off the coast it is recommended that financial support by the government to investments in offshore cable infrastructure stays intact. Moreover, the long distances urge to consider shared cable routes.

5.3 Environmental impact

A new wind energy zone should be designated based on a SEA and is preferably located closer to the shore.

EIA standards and requirements should be reconsidered based on improved understanding and recent experiences.

Possible visual disturbance has been of major influence in the postponement and cancellation of several projects in Belgium. Partly as a consequence, Belgian government designated Thornton Bank as the alternative location. The Belgian government now designated a zone, including Thornton Bank and two other sandbanks further offshore, where offshore wind turbines can be installed. It is recommended that, based on a SEA, other areas are designated, preferably closer to shore.

As stated in 5.1, the distinction between pilot phase and full project phase poses financial problems to the Thornton Bank project. Regarding environmental impact, this distinction has lost its relevance as well. When knowledge on environmental impact from other projects is utilized, it seems recommendable to reconsider this distinction[43]. Notwithstanding the virtue of the substantial environmental researches and impact analyses conducted at Thornton Bank, it is recommended to reconsider EIA standards and requirements, based on improved understanding and recent experiences in the North Sea region.

[40] See www.belspo.be and Palmers et al. (2004) and Van Hulle et al. (2004).
[41] In order to prevent 'Dutch' experiences; see chapter 4 and Gerdes et al. (2006) and Zeelenberg (2006a).
[42] Palmers et al. (2004) and Zeelenberg (2006b).
[43] The full use of COD alike database structures can be crucial to this: www.offshorewindenergy.org.

5.4 Project management and finances

Consent procedures should leave freedom to the developer to select turbines in a later stage. This makes it possible to use state of the art technologies which increases the financial feasibility.

When state of the art technologies are used, a comprehensive testing programme should be executed. Onshore test sites should be created at an early stage.

The consortia developing Thornton Bank and Eldepasco comprise several partners with specific knowledge. As such, it is expected that only procurement and installation will be commissioned by means of a tender. Since most of the knowledge and skills required are present within the developing consortium, interface and risk management can be dealt with internally. This reduces costs considerably[44].

The consents awarded for the Thornton Bank project allow considerable freedom with respect to the capacity of turbines installed. Consequently, C-power is able to select turbines at a later stage, allowing the state of the art technologies to be used. This increases the project's financial feasibility. Especially for the Belgian case, in which wind farms are located far off the coast, this advantage can become crucial. Therefore, it is recommended that future consent procedures bear a comparable level of freedom.

Using state of the art technology draws specific attention to (pre-)testing of materials used. It is stressed that a comprehensive testing programme should be executed on land, focusing on the workings of the turbine itself, service and maintenance, access and safety. It is advised that specific onshore test sites are created at an early stage. Furthermore, it is advised to conduct extensive on-site soil research at an early stage[45].

5.5 Stakeholder involvement

When construction works at Thornton bank commence the media activities should be increased.

Offshore wind farms should be included in tourism policies.

In the past, Belgium has experienced severe and successful public resistance to offshore wind projects. This resistance was based mainly on visual disturbance. For the case of the Thornton Bank project, opposition has been overcome. The main reason for this seems to be location of the turbines, on a distance where visual impact hardly exists. The building of an information centre in Oostende contributes to a better understanding and education in general[46]. Figure 6 shows a computer application that was made for the visitor centre in Oostende. This will be part of the activities in the information centre. It is advised to increase the number of media activities when the construction works start taking place.

Given the economic importance of tourism along the Belgian coastline, it is recommended to include offshore wind farms in tourism policies. The experiences with Scroby Sands wind farm in Great Yarmouth serve as a good example.

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[44] See Gerdes et al. (2006).
[45] Ibid.
[46] For more general information on information centres the POWER document *Informing the general public about offshore wind energy – A road map on how to realize an offshore wind energy information centre including info material and multimedia tools* (available at www.offshore-power.net) might be of interest.

5.6 Regional economics

Offshore wind is a unique opportunity for companies to display their know-how in their own country.

The information centre in Oostende may lead to some employment in the region. Furthermore, C-power is a consortium existing of several regional partners. Because these regional companies will carry out a lot of the work during construction employment in the region increases temporarily. When these partners will also carry out maintenance, this may lead to some permanent jobs. The building of offshore wind farms may lead to a breakthrough for the employment in the renewable energy sector. For many Belgian companies currently active in the wind energy sector, offshore wind is a unique opportunity to display their know-how in their own country as well.

5.7 Challenges

A strategic outlook is absent in Belgian offshore wind energy policies. As a consequence, developers are hesitant and expectant. A 10-15 year perspective will prove beneficial. In this perspective, policy targets, grid reinforcement requirements, financial support, environmental impact and a flexible consent regime should be considered comprehensively. A SEA could well be a part of this perspective. Providing this strategic perspective, preferably in combination with an elaborated *one stop shop* procedure, is the main challenge to Belgian politics.

Besides this strategic outlook, specific market developments should be anticipated by developers and policy makers in Belgium. Like the German situation, Belgian projects are located relatively far off the coast. To increase financial security and feasibility, the use of 5 MW turbines is crucial. In order to benefit fully from the introduction of the next generation turbines, market and industry are urged to support or participate in the current research and development practises.

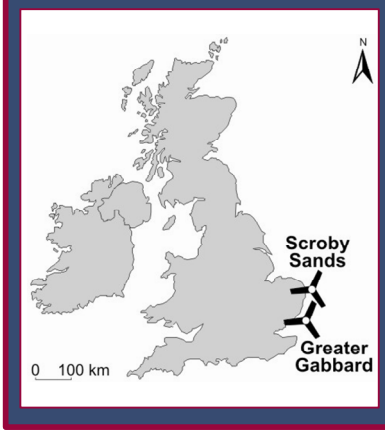
Main challenges for Belgium

- The federal government should develop a strategic perspective for offshore wind considering various issues;
- A *one stop shop* procedure should be introduced in Belgium.

6. United Kingdom

The offshore wind energy market in the United Kingdom has developed rapidly. Backed up with significant governmental support, the United Kingdom is poised to become the world's largest offshore market.

UNITED KINGDOM



Wind farms studied

Scroby Sands

Owner: E.ON UK Renewables Offshore Wind Ltd.
Turbines: Vestas V80 – 2 MW
Capacity: 60 MW
Operational since March 2005
www.eon-uk.com/481.aspx

Greater Gabbard

Owner: Greater Gabbard Offshore Winds Ltd.
Turbines: 3-7 MW
Capacity: 500 MW
Expected to become operational in 2009
www.greatergabbard.com

Recent developments

There have been two rounds of offshore wind development in the UK. The Scroby Sands wind farm was consented in Round 1. This was a demonstration round for the testing of technology.
During the second round strategic areas were identified. 15 developers got a license in Round 2 and are currently working on the necessary consents. One of these wind farms is the Greater Gabbard wind farm.

6.1 Planning practices

The balance between security for the developers and room for technical changes is one of the grounds for he success of the current English regime, and should be consolidated.

When a new SEA is carried out it should include grid connection possibilities.

Governmental policies have been supportive to offshore wind energy throughout the years. This has resulted in stable side conditions for the market to operate and a concerted approach[47]. In retrospect, the phased approach adopted in Round 1, followed by full-grown initiatives in Round 2, has proven fruitful. The presence and work of the Offshore Renewables Consent Unit, is considered to be exemplary to the other North Sea region countries. The fact that consent regimes in the Renewable Energy Zone do not differ from the regimes in territorial waters has prevented potential slowing down of offshore developments.

The Round 2 approach provides security to project developers at an early stage, while at the same time leaving enough room for technological changes in the project[48] (e.g. use of other turbines, type of electricity cables). This delicate balance is a crucial virtue of the current English regime.

The Strategic Environmental Assessment, basis for Round 2 developments, has indicated three preferential areas for offshore wind. All Round 2 proposals are located in one of these areas[49]. However, this SEA has insufficiently considered the grid connection possibilities. Especially for

[47] See also BWEA (2005).
[48] With respect to this, for a good example see the Greater Gabbard project and for an unfortunate example see the Egmond aan Zee project in the case study report by Gerdes et al. (2006).
[49] See Gerdes et al. (2006) and BWEA (2006).

the Greater Wash area, where a significant number of new projects is located, it is recommended that the United Kingdom departments concerned take deliberate action, as grid connection possibilities are limited.

Part of the Round 2 approach is the withdrawal of direct financial support by national government. The mandatory use of Renewable Obligation Certificates can provide financial support. However, it is recommended to examine closely the actual workings of the ROC market. A periodical review, like in 2004 and the current consultation in 2006/2007, seems advisable[50].

The United Kingdom government has not yet given any indication to the development and timing of a Round 3 for offshore wind developments. If a third round is not announced soon, there will be less market certainty for companies considering to enter the offshore wind supply chain.

6.2 Grid issues

Government, offshore industry and grid operators should work cooperatively on a solution for possible grid connection problems.

The British SEA executed did not focus explicitly on onshore grid conditions. It is recommended that in the Greater Wash area, in which grid connection can become problematic, government, offshore industry and grid operator cooperatively find a solution to this. The funding of onshore grid reinforcements will be a critical point of debate. With regard to the projects studied in this report,[51] no significant grid problems occurred.

6.3 Environmental impact

The possible impact of wind farms located in the neighbourhood of bird routes should be examined.

Results of the first monitoring programmes can be used to redefine European EIA standards.

As stated earlier, the SEA conducted has proven beneficial. Currently, the first projects that are operational render significant information with respect to the environmental impact of offshore wind turbines. It is recommended to exchange knowledge on environmental impact on a European level, as well as to re-establish European EIA standards for offshore wind farms.

In the past, the Royal Society for the Protection of Birds has raised serious doubts concerning the hazardous consequences of offshore wind farms to migrating birds. Although these objections are withdrawn currently and several studies hardly find any significant effects[52], it is recommended to examine closely the possible impact of wind farms, located in the proximity of bird routes.

6.4 Project management and finances

Subcontractors should be involved adequately in project management and planning in order to make sure the design of components can be ratified before procurement takes place.

In planning offshore construction activities, bad weather should be anticipated to make sure postponement of activities will not lead to problems.

The English experiences show convincingly that there is an alternative to financial support by

[50] See EWEA (2004).
[51] I.e. Scroby Sands and Greater Gabbard.
[52] See COD (2005C).

means of fixed feed-in tariffs: the Renewable Obligation Certificates. However, the ROC system cannot cover extra costs, resulting from single circumstances project developers are faced with. Especially with regard to the considerable grid reinforcements in the Greater Wash area, it is doubted whether the ROCs can sufficiently support these investments.

Currently there are consultations on a reform of the ROCs, in order to award more ROCs per MWh for emerging renewables technologies than established technologies. Differentiated support levels for different renewable technologies are proposed[53]. This may support the development of less mature renewable energy technologies, such as offshore wind energy.

On the project management level, the following recommendations can be made, largely based on experiences at Scroby Sands wind farm[54]. Risk and interface management are crucial to a project's progress, indifferent to whether an EPC or multi-contracting approach is adopted. The design of components should be ratified prior to procurement. Therefore, system designers and other subcontractors should be involved adequately in the project management and planning. Factory acceptance tests should be comprehensive. Weather windows should not be too tight, and allow for postponement of offshore activities due to bad weather.

Figure 6. Scroby Sands wind farm: Acces to pile and Elements at quayside[55].

[53] See DTI (2006).
[54] Derived from the Scroby Sands case study in Gerdes et al. (2006).
[55] © E.ON UK (www.eon-uk.com).

6.5 Stakeholder involvement

The collaboration of industry, market and departments involved in planning offshore activities has been important for the development of offshore wind energy in the UK.

The role of the BWEA has been of major importance to the offshore wind energy development in the United Kingdom. Through its activities, institutional capacity building has been substantial. The symbiosis of industry, market and departments involved in planning offshore activities has proven to be fruitful.

The media strategy adopted for the Greater Gabbard project is remarkable. Although constructions works are due only just in 2008, several exhibitions and public activities have taken place already[56]. For the British case, such extensive media strategies seem beneficial.

The positive effects of Scroby Sands wind farm on tourism and regional economy of Great Yarmouth underline the potential of the industry[57]. Although recognizing the specific situation of Scroby Sands located close to shore, it is generally advised to attempt deliberately to include tourism strategies in project proposals and vice versa.

6.6 Regional economics

Ports and onshore infrastructure should be updated in order to become more suitable for future offshore wind energy developments.

The market prospects for the United Kingdom are very good. There are supportive mechanisms in place to structure offshore wind development. The offshore wind market in the United Kingdom is the strongest in the world, with excellent mid-term and long-term prospects. East of England's key strengths in the development phase appear in the site investigation field, namely environmental monitoring and site surveys[58].

The region is home to the company that managed the construction of the Scroby Sands project and there is operation and maintenance capacity. The operation and maintenance of Scroby Sands created 15 permanent jobs. Construction activities only created temporary employment. However, due to the large number of offshore wind farms planned, the construction can be a major source of employment in the longer term. All companies involved in Scroby Sands see offshore wind mainly as diversification of their core business, often in oil and gas. Regional companies can carry out the onshore work associated with offshore wind development completely. Regional economic spin-off in terms of knowledge and skills is difficult to estimate.

The manufacturing capacity is very limited in the East of England. Ports in the region need some upgrades to become more suitable for offshore wind energy developments. The local onshore infrastructure in the region is poor. This results in weak transport and delivery. In the region little capability exists in offshore installation[59].

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[56] See www.greatergabbard.com and Gerdes et al. (2006).
[57] See also the POWER supply chain study by Douglas-Westwood Ltd (2006), available at www.offshore-power.net.
[58] Douglas-Westwood Ltd. (2006).
[59] Ibid.

6.7 Challenges

The upcoming years, the onshore grid reinforcements in the Greater Wash area is one of the biggest infrastructural challenges in the United Kingdom. Finding a solution, backed up by all partners in the field (i.e. BWEA, grid operator, developers, DTI) is crucial.

It will be of high importance for the government of the United Kingdom to outline the long term future for offshore wind, including the announcement of a Round 3, to give the market a high degree of certainty in the long term offshore wind prospects in the United Kingdom.

Another challenge might be setting up a durable economic relationship with other regions in the North Sea region. Especially the East of England region can be at the forefront of such developments. Efficient supply chain management throughout the North Sea region should be the strategic perspective.

Main challenges for the UK

- All partners in the field should work together on a solution for the onshore grid reinforcements needed in the Greater Wash area;
- To give the market a high degree of certainty, the government should outline the long-term future for offshore wind.

7. Guiding principles

The country-specific recommendations and challenges have common grounds. In this chapter these common grounds are elaborated upon, presenting generic guiding principles. Given the fact that project experiences differ considerably and the offshore wind sector still is maturing, these principles are subject to change. Besides, some are focused on the short term, whilst others have a long term character. Consequently, it is crucial to reflect upon these principles and their validity whenever new experiences become available.

7.1 Planning practices

Guiding principles

- A stable and structural policy framework seems to be more important than the actual type of regulation;
- A gradual growth of capacity installed allows the market to fully benefit from technological innovations and allows the government to reduce financial support gradually;
- When a SEA incorporates non-environmental issues, it is less likely that problems occur concerning the selected area at a later stage;
- The regimes in the Economic Exclusive Zone and territorial waters should be one, in order to make progress of offshore wind projects easier;
- Procedures should be organised in a *one stop shop* approach;
- Rights should be granted to developers as soon as possible, but should leave a certain degree of freedom for developers so they can benefit from the newest technologies.

Providing a stable and structural policy framework is the major challenge to government. For a young industry to mature, it is of the utmost importance that the 'rules of the game' stay fixed. These rules entail the complete regulatory framework ranging from spatial planning, consent procedures, energy and environmental policies to financial support. The actual difference between a *tender system* or a *first come, first served system* has proven subordinate to this. Although we cannot deny the fact that almost all projects currently realized have been commissioned in a tender like procedure, there is no unambiguous indication that the tender procedure *itself* should be credited for the successful practises[60]. Developments in other policy domains, market developments, societal preferences, the execution of a SEA or of a full demonstration programme: all these factors constituted a specific mixture of side-conditions that explains the relative success in e.g. the United Kingdom and Denmark. Though, it seems fair to state that, at first sight, the *first come, first served principle* provides decisive benefits when the offshore wind market has matured and has become less turbulent.

However, it should be noted that a gradual growth of capacity installed is bound to be established more effectively when a *tender approach* is applied. A gradual growth of capacity installed seems beneficial, as it allows the market to benefit fully from technological innovations. At the same time, it allows government to reduce financial support gradually. If such an approach is adopted, tenders are best to be based on a strategic environmental assessment. Given the positive experiences in Denmark, such a strategic assessment should preferably include non-environmental issues that are relevant to offshore wind energy, i.e. grid connection possibilities, water depth, soil conditions etc.

A strategic environmental assessment allows the full incorporation of spatial considerations into the offshore wind energy domain. This brings spatial planning on the North Sea to a higher level.

[60] See also COD (2005a, 2005b).

Given the various and often conflicting spatial claims on the North Sea, it is advised to incorporate the SEA in a broader framework of spatial planning. Alongside the possible establishment of a spatial perspective for the North Sea, it is essential that the regimes in a country's territorial waters and Economic Exclusive Zone correspond. Different regimes, often implying different competent authorities and legislation, thwart the progress of offshore wind projects.

Thus, countries are advised to strive for one single regulatory regime and legislative framework applicable to both territorial waters and the EEZ. Such a regime and framework are best effectuated by one single authority or department, holding all necessary competences and legal instruments. As mentioned in several documents[61], a *one stop shop procedure*, in which one governmental office acts as bureaucratic pivot to offshore wind procedures, has proven beneficial. Closely related to this is the level of security to be provided in consent procedures; rights should be granted to developers as soon as possible. This results in increased commitment, higher planning security and more efficient processes. At the same time, granted rights should allow for a certain degree of change, especially on the technological level, in order to fully benefit from technological developments and to be able to use state of the art techniques, whilst at the same time reducing costs.

7.2 Grid issues

Guiding principles

- Long term grid planning should be an essential part of spatial policy perspectives considering offshore wind energy;
- The use of shared offshore cables and onshore connection facilities should be encouraged;
- Grid connection facilities of an offshore project should be implemented in close harmony with other adjustments or extensions of inland electricity infrastructure;
- A Trans European perspective on grid reinforcements should be established to explore possibilities of transnational cable routes and cross-border grid connections;
- Possibilities of using existing interconnection cables should be explored as this may lead to significant cost reductions.

As already indicated at the previous section, spatial policy perspectives considering offshore wind energy should incorporate the condition of grid infrastructure. Long-term grid planning is an essential part of this. The use of common offshore cables and onshore connection facilities should be encouraged. Furthermore, it is advised to implement grid connection facilities of an offshore project in close harmony with other adjustments or extensions of inland electricity infrastructure. In future, it is crucial that grid reinforcements are considered in a Trans European perspective.

This Trans European perspective is necessary to explore possibilities of transnational cable routes and cross-border grid connections. Possibilities should be explored to improve interconnection capacity in the North Sea region. The interconnection cables between e.g. The Netherlands and Norway and the United Kingdom and The Netherlands may be used to connect offshore wind farms. Because connection to the onshore grid is a large share of the total costs of an offshore wind farm, this may lead to an eminent cost reduction[62]. A Trans European

[61] E.g. COD (2005a), Gerdes et al. (2006), Zeelenberg (2006b).
[62] Hendriks and Ummels (2005).

perspective on offshore wind energy must be embedded in a Trans European regulatory framework on power exchange. In itself, this need is not new. What is new is the current impasse between TSOs and project developers, created under the new liberalized market frameworks[63]. It is up to EU member states, backed by European directives, to overcome this impasse. It seems inevitable that, on the European policy level, the directives focus at the creation of a European energy market, including power exchange, pricing tools and the development of common infrastructure.

7.3 Environmental impact

Guiding principles

- Detailed information about the impacts of the first offshore wind farms should be used to reconsider EIA standards and to determine the impact of new projects;
- A transnational SEA for the North Sea combines minimal environmental damage with an efficient use of means on European level.

Elaboration of the European COD database[64] is put forward as an important step in investigating the environmental impact of offshore wind farms. At this moment, generic statements cannot be done regarding the impact of offshore wind farms on the marine environment. Allocating a specific effect to a single cause is arbitrary[65]. Therefore, there still is an urgent need to map possible adverse impacts.

In the upcoming years, the market is expected to boom. Several new wind farms will be realized, using the latest techniques. It is essential to know the exact impact of such projects in order to facilitate this. Detailed information allows us to reconsider EIA standards and requirements. These can become more specific when knowledge on the impact increases. The presentation of the final results of the Danish monitoring programme can serve as a starting point.

The implementation of a transnational strategic environmental assessment for the North Sea is beneficial. It is closely related to a Trans European energy infrastructure perspective and a strategic cross-border outlook on offshore wind energy It combines minimal environmental damage with an efficient use of means on a European level. It creates a strategic perspective that unites all stakeholders in the world of offshore wind.

7.4 Project management and finances

Guiding principles

- The choice between EPC and multi-contracting depends on the capability of a consortium to manage processes and to bear risks;
- Onshore testing and assembling is crucial and should not be rushed. Offshore work is generally up to 5 times more expensive than onshore work;
- A structural and stable support mechanism is more important than the actual type of regulation. Support by government should be adjsuted to a country's strategic perspective on offshore wind industry in general;
- The introduction of next generation technologies should be accompanied by an extensive action plan, in which testing and demonstration is carried out;
- Consent procedures should leave freedom to the developer to select turbines in a later stage.

[63] COD (2005a, 2005d) and the Copenhagen strategy on offshore wind power deployment, available at www2.ewea.org/documents/051028_copenhagen_strategy.pdf.
[64] See www.offshorewindenergy.org.
[65] COD (2005c).

The traditional distinction between project management on a multi-contracting basis or by means of an EPC contract still applies. Although total project costs are expected to be up to 20 percent lower using multi-contracting[66], in practise the type of contracting used depends on other factors. Adopting a multi-contractual approach requires that the consortium is able to manage complete procurement, installation and commission processes and bears all risks involved. This requires sufficient in-house skills and knowledge. It is expected that multi-contracting will become the common style for contracting. In this style of contracting there are opportunities for more and smaller companies to cooperate. Therefore, this style offers enormous potential for cooperation by regional companies

Although a lump sum EPC construction generally implies higher total costs and a significant risk reduction for the developer, it poses other, serious challenges. One of these challenges is that the tender invitation and evaluation must be highly detailed. Furthermore, work package and interface management require specific skills and an excellent relation amongst developer and subcontractors. The developer should have full access to design processes and quality control at the work package interfaces, in order to assure well-adjusted cooperation of the different work packages (often executed by different subcontractors)[67].

Current experiences have shown that onshore testing and assembling is crucial and should not be rushed, even when time is scarce. One of the main reasons to this is the fact that offshore work is generally up to 5 times more expensive than onshore work. This has been underestimated previously: onshore logistics have proven to become a bottleneck if not properly organized. For more specific information on the discerned work packages and the intern management, the reader may turn directly to the case study analyses by Gerdes et al. (2006).

Except for the United Kingdom, in all countries in the North Sea region a type of feed-in tariffs applies to offshore wind projects. On this basis however, we cannot state that a certain type of financial support provided by the government is preferred to another. Especially not when the successful market developments under the British ROC-system are considered. Again, the structural and stable presence of a support mechanism seems to be more important than the actual type of regulation. The structural and stable presence of support by government should be adjusted to a country's strategic perspective on offshore wind industry in general. As such, it reduces insecurities to the market and project developers specifically.

All countries in the North Sea region, and Germany and Belgium in particular, are expected to benefit from the next generation turbines coming into operation. As stressed in the Copenhagen strategy, it is essential that the introduction of this next generation technologies is accompanied by an extensive action plan, in which testing and demonstration is carried out. All countries in the region should cooperate closely in setting up this action plan. To make it possible for developers to use state of the art technologies consents should leave room for developers to select turbines in a later stage.

[66] See Gerdes et al. (2006).
[67] Ibid.

7.5 Stakeholder involvement

Guiding principles
- Public participation and information enhances a fact-oriented discussion;
- Formal occasions of public participation are very important for creating public support and should be complemented by research programmes involving a broad range of stakeholders;
- It is very important that information is available during the construction and operation phases;
- Cooperative ownership may increase public involvement but for such initiatives to be successful they need to be relatively small-scale and close to the coastline.

The EIAs and other legal procedures have ensured extensive stakeholder involvement during the realisation of projects. It is generally acknowledged that public participation and information enhances a fact-oriented discussion. Besides these formal occasions of participation, it is recommended that the (often compulsory) research programmes are utilized for creating public support. This can be done by involving a broad range of organisations, each with specific interests or fields of knowledge, in the research programme. Public debate and, eventually support, is expected to benefit from such a collaborative approach.

Furthermore, public debate can be enhanced by means of several information tools. Especially when realized in the proximity of offshore projects and in combination with other tourist attractions, information centres prove to be an effective tool, providing economic value to the region[68].

Finally, cooperative-ownership is mentioned frequently to increase public involvement and acceptance. However, it should be noted that cooperative offshore wind projects do require specific conditions and arrangements in order to be successful. As current experiences[69] show, reimbursement rates expected are rather low, whilst at the same time initial investments are considerable. Both conditions are hard to bear by cooperatives. This unfortunate combination implies that cooperative initiatives need to be relatively small-scale and close to the coastline in order to be successful. Support by government or regional business consortia is generally acknowledged to increase the viability of community initiatives.

7.6 Regional economics

Guiding principles
- Competition in the supply chain is necessary to further the technological development of offshore turbines;
- The supply chains in the POWER regions should be combined to establish a fully capable offshore wind supply chain capable of serving the North Sea Region and future export markets.

Each POWER region has its own parts in the supply chain in which experience and capability are high. When combining these capabilities, a North Sea region supply chain can be established, which can serve the whole offshore wind supply chain – a unique offering to European and global markets.

There is a high manufacturing capability in Denmark and Germany. Manufacturing companies have a very large potential market. Competition between the manufacturers results in a great emphasis on research and development of improved turbines. A clear example of this is the development of the 5 MW turbines, which are seen as being the key to the large-scale,

[68] For more information on the POWER information tools, the reader should turn to www.offshore-power.net.
[69] Middelgrunden (Dk) and Butendiek (G) are cooperatively-owned.

economically viable development of offshore wind. For the manufacturing of foundations, the majority of the suppliers is based in the United Kingdom and The Netherlands at the moment. The most important turbine installation companies are also located in these countries and in Denmark.

At the moment there are only few wind farms installed per year. However, a situation in which there is a shortage in installation capacity seems to be likely by the end of the decade. The Netherlands (in particular due to the suitability of the ports), and to a lesser extent the United Kingdom, have the particular ability to position themselves as service centres for international offshore wind projects.

The various countries surrounding the North Sea have different sets of capabilities and needs. None of the regions is entirely self sufficient for its forecast level of development to 2010. Together though the different POWER regions can deliver a fully capable supply chain. Because the POWER countries are geographically close there are opportunities for, for example, contractors to service the international markets. The North Sea region is fully capable of supporting projects undertaken in its own area and in Europe as a whole. The region also holds potential to gain value from market developments elsewhere in the world. The POWER regions are 'ahead of the game' and should investigate how they can use this position. They should use their advantage to realise the offshore wind energy potential of the North Sea region and try to serve future export markets. As long as only few wind turbines are expected to be installed, the wind farm installation is a secondary-priority business compared to long-term activities such as container shipping and other continuous naval business in harbours. When a few suitable harbours are selected, these may have more work in wind farm installation. Wind farm installation may become a priority business for these harbours then[70]. Furthermore, employees in offshore wind energy may have a continuous amount of work when projects in the different countries are harmonized. Vocational qualifications should be the same throughout European countries, to make exchange of employees easier. Comparable vocational qualifications in different countries in the region can make exchange of employees easier[71].

In all the issues discussed above, there is one repetitive theme: concerted action. Concerted action between regions, between member states, and between industry and government. Whether we think of planning issues, financing and project management, environmental impact or grid infrastructure, concerted action is the way forward. Concerted action means knowledge sharing and exchange, which results in a more efficient use of means and knowledge. It also means fine-tuning and collaboration between different sectors and regions in the offshore industry. And finally, it means direct and stable government involvement, which is crucial to successful collaboration with project developers. Concerted action is the result of institutional capacity building. In the following and final chapter, this capacity building will be discussed in the light of European transnational cooperation.

[70] Section based on Douglas-Westwood Ltd. (2006).
[71] See Hammer and Müller (2005).

8. Concluding remarks: capacity building in the North Sea region

The Copenhagen Strategy[72] called for a European Action Plan on offshore wind power deployment. The development and demonstration of next generation turbines, a strategic vision on grid connections taking into account a European dimension, integration of wind energy in the grid infrastructure from a European perspective and development of a tool to assess cumulative impact of offshore wind farms were thought of as actions necessary to take offshore wind energy to a higher level. European policy for offshore wind should be established to facilitate increased cooperation and research among Member States. In *Challenging offshore wind* some of the recommendations of the conference are affirmed. Moreover, *Challenging offshore wind* is an example of the proposed transnational offshore wind related research.

Based on the recommendations and guiding principles in previous chapters, a transnational perspective on offshore wind energy can be given. This final chapter provides the outline of such a perspective.

Looking at environmental impact, a transnational strategic environmental assessment leads to minimal environmental damage, combined with an efficient use of means on European level. When such an assessment allows full incorporation of non-environmental issues that are relevant to offshore wind energy, it brings spatial planning on the North Sea to a higher level. Then , the strategic environmental assessment is incorporated in a broader framework on spatial planning, which is a possibility to deal with the various and often conflicting claims on the North Sea. The results of the first monitoring programmes should be used to redefine EIA standards, if possible on a European level.

Such a spatial perspective on offshore wind energy should also incorporate the condition of the grid infrastructure. In future, a Trans European perspective on grid reinforcements is necessary to explore possibilities of transnational cable routes and cross-border grid connections. This perspective on grid reinforcements must be embedded in a Trans European regulatory framework on power exchange. On European policy level, directives should focus at the creation of a European energy market, including power exchange, pricing tools and the development of common infrastructure.

When the next generation turbines is introduced, the countries surrounding the North Sea should cooperate closely in setting up an action plan. In this plan, testing and demonstration must be arranged. Because all the countries can profit from the gained knowledge, this knowledge building should be carried out by all the countries surrounding the North Sea.

The countries surrounding the North Sea have different sets of capabilities and needs. None of the regions is completely self-sufficient for its forecast level of development. Together though, the countries can deliver a fully capable supply chain. With this supply chain, they can support projects undertaken in the North Sea region, in Europe as a whole and they can gain value from markets elsewhere in the world. Harmonisation of the different supply chains may also lead to industrial services focused on offshore wind energy. It increases efficiency and employment

[72] See DEA (2005).

throughout the region.

8.1 Capacity building as the challenge

Advancing offshore wind energy in the North Sea region means dealing with the issues described in this document in a transnational manner. Problems are best tackled and opportunities are best seized by collaborating on European level. This is the core message of *Challenging offshore wind*. To achieve this, a certain level of institutional capacity is needed. A high institutional capacity increases the chance of finding a solution for a specific project. Following the rich literature on institutional capacity building, we can discern a social, knowledge and political component that constitute the institutional capacity[73]. These three components are reflected clearly throughout this document, and throughout the POWER project in general.

The first component, social capacity, refers to the social and functional relations that are present between actors in the field of offshore wind. It has become clear that the offshore wind energy market in the North Sea region is dispersed and highly internationalized. However, to get projects realized, parties have to find each other easily. Lines must be short and clear, in order to make cooperation worthwhile and beneficial. Therefore, it is essential to invest in long-lasting social and functional relations throughout the region. Trust, confidence, commitment and reliability are crucial to maintain and improve the social capacity of a network. More than often, we have seen that unstable or unreliable behaviour by either governments or market parties thwarted the progress of offshore wind energy projects in the past years.

Through these social networks, knowledge can be transferred easily. Shared knowledge is the second component that constitutes institutional capacity. Given the fact that offshore wind energy is still a young industry, exchange of knowledge and experiences is crucial. The expected learning effects facilitate cost reductions and a more efficient use of means and resources. Not only the offshore industry and wind energy technology industry benefit from this; it also implies decreasing financial support by government.

The third component that contributes to institutional capacity building is political capacity. Political support means governments can get things done. They can actively stimulate developments to take place, or adverse impacts to be prevented. Currently, political support at European level and in most member states is at a rather high level. This support must be accompanied by an equivalent level of government involvement and commitment. Closely related to the other elements of institutional capacity, political capacity means that government has to be a reliable player. Consent regimes, financial support mechanisms, environmental and spatial policies: it is essential that they do not change dramatically, and especially not without proper notice beforehand. Again, experiences (e.g. The Netherlands) have shown potential negative consequences of this.

Projects like POWER increase the institutional capacity, and thereby enhance the conditions for full exploitation of the wind energy potential. Such projects contribute to capacity building by proposing North Sea wide planning and environmental policies, by developing international supply chains and by supporting knowledge exchange on environmental impact. It is vital to

[73] Healey (1997), De Vries (2006).

continue similar projects. Ultimately, the objective of institutional capacity building can be the establishment of one political regime for the North Sea. This regime should preferably unite spatial and environmental regulations, as well as include proper legal arrangements on shared use of grid infrastructure and the European energy market. Whether this is a realistic objective depends upon a lot of factors, which lie outside the offshore wind energy debate. Until that moment, it is up to the local and regional players, who want to be at the forefront of offshore wind energy developments, to pursue their leading role, lighting the way forward for the North Sea region, and Europe as a whole.

Acknowledgements

The POWER project unites North Sea regions with an interest in supporting and realising the economic and technological potentials of offshore wind energy. This study was created within the framework of the Planning and participation work package of the POWER project. One of the focal points of work package 1 is on the integration of the different planning systems of the Member States bordering the North Sea. Its aim is to give insight in possible improvements in the decision-making process for the location of offshore wind farms, and to harmonise planning and information strategies for offshore wind farms in compliance with government legislation.

The work of *Challenging offshore wind: guiding experiences for the North Sea region*, does not stand on its own, evidently. Much of the content is based on work performed by the work package 1 partners earlier. Two work package 1 products are of specific interest here, namely *Quick Scan: the state of affairs of offshore wind energy projects in the North Sea region* and *Case study: European Offshore Wind Farms – A Survey to Analyse Experiences and Lessons Learned by Developers of Offshore Wind Farms*. The content of this report draws heavily on the results of both reports[74]. For a complete overview and understanding of current projects in the North Sea, the reader should consider the three reports complementary. The themes *Regional Economics* and *Education and skills development* have been partly based on products by the work packages 2 and 3 of the POWER project.

This report is the first comprehensive approach to wind energy in the North Sea based on extensive case study research. Notwithstanding possible shortcomings that come along with such an approach, it clearly provides an insight in contextual, case-specific factors that determine respective failures or successes. Aside from the case studies, several projects outside the POWER realm partly have addressed comparable topics. With proper references, the results of the projects have been included in this report if necessary.

This document is written by Sjoerd Zeelenberg and Jelly van der Kloet (University of Groningen). Other POWER partners and numerous experts have contributed to the contents. Special thanks in this respect goes to Gerard Linden, Jochem de Vries and Tamara Kaspers (University of Groningen). For questions regarding the content of *Challenging offshore wind*, the reader may turn to the University of Groningen[75]. ICBM[76] (University of Oldenburg) is work package responsible partner and is able to answer the reader's questions on other activities of the work package. More information on the POWER project is available at www.offshore-power.net and www.interregnorthsea.org.

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Abbreviations and concepts explained

East of England. Region consisting of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk

EEZ – Exclusive Economical Zone. A sea zone in which a country has specific rights for exploration and use of marine resources. One of these rights is building wind farms in the sea.

EIA – Environmental Impact Assessment. An EIA presents the results of research considering the impact of a planned offshore wind farm on the environment. Topics that are addressed in an EIA are for example birds, landscape, fish and mammals and technology. An EIA has to be conducted in all countries studied before a permit for an offshore wind farm can be given.

EPC turnkey contracting – Engineering, Procurement and Construction. In this form of contracting the developer signs a contract with one company or consortium for engineering, procurement and construction. This type of contracting is often used when the developer does not have enough management capacity and knowledge to manage the whole process itself. For this type of contracting the tender invitation needs to be highly detailed.

Greater Wash. Area from the Norfolk coast towards Flamborough Head and out into the North Sea.

Multi-contracting. In this form of contracting the developer signs different contracts with various companies. The developer manages the process and risks herself. Therefore, sufficient management capacity and knowledge is necessary.

North Sea region. The North Sea Region in Interreg IIIB programmes covers areas of Norway, Sweden, Denmark, Germany, The Netherlands, the Flemish Region of Belgium and the United Kingdom. When speaking about the North Sea region in *Challenging offshore wind* the Southern North Sea region is meant. This area covers parts of Denmark, Germany, The Netherlands, Belgium and the United Kingdom.

Round 1. First round of UK offshore wind farms – located within 12 nautical mile limit.

Round 2. Second round of UK offshore wind farms – focussed on 3 strategic areas in the territorial waters.

SEA – Strategic Environmental Assessment. In a SEA the cumulative environmental impacts of offshore wind energy are looked at in a broader perspective on offshore spatial developments.

Territorial Waters. Coastal waters upto 12 nautical miles from the mean low water mark. This zone is regarded as sovereign territory of the state but foreign ships have innocent passage trough it.

TSO – Transmission System Operator

References

Airtricity (2006) *European Offshore Supergrid® Proposal, Vision and Executive Summary*, available at www.airtricity.com/ireland/wind_farms/supergrid/

BWEA (2005) *Briefing Sheet Offshore Wind*, British Wind Energy Association, London

BWEA (2006) *Offshore Wind*, www.bwea.com/offshore , last visited 14th June 2006

COD (2005a) *Principal findings 2003-2005*, Concerted action for offshore wind energy deployment and European Communities, available at www.offshorewindenergy.org

COD (2005b) *Work package 3: legal and administrative issues*, Concerted action for offshore wind energy deployment and European Communities, available at www.offshorewindenergy.org

COD (2005c) *Work package 4: environmental issues*, Concerted action for offshore wind energy deployment and European Communities, available at www.offshorewindenergy.org

COD (2005d) *Work package 8: grid issues*, Concerted action for offshore wind energy deployment and European Communities, available at www.offshorewindenergy.org

DEA (2005), *Copenhagen Strategy on Offshore Wind Power Deployment. European Policy,* European Policy Seminar on Offshore Wind Power, Copenhagen, October 27th 2005, available at www.ens.dk/graphics/UK_Energy_Supply/Renewable_energy/Windpower/Copenhagen_Strategy.pdf

Dena (2005) *Offshore-Windenergie: Energie vom stürmischen Meer*, Deutsche Energie-Agentur GmbH (dena), dena-info Offshore Wind (01/2005)

Dena (2006) *State of affairs of German offshore wind energy*, available at www.offshore-wind.de/show_article.cfm?id=5866 last update December 2006, last visited 18th January 2007

DEWI (2006) *WindEnergy Study 2006 – Assessment of the Wind Energy Market until 2006*, German Wind Energy Institute (DEWI) in the course of the WindEnergy 2006 – International Trade Fair

Douglas-Westwood Ltd (2006) *POWER Transnational Offshore Wind Supply Chain Study,* POWER and Douglas-Westwood Ltd, available at www.offshore-power.net

DTI (2006) *Reform of the Renewables Obligation & Statutory Consultation on the Renewables Obligation Order 2007,* available at www.dti.gov.uk/consultations/page34162.html

ECN (2004) *Locaties en opwekkosten 6000 MW offshore windenergie. Revisie maart 2004*, ECN report ECN-CX---04-051, March 2004, available at www.ecn.nl

Eijk, A. van der (2005) 'CPB blundert met berekeningen' in *Energie+*, vol.25, nr. 6, pp. 17-19

Eleveld, H., J. Enslin, J. Groeman, K. van Oeveren and M. van Schaik (2005) Connect 6000 MW-II: electrische infrastructuur op zee, KEMA T&D Consulting

EWEA (2004) 'Focus on UK' in *Wind Directions*, November/December 2004

EWEA (2005) *Prioritising wind energy research – Strategic research agenda of the wind energy sector*, EWEA, July 2005, available at www.ewea.org

Gerdes, G., A. Tiedemann and S. Zeelenberg (2006) *Case study: European offshore wind farms. A Survey for the analysis of the experiences and lessons learnt by developers of offshore wind farms,* POWER, Deutsche Windguard, Deutsche Energie Agentur, University of Groningen, available at www.offshore-power.net

Hammer, G. and W. Müller (2005) *Qualification Requirement Analysis Offshore Wind Energy Industry*, final report, July 2005, POWER, University of Bremen and Bremerhavener Arbeit GmbH, available at www.offshore-power.net

Healey, P. (1997) *Collaborative planning. Shaping places in fragmented societies,* MacMillan, London

Hendriks, R. and B. Ummels (2005) 'Netinpassing van grootschalige offshore windenergie' in *Energie+*, vol. 25, nr. 6, pp. 22-23

Hondebrink, P., B. Wilbrink, R. de Bruijne and J. 't Hooft (2004) *Connect 6000*, Ministry of Economic Affairs, May 2004

Hulle, van F., S. Le Bot, V. Van Lancker, S. Deleu, J. Henriet, Y. Cabooter, G. Palmers, L. Dewilde, J. Soens, J. Driesen, P. Van Roy and R. Belmans (2004) *Optimal offshore wind energy developments in Belgium, Scientific support plan for a sustainable development policy*, Belgian Science Policy, Brussels

Kloet, van der J. (2006) *De planning van windenergie op de Noordzee – Naar een nieuw Nederlands regime voor wind op zee*, Faculty of Spatial Sciences, University of Groningen

Krohn, S. (2002) *Wind Energy Policy in Denmark: 25 years of Success* – What Now?, Danish Wind Industry Association

Olesen, G. (2002) *Guidelines for spatial planning of wind turbines*, Danish Organisation for Renewable Energy, Predac Project

Palmers, G., G. Dooms, S. Shaw, J. Neyens, C. Scheuren, P. André, F. De Stexhe and J. Martin (2004) *Renewable energy evolution in Belgium 1974 – 2025*, Scientific support plan for a sustainable development policy, Belgian Science Policy, Brussels

Roggenkamp, M. and Van Beuge (2005) 'De regulering van offshore windparken in Nederland: een Holland drama?' in *Nederlands Tijdschrift voor Energierecht*, vol. 3, nr. 1, pp. 4-16

Utilities and Energy Agency (1997) *Havmølle-handlingsplan for de Danske farvande - the Offshore Wind turbine Action Plan for Danish Waters*, Elselskabernes og Energistyrelsens Arbejdsgruppe for Havmøller - Committee for offshore wind turbines by the utilities and the Energy Agency, June 1997

Verrips, A. and H. de Vries (2005) 'CPB en ECN: de echte kosten en baten van windenergie op zee' in *Energie+,* vol.25, nr. 6, pp. 14-15

Verrips, A., H. de Vries, A. Seebregts and M. Lijesen (2005) *Windenergie op de Noordzeee. Een maatschappelijke kosten-batenanalyse*, CPB en ECN, Den Haag

Vries, J. de (2006) 'Grensoverschrijdend samenwerken in de Rijn-Schelde delta' in L. Janssen-Jansen and B. Waterhout (eds.) *Grenzeloze ruimte. Regionale gebiedsgerichte ontwikkelingsplanologie in Europees perspectief,* Sdu Uitgevers, Den Haag

Zeelenberg, S. (2006a) 'Projectdossier windenergie: Egmond aan Zee smaakt naar meer' in *ROM*, vol. 24, nr. 3, pp. 34-39

Zeelenberg, S. (ed.) (2006b) *Quick scan: the state of affairs of offshore wind energy projects in the North Sea Region*, final report, July 2006, POWER and University of Groningen, available at www.offshore-power.net