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The World Bank

Asia Sustainable and Alternative Energy Program

China

Meeting the Challenges of Offshore and Large-Scale Wind Power: *Regulatory Review of Offshore Wind in Five European Countries*

Australian Government
AusAID

ASTAE

China: Meeting the Challenges of Offshore and Large-Scale Wind Power

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Preface

This publication is the result of a joint effort of the Government of China and the World Bank. The objective of this effort, implemented with support from the Australian Agency for International Development (AusAID) and the Asia Sustainable and Alternative Energy Program (ASTAE), was to gather lessons learned from international experience in large-scale onshore and offshore wind power development, with a view to informing China's strategy going forward.

This effort resulted in two publications:

1. The first publication, *Regulatory Review of Offshore Wind in Five European Countries*, provides a detailed description and evaluation of the regulatory approaches that various countries in Europe have taken to develop offshore wind energy.
2. The second publication, *Strategic Guidance,* defines a roadmap for the promotion of offshore and large-scale onshore wind developments in China, and summarizes the messages emerging from a high-level workshop held in Beijing.

Garrad Hassan and Partners Limited was commissioned by the World Bank to undertake research and analysis in support of this effort. Both publications rely on investigations undertaken by Garrad Hassan and Partners Limited for the World Bank.

The current publication is the first of the two, and was prepared by Garrad Hassan and Partners Limited. Data provided in this report and its annexes are current as of May 2009, unless otherwise indicated.[1]

The second report, which is a companion to this one, was published separately under the ASTAE Technical Report Series.

1. Readers are reminded that, given the pace of development in offshore wind development, some of the tables may be out of date by the time of printing.

Acknowledgments

This publication is the product of a joint activity of the National Energy Administration (NEA) of the People's Republic of China and the World Bank. Its objective was to develop implementation guidance for large-scale onshore, intertidal, and offshore wind farm development in China.

Andrew Garrad, Andrew R. Henderson, Colin Morgan, and Joseph L. Phillips from Garrad Hassan and Partners Limited were the major contributors to this publication.

The World Bank team working on this activity—Noureddine Berrah, Richard Spencer, Ranjit Lamech, Yanqin Song, and Defne Gencer—would like to give special recognition to the staff of the Project Management Office of the Energy Research Institute (ERI) of the National Development and Reform Comission (NDRC), staff of the Government of China–World Bank–GEF China Renewable Energy Scale-Up Program (CRESP), to peer reviewers Anil Cabraal and Soren Krohn, to editor Rebecca Kary, and to designer Laura Johnson.

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Finally, the NEA and World Bank teams would like to call attention to the leadership and guidance of Zhang Guobao, Administrator of the NEA. His vision and encouragement helped steer this effort to its ultimately successful outcome.

Glossary

AER	Alternative Energy Requirement Programme (Ireland)
AusAID	Australian Agency for International Development
BERR	Department for Business, Enterprise and Regulatory Reform (UK government department)
BfN	Bundesamt für Naturschutz (Federal Agency for Environmental Protection, Germany)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (The Federal Environment Ministry, Germany)
BoP	Balance of Plant—all elements of a wind farm other than the turbines
BSH	Bundesamt für Schifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency, Germany)
BWEA	British Wind Energy Association
CCL	Climate Change Levy (UK tax on high energy users)
CDM	Clean Development Mechanism
CE	The Crown Estate (UK body that retains responsible for concessionary award)
CHP	Combined heat and power
CNE	Comisión Nacional de Energía (Spain)(National Energy Commission)
Contiguous Zone	Area between 12 and 24 miles from the coast—limited law enforcement rights
COWRIE	Collaborative Offshore Wind Research into the Environment (UK body)
CPA	Coastal Protection Act (UK legislation)
CRE	Commission de Régulation de l'Énergie (France) (Energy Regulatory Commission)
CRESP	China Renewable Energy Scale-Up Program
DBERR	Department for Business, Enterprise and Regulatory Reform (UK government department)
DEA	Danish Energy Authority
Defra	Department for Environment, Food and Rural Affairs (UK government department)
dena	Deutsche Energie-Agentur (German Energy Agency)
DfT	Department for Transport (UK government department)
DNZ	Directie Noordzee (The Netherlands) (North Sea Directorate)
DTI	Department of Trade and Industry (UK government department)
EA	Electricity Act (UK legislation)
ECN	Energy Research Centre of The Netherlands
EEG	Erneuerbare-Energien-Gesetz (Germany) (The Renewable Energy Sources Act)
EIA	Environmental Impact Assessment (statutory process for projects in the European Union)
EIS	Environmental Impact Statement
EEZ	Exclusive Economic Zone—area extending 200 nautical miles from the coast
EPC	Engineering Procurement Construction—single contract for delivery of project
ERI	Energy Research Institute
EU	European Union
FEPA	Food and Environment Protection Act (UK legislation)
FINO	Forschungsplattformen in Nord- und Ostsee (Research Platforms in the North and Baltic Seas)
FIT	Feed-in tariff
GHG	Greenhouse gas
GIS	Geographic information system
GW	Gigawatt
HSE	Health and Safety Executive (UK government body administering the HSW Act)
HSW	Health and Safety at Work Act—primary UK health and safety legislation
JI	Joint Implementation
km	Kilometer
kV	Kilovolt
kWh	Kilowatt-hour

m	Meter
MCEU	Marine Consents and Environment Unit—UK department within DfT and Defra
MEP	Milieukwaliteit Elektriciteitsproductie (The Netherlands)—support mechanism for environmentally friendly electricity production
MUMM	Management Unit of the North Sea Mathematical Models (Belgium)
MW	Megawatt—installed power capacity of turbine or project
MWh	Megawatt-hour—unit of electrical energy
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
nm	Nautical mile
NSW	Near Shore Wind Farm (Netherlands)
O&M	Operations and maintenance
Ofgem	Office of the Gas and Electricity Markets—the UK gas and electricity regulator
OMEL	Operador del Mercado Ibérico de Energía (Spain)—market operator
ORCU	Offshore Renewables Consents Unit—UK government department within DTI
PPI	Programmation pluriannuelle des investissements (France) (Multiyear Investment Program)
PV	Photovoltaic(s)
PWA	Public Works Act
R&D	Research and development
RAB	Renewables Advisory Board—UK information coordination body
RE	Renewable energy
REE	Red Eléctrica Española (Spain)—grid operator
REFIT	Renewable energy feed-in tariff
RO	Renewables Obligation—UK market mechanism for encouraging renewable
ROC	Renewables Obligation Certificate—UK tradable "green certificate"
SDE	Stimuleringsregeling duurzame energieproductie (The Netherlands) (Sustainable Energy Production Incentive Programme)
SEA	Strategic Environmental Assessment
SSSI	Site of Special Scientific Interest—UK legal designation for protected areas
Territorial waters	Waters within 12 nautical miles of the coast—full national legal jurisdiction
TSO	Transmission system operator
TWA	Transport and Works Act—UK legislation
TWh	Terawatt-hour
UBA	Umweltbundesamt (Germany) (Federal Environment Agency)
UNCLOS	United Nations Convention of the Law of the Sea
V	Volt
V&W	Verkeer und Waterstaat (The Netherlands) (Ministry of Transport, Public Works and Water Management)
Wbr	Wet beheer rijkswaterstaatswerken—Dutch law governing federal waters (Public Works and Water Management Act)
WTG	Wind turbine generator

Executive Summary

The objective of this study is to review international experience in offshore wind power development and draw on the lessons learned from the experience of different countries. To date, that experience has predominantly been limited to Europe. Significantly different regulatory and physical planning approaches have been taken in the different countries. Hence, the experience is particularly helpful in providing suggestions for a new market.

This study provides a review of the market and regulatory approaches taken by the various different active European countries and provides some conclusions about the efficacy of the different approaches. The study also makes recommendations to develop suggested best practice for the regulation of offshore wind.

The five national markets examined for the study are those with arguably the greatest long-term offshore wind energy potential: Denmark, Germany, The Netherlands, Spain, and the United Kingdom.

Market Development

The historical development of offshore wind has been described for each of the countries of interest. The greatest deployment to date has been in Denmark where, along with Sweden and The Netherlands, much of the early deployment took place. The United Kingdom took the lead at the end of 2007, with a reasonable pipeline of projects coming online before 2010. The transition from a dominance of research and development (R&D) projects (with a strong academic involvement and public funding) to demonstration schemes (led by commercial entities with some funding support) has been described, with the most significant projects highlighted.

The reason for the slower-than-anticipated development of the industry has been discussed in terms of the key stumbling blocks. It is notable that these have mainly been commercial in nature rather than the result of technical or regulatory difficulties. In particular, the issue of rising capital costs because of a number of commercial factors has been the most significant impediment. This effect is common to all national markets.

Targets and Incentives

National renewable energy (RE) targets and incentive schemes have been examined for the five countries of interest in the context of international commitments and policy drivers. Germany and the United Kingdom have the most ambitious plans for offshore wind of the national markets examined, with an aspiration for installation of 25 GW by 2030. From the point of view of incentives, Germany has perhaps by a small margin the most attractive of the national markets considered, with increased revenue support for offshore wind announced recently. However, the premiums offered in Ireland, Spain, and the United Kingdom are very similar. Denmark has in place a firm plan for the gradual deployment of offshore wind projects, with sites defined out to 2025, and the tender process for the next project commencing. The Netherlands also has relatively ambitious targets for offshore wind deployment, although the incentive scheme (and regulation) is considered insufficient to achieve this.

Regulatory Framework

Various aspects of offshore wind regulation are considered in the study, including relevant legal provision, concessionary award systems, consenting processes, and access to the grid. A large diversity was found from country to country with existing national regulatory structures utilized for offshore wind development even when they were, in general, originally developed to regulate other industries. This has led to mixed results, with the most successful countries being those that have actively reformed regulatory systems to encourage offshore wind deployment: Denmark, Germany, and the United Kingdom.

Drivers, Barriers, and Experiences

For each of the five countries examined, experience to date with offshore wind has been analyzed with respect to driving factors and regulatory barriers that exist.

In Denmark, a successful indigenous wind turbine industry was identified, along with generally high levels of political support, as the most important drivers for offshore wind. Denmark has led the world in the development of offshore wind and has in place a relatively stable and mature regulatory regime that was achieved through simplification, centralization, and long-term strategic planning.

In Germany, the successful deployment and impending saturation of onshore wind has led to a shift in political focus to offshore wind deployment. Highly ambitious plans are in place for deployment over the next two decades, with the feed-in tariff having been raised recently to levels that generated a flurry of project transactions. The effects of the predominance of relatively small companies in the offshore arena in Germany have delayed to a certain extent the initiation of large-scale construction of offshore wind farms. However, the presence of several large European utilities and developers with offshore wind experience elsewhere means that the first projects can confidently be online by 2010. It can be argued that the small developers did play a major role in achieving a relatively high degree of consenting success.

In The Netherlands, offshore wind represents the most promising means of achieving significant deployment of renewables, given the limited potential for onshore wind capacity. However, given that in the short term the country is on track to achieve international commitments on climate change, and given the apparent high costs associated with necessary grid reinforcement works, political support for offshore wind remains questionable. In the absence of clear political support, deployment will be limited, and the necessary reforms to regulation will be difficult to implement. In addition, the historical and ongoing instability and unnecessary complexity of incentive support for RE constitute a significant barrier for the offshore wind industry in this country.

There are good prospects for offshore wind in the United Kingdom despite the much slower-than-anticipated development of the industry. The strong level of political support for the technology has been proven through the inception of two successive rounds of concessionary awards, streamlining of the consenting process, and recently the announcement of additional revenue support for offshore wind projects. Access to the grid has been a significant barrier for some offshore wind projects. The nonalignment of electricity regulation with government energy policy has been a problem. Inherent deficiencies in a nontechnologically differentiated RE certificate trading system have been discussed in the context of experience in the United Kingdom, where the cheapest renewable technology (currently onshore wind) has dominated. In general, the government has been receptive to reform in order to facilitate and encourage offshore wind power deployment.

Conclusions

Based on the review of experience in the five countries, conclusions were drawn in the form of generic findings that constitute best practice for offshore wind project regulation. Some of the conclusions may not be relevant to the offshore activities in China, but they are nevertheless informative.

Appropriate Legislative Frameworks

Coordinated industry lobbying of the government is the most effective way to achieve the required regulatory reform, although in the absence of genuine political support for offshore wind, this is unlikely to be enough to bring about necessary changes.

Effective Industry Coordination

The development of strong, united, and influential industry associations provides the coordination necessary to have a significant impact on government policy and regulation of offshore wind deployment.

Transparency of the Grid Access Process

Access to the grid is a significant barrier to offshore wind energy, unless its regulation is aligned to RE policy objectives, and the responsibility for costs and construction is clearly delineated at an early stage.

Political and Regulatory Stability

Repeated reform of regulations has hindered development and can be avoided if they are well drafted in the first instance. New markets for offshore wind should draw heavily on experience in other countries. A stable regulatory regime engenders greater investor confidence.

Appropriate Site Awards

Technoeconomic and environmental feasibility for offshore wind should be assessed at the national strategic level before awarding any sites for development. The system for such award would benefit from allowing for a mix of large companies and small entrepreneurial developers to stimulate growth.

Strong Political Will

Although effective industrial coordination and lobbying can play an important role in specific regulatory issues, in the absence of genuine political ambition to deploy RE—and specifically offshore wind—little progress can be made.

Prescreening of Sites

A systematic evaluation of potential sites is a helpful starting point. This should be a technically rigorous assessment of the wind resource through both computational modeling and full-scale assessment. The evaluation of wind resource should be coupled with the identification and evaluation of constraints. Compilation of all these data into a single geographic information system (GIS) has been demonstrated to be very helpful.

Coordination of Stakeholder Interests

Many stakeholders, both commercial and governmental, have interests in and influence on offshore wind development. Identification and coordination of these stakeholders are essential.

Simplification and Centralization

Simplification of regulation provides the necessary transparency and confidence to industry so that it can move forward with development of offshore wind. Significant efficiency gains can also be made through the administration of the regulatory regime by a single government agency through the mitigation of user conflicts and alignment of government strategic objectives.

Strategic Spatial Planning

Long-term strategic planning for the future use of offshore regions can improve the prospects for offshore wind deployment through the avoidance of potential stakeholder conflicts and improvement in grid connection efficiency.

Capital Support and Grid Ownership

Capital support for the first offshore wind projects in any national market is important in order to achieve early momentum. Transfer of grid connection costs to network operators is an important support mechanism in markets where such costs are prohibitively high.

Incentives: Fixed Feed-In Tariff versus Certificate Trading

Experience has shown that both systems can work, although on balance a feed-in tariff is considered to be a more effective instrument for encouraging deployment because of the simplicity and long-term certainty of the system.

Encouragement of Technical Innovation

Technical innovation should be encouraged in order to bring down the costs of offshore wind energy in the medium and long term. This can be facilitated through continued funding of R&D and demonstration projects with a focus on offshore-specific technological solutions.

Allowing Foreign Involvement

Access to national markets for foreign companies should be provided where skills and experience are lacking domestically. The benefits of this approach in terms of deployment volume and knock-on learning are of significant value.

International Competition

Any entrance of a new national market for offshore wind requires a regulatory framework and market incentives that are sufficiently attractive to international developers and contractors to be competitive with existing markets.

1

Introduction

This study constitutes a review of the regulatory framework for offshore wind development in different countries. The objective of this effort is to gain information and derive lessons learned from international experience to date.

The following issues are covered for Denmark, Germany, The Netherlands, Spain, and the United Kingdom:

- Market development
- Targets and incentives
- Regulatory framework
- Drivers, barriers, and experiences.

Although Spain has not developed any offshore wind farms to date, a considerable amount of thought has been applied to potential development and, given Spain's remarkable success in developing onshore projects and the wind industry as a whole, the Spanish approach is considered valuable to this study.

The study focuses on describing the past, present, and planned future regulatory regime in each country. Both positive and negative experiences to date have been explored in the context of regulatory arrangements, and they have been used to draw general conclusions on the characteristics of the most effective systems. At the same time, it has been recognized throughout that a single model is unlikely to provide the "best fit" for all countries, given national differences.

Chapters 2, 3, and 4, focusing on market development, targets and incentives, and regulatory framework, respectively, provide background information on each country studied. These chapters are primarily descriptive in nature.

Chapter 5 provides a discussion of the lessons that can be learned from the experience in each national market, as well as the underlying incentives (or drivers) for overcoming barriers and deploying offshore wind capacity in each case.

Chapter 6 draws this experience together as it identifies and summarizes recurring themes and uses them to develop suggested best practice for the regulation of offshore wind.

A glossary is included that explains important terms and abbreviations used within the report. The appendixes summarize the actual consenting experience in a number of countries.

2

Market Development

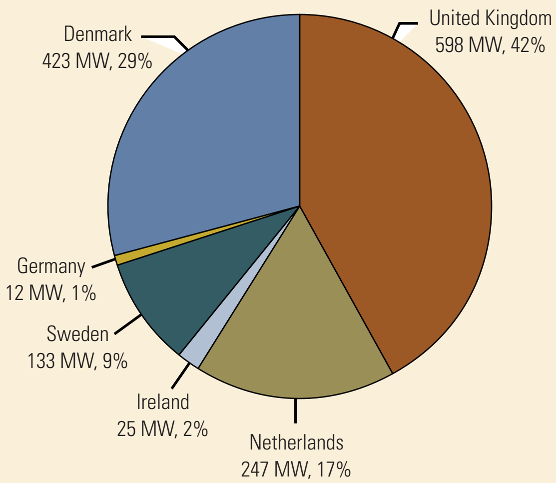
Development of national markets for offshore wind projects to date has been highly varied in terms of structure and results. This is partly because of a lack of industry maturity. Perhaps more important, however, are differences driven by national policy objectives and existing legislative arrangements. This chapter provides an overview of the historic development, current status, and future prospects of the offshore wind market in general before providing more specific details for the five countries of interest.

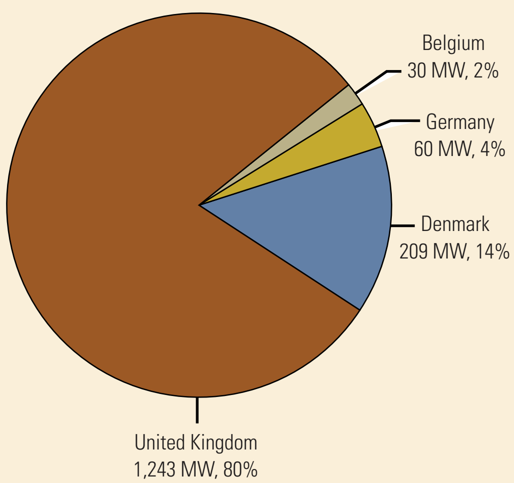
A total of 1,240 MW of offshore wind farms are currently in operation around the world, with a further 704 MW under construction at the time of writing. Figure 1 presents a breakdown of these totals by national market.

As evidenced by Figure 1, the industry is currently undergoing a period of rapid growth, with the majority of construction occurring in the United Kingdom. With the exception of a small demonstration project in Japan, Europe is host to all the offshore wind projects built or under construction as of the time of this report, as shown in Figure 1.

Offshore wind projects constructed to date can be categorized into two groups corresponding to two sequential

FIGURE 1: WORLD OFFSHORE WIND INSTALLED CAPACITY, MAY 2009





Source: Garrad Hassan and Partners Limited.

phases of industry development: R&D and demonstration. Today the first quasi-commercial projects are being contracted ready for construction over the coming years.

From R&D to Demonstration

The first offshore deployment of a wind turbine took place at Nogersund, Sweden, in 1990. Over the next decade, a series of R&D deployments followed in Denmark, The Netherlands, Sweden, and the United Kingdom that were largely publicly funded with significant academic involvement. This phase ended perhaps in 2002 with the construction of the 160 MW Horns Rev offshore wind project that constituted a major ramp-up in the scale of deployment over the previous largest offshore project, which was 40 MW (Figure 2).

The demonstration phase has continued since then with a significant further deployment in Denmark (Nysted—166 MW) followed by several projects in the United Kingdom. These demonstration projects can be categorized as being funded primarily commercially with some level of capital and revenue support from the government. Figure 3 clearly shows the transition between these phases from 1999 to 2001.

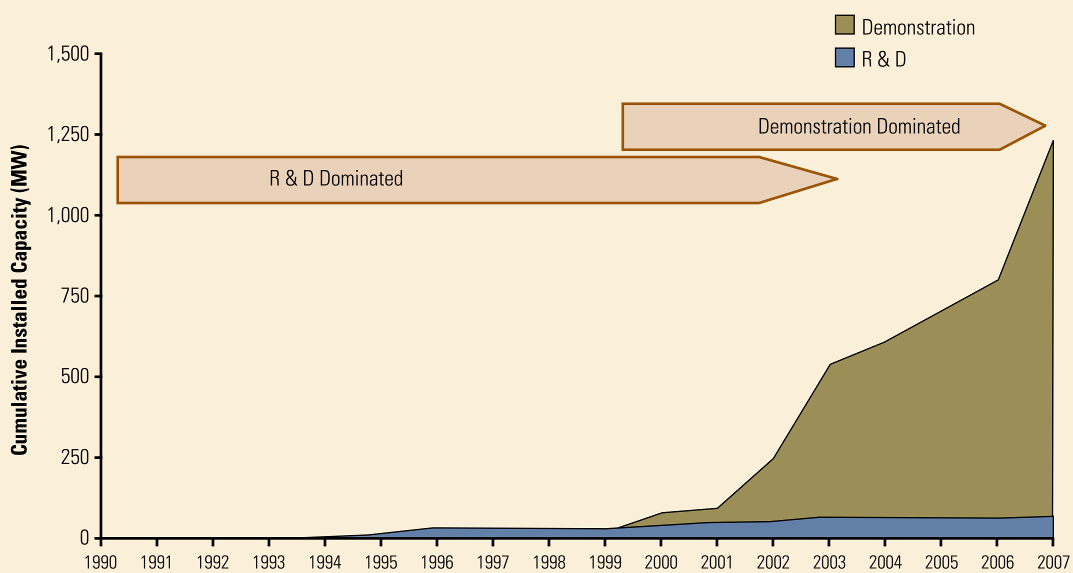
FIGURE 2: LOCATION OF EUROPEAN OFFSHORE WIND PROJECTS, JUNE 2008

Source: Garrad Hassan and Partners Limited.

A False Dawn

Following what may be described as the "Danish surge" in the early years of this decade, consisting of the demonstration projects at Horns Rev and Nysted, the growth rate of the industry slowed substantially for the three-year period from 2004 to 2006, with just one project

FIGURE 3: CUMULATIVE OFFSHORE WIND CAPACITY SINCE 1990



Source: Garrad Hassan and Partners Limited.

completed in each of those years—all in the United Kingdom (Scroby Sands, Kentish Flats, and Barrow). Since then, construction momentum has recovered thanks largely to renewed activity in The Netherlands and Sweden. This has augmented ongoing efforts in the United Kingdom.

It is noteworthy that despite the strong growth rate currently exhibited, the offshore wind industry was widely anticipated to deliver substantially greater installed capacities between 2004 and 2006. As recently as 2005, the total installed capacity for offshore wind by the end of 2007 was predicted to be 3.6 GW [1] by a leading industry analyst, whereas the actual total was about one-third of this figure.

Three main reasons exist for this false dawn. First, and with the benefit of hindsight, offshore growth projections since 2000 have been optimistic primarily because of an overestimation of learning effects and associated cost reductions. Second, since the early demonstration projects, costs have in fact increased, which has meant that many marginally economic sites have become unfeasible under current conditions. Third, wind turbine manufacturers have stopped offering EPC[2] contracts for offshore wind farms, forcing developers to take on more technical and commercial risks within a multicontract framework, and offshore contractors have yet to step in to fill this void. The last point is related to the mixed early project experience, which is discussed further below and which has led to the lengthy delay of many of the more advanced offshore wind projects while contracts were renegotiated.

Rising Costs

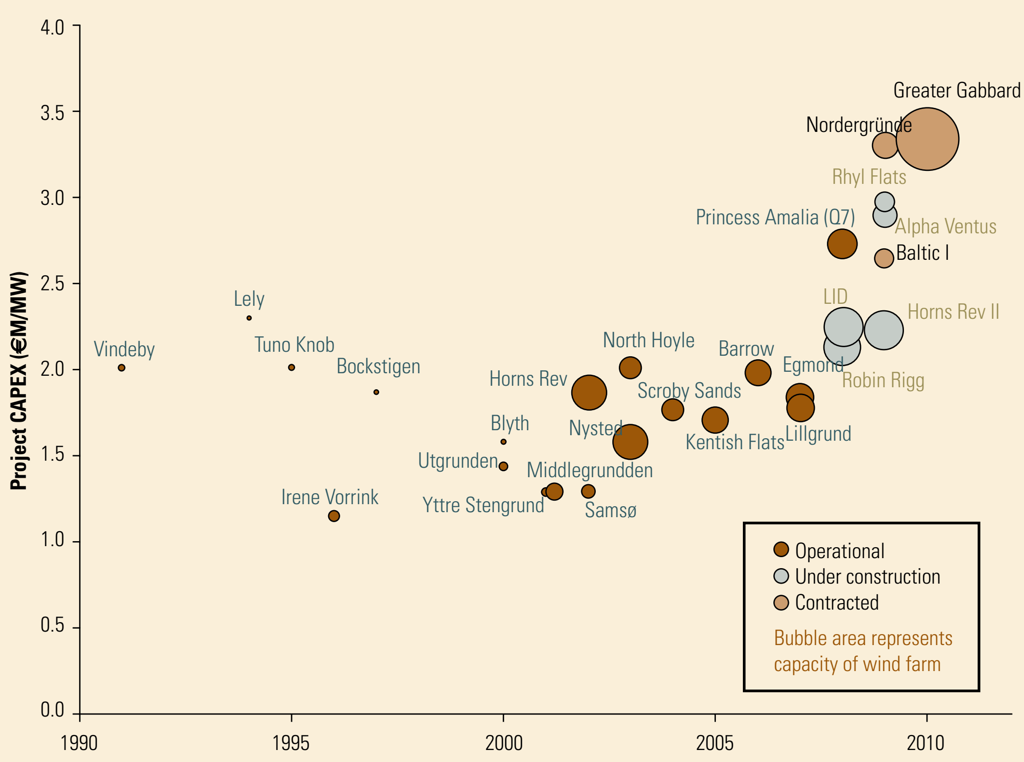
Figure 4 is based on published cost data. It illustrates the unanticipated upward trend in offshore project capital costs.

There are four principal reasons for this trend:

1. **Initial fierce competition and losses**
   The initial high degree of optimism for future offshore wind led to fierce competition between turbine

2. Engineering Procurement Construction (EPC): Used to imply a single point of responsibility to deliver a turnkey project.

FIGURE 4: PUBLISHED CAPITAL COSTS FOR OFFSHORE WIND PROJECTS



Source: Garrad Hassan and Partners Limited.

manufacturers and installation contractors for the early demonstration phase projects. In an attempt to establish a good market position, optimistically low EPC contract prices were offered. Be it the result of a deliberate policy of "loss leading" or inadvertent cost optimism, it is unlikely that the principal contractors turned a profit on these early contracts. This result has led to somewhat of a backlash—with contractors readjusting tender prices to ensure that profit margins are met.

2. **Price rises in the overall wind turbine market**
Since 2005 there has been a significant rise in turbine prices for both onshore and offshore wind projects. This has been caused to a large extent through supply not keeping up with demand, leading to low competition. In particular, shortages of key wind turbine subcomponents, such as gears, large bearings, transformers, castings, forgings, and carbon fiber, has limited the supply capacity growth rate in the face of steeply increasing demand.

3. **Greater risk and lower profitability in the offshore wind turbine market**
Currently, the market for offshore wind turbines is largely coincident with that for onshore projects in terms of both products and players. However, given the additional risks associated with supplying machines offshore and the high demand for turbines onshore, manufacturers currently have a limited incentive to bid competitively for supply contracts for offshore wind projects. If the choice is between 250 MW in the North Sea and 250 MW in Texas, the choice of Texas is clear.

4. **Balance of Plant (BoP)[3] supply chains.**
Certain BoP items and equipment required for offshore wind projects are currently in short supply. Of particular note are installation vessels, subsea cables, and project transformers. This shortage has led to low competition and high prices in specific parts of the BoP supply chain.

All of these causes may be mitigated over the next few years if market forces redress imbalances in the supply chain. In addition, a true bifurcation in wind turbine design is likely to be required, which will result in offshore-specific products and, to a greater or lesser extent, supply chains. This will allow the establishment of a separate offshore wind market that is not subject to overwhelming supply competition from the onshore wind industry. Both of these mitigating factors are likely to require additional governmental support if they are to gain enough momentum to achieve a substantive impact. It is clear that the supply constraints took place before there was any substantial manufacturing capacity in China.

3. Balance of Plant: project elements other than the turbine.

The Future—Sink or Swim

Following the first two phases of industry development outlined above (R&D and demonstration-dominated), it can be seen that a third phase is emerging, which may be termed *commercial expansion*. Such projects will be those that benefit from some form of revenue support, but that are not eligible for capital support. The UK Round 2 and German Pilot Projects may be the first to be built in this third phase, although it is notable that both are likely to be subject to increased levels of revenue support in the absence of the anticipated downward cost trend for offshore wind technology, so that in fact, this transition is perhaps somewhat arbitrary. A more notable difference between Phase 2 (demonstration) and Phase 3 (commercial) projects is likely to be their scale, with the latter typically reaching an installed capacity of several hundred megawatts.

New markets for offshore wind are likely to reach a level of commercial viability and regulatory maturity within the next decade. In Europe, these are likely to include France and Spain, where recent legislative and policy changes indicate some degree of potential for significant deployment. Beyond Europe, prospects are currently unclear, although there has been significant, albeit nascent or sporadic, offshore wind project development activity in Canada, China, Korea, Taiwan (China), and the United States, as evidenced by this report. However, unless there is substantial activity in China, the vast majority of new offshore wind projects likely to come online in the next decade will be built in Europe, with the majority of these being established in UK or German waters.

Another possibility in the coming years is the re-emergence of EPC contracting, with the entrance of specialist contractors prepared to target project management risk as a means of generating profit. All other things being equal, this is likely to have the effect of increasing project prices as interface and management risk is passed from owner to contractor. However, this may enable owners to realize their offshore project pipeline more quickly by not having to manage such risks in-house.

There is good potential for reducing project costs through technical innovation. Several areas may be targeted on this front, including wind turbine design and installation methods. Some evidence of the former has surfaced with the emergence of a limited number of new offshore-specific wind turbine designs and manufacturers. In addition, technology demonstration projects, such as Beatrice in the United Kingdom and Alpha Ventus in Germany for deeper water development, are designed to accelerate the deployment of new approaches to design and installation, and they have the potential to make a significant contribution in this regard.

Finally, it is anticipated that an increased level of competition will develop within certain parts of the project supply chain, with new entrants and equipment coming online as the industry gathers momentum. This will happen only if a consistent market is developed that is free from the stop-start characteristics that have existed to date.

The European Union

Europe is heavily dependent on imports for its energy, with about 50 percent originating from outside its common borders. With indigenous hydrocarbon reserves in the North Sea rapidly being extracted, this figure is expected to rise to 70 percent in the next couple of decades [28]. There is a perception that Europe is entering a new energy era, where new objectives of sustainability, competitiveness, and security of supply will apply, and risk mitigation will be of increasing importance [25].

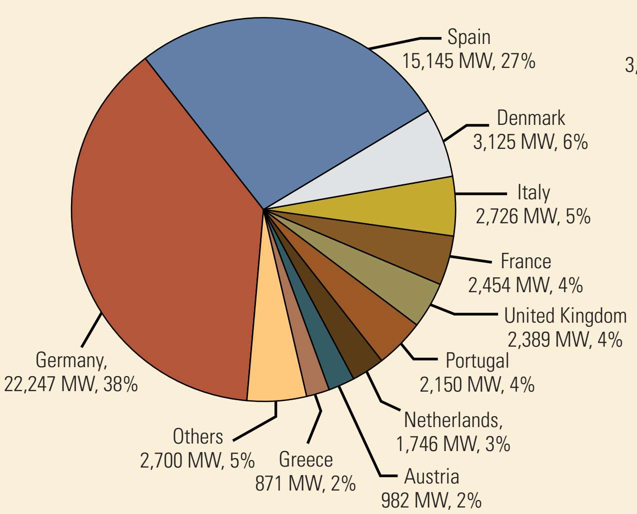
RE has been given an important and high-profile role within the Europe-wide strategy to reduce reliance on imports, as well as to aid progress toward Kyoto targets, with wind energy being critical and expected to make the largest contribution toward electricity supply among the RE candidates according to the *2007 Renewable Energy Road Map* [27].

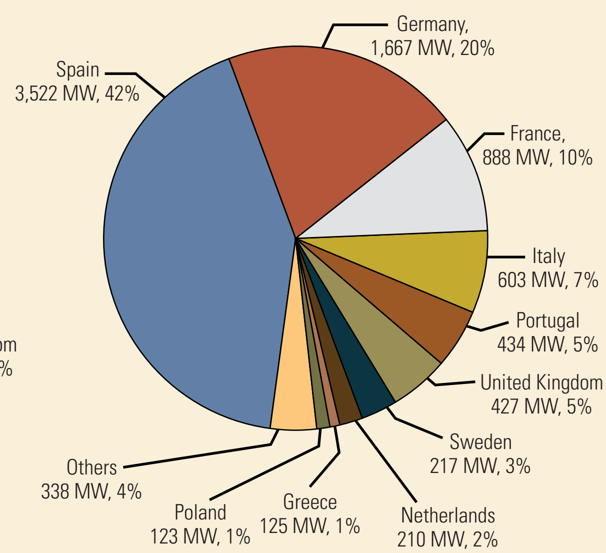
In 2007, slightly more than 8,500 MW of new wind energy capacity was added in Europe, with around 200 MW of this being offshore [7]. The total generating capacity at the end of 2007 was more than 55 GW, representing a rise of 18 percent over the previous year, of which about 1 GW is offshore. It is clear that offshore is still a minor part of the mix.

Figure 5 illustrates how two countries in particular continue to dominate the industry in Europe: Germany and Spain. As this report shows, Germany is expected to play a leading role in the offshore wind energy industry as well, not only in terms of projects, but also of technology. Spain may also enter this field, although this is unlikely to occur immediately, because of a number of country-specific characteristics and constraints, not least of which is the substantial remaining capacity suitable for development onshore in that country.

Other countries are expected to host significant new offshore wind capacity, in particular the United Kingdom, followed by Denmark and The Netherlands and possibly France, Ireland, and Sweden as well. This should bring some much needed diversification to the wind industry

FIGURE 5: EUROPEAN WIND ENERGY CAPACITY—ONSHORE AND OFFSHORE, END OF 2007





Source: [7].

in further countries and regions, a major new market, and possibly technologies, if offshore specific wind turbines become available.

Denmark

Pilot Projects

In 1991, the Danish company Elkraft established a 5 MW test plant at Vindeby. In 1995, Elsam followed suit and established a 5 MW wind power plant at Tunø Knob.

The effect of the offshore wind turbines on the environment at Vindeby and Tunø Knob was studied during installation and into operation. These studies indicated that offshore wind turbines did not have a significant impact on the environment. However, the potential impact of large offshore wind farms was not addressed during this environmental monitoring campaign. Therefore, in connection with the demonstration program for the next two large wind farms (Horn Rev 1 and Nysted/Rødsand 1), a number of additional studies were implemented to observe the effect of the wind farms on the environment [40].

Agenda 21 Project

In December 1999, after a full environmental assessment, the Danish Energy Authority (DEA) approved an offshore wind farm at Middelgrunden 3.5 km outside of Copenhagen harbor that consisted of 20 wind turbines, with a total installed capacity of 40 MW. The project was developed by a partnership between Middelgrundens Vindmøllelaug (a community partnership) and the Copenhagen Utility Københavns Energi (later Energi E2; today DONG Energy).

The Renewable Energy Island

The Samsø offshore wind turbine project was installed during the autumn of 2002 and connected to the grid at the beginning of 2003. In 1997, Samsø was chosen as Denmark's "renewable energy island" after a nationwide competition involving all Danish islands. The offshore project was part of this development. The project consists of 10 wind turbines with a total installed capacity of 23 MW.

Two 160 MW Demonstration Projects

The two projects, Horns Rev 1 and Nysted/Rødsand 1, were completed in 2002 and 2003, respectively, as the first two projects following the Action Plan for offshore wind established in 1997 [41]. In connection with these two projects, a comprehensive environment program was established [40].

Private Development

The only 100 percent private (that is, without the participation of utilities) offshore project was established in 2003 at Rønland, Harboøre. In this project, a total of eight wind turbines were deployed in a nearshore location. Fifty percent of the project is owned by a cooperative.

Research Project in Frederikshavn

In 2003, a consortium of MBD Offshore Power, Aalborg University (AAU), and DONG Energy established three wind turbines at the harbor area at Frederikshavn with the purpose of studying different support structure concepts.

Cancelled Projects

In 1997, a national committee identified areas for five demonstration offshore wind projects, totaling 750 MW, to be developed by the utilities by 2007 under agreement with the government and approved by the European Union. The five demonstration project areas are also the basis for the further development, with a target build-out rate (on average) of 150 MW per year up to 4,000 MW by 2030.

By 1999, the utilities received preliminary approvals for four of the five "demonstration" offshore wind farms—Horns Rev, Læsø, Omø Stålgrunde, and Rødsand/Nysted—which triggered environmental and technical studies.

In 2002, the order for three of the five demonstration projects, where construction had not commenced, was revoked (Læsø, Omø Stålgrunde, and Gedser Rev). This was variously reported as a climb-down on the program because of a change of government in Denmark, or simply a deceleration in the light of better-than-anticipated growth in RE.

Horns Rev became operational in 2002, and Nysted was completed at the end of 2003.

Following an open tender at the end of June 2005, the government awarded a concession to Energi E2 (now DONG Energy) for extension of the Horns Rev project (Horns Rev II). E2 bid the lowest unit energy price for an approximately 12-year period and has contracted

Siemens to deliver 91 of the SWT-2.3-93 VS models for installation during 2009.

In January 2006, the government initiated the second round of bidding for the 200 MW extension of the existing Nysted wind farm, which was also subsequently awarded to E2. The project has since been transferred to E.ON Sverige during the restructuring of the Danish energy industry. In December 2007, however, E.ON decided to relinquish the project because of worsening economics—in particular, rising wind turbine prices. With the feed-in tariff fixed at the price they had bid, there was no flexibility regarding income. Hence, the Danish government announced in February 2008 the initiation of a new competitive tender round to reallocate rights to this wind farm. Potential bidders had two months to prepare, with the deadline for grid connection being delayed a year to 2011. E.ON was the successful bidder once more, albeit with a higher and viable bid.

Concurrently, the Danish Energy Agency has been updating its offshore wind action plan, which guides policy concerning grid integration, shipping, and environmental considerations, as well as identification of offshore protected areas.

To coincide with the United Nations COP15 Climate Change Conference in Copenhagen in November and December 2009, DONG Energy and Hvidovre Vindmøllelaug have applied through the open procedure to replace the 11 turbines close to the power plant at Avedøre, south of Copenhagen, with three 3–5 MW demonstration wind turbines to be placed 40–100 m offshore from the existing 350 kW turbines. Planning permission has not been given as yet with the Environmental Impact Assessment (EIA) report due to be issued during the spring 2008. Table 1 summarizes operational and consented wind farms in Denmark.

Beyond 2010

The Committee for Future Offshore Wind Turbine Locations published the report, "Future Offshore Wind Turbine Sites—2025," in April 2007 [42]. The report charts a number of possible areas where offshore turbines could be built to an overall capacity of some 4,600 MW. Turbines with such capacity could generate approximately 18 TWh, or just over 8 percent of total energy consumption in Denmark. This corresponds to approximately 50 percent of Danish electricity consumption. The committee has examined in detail 23 specific possible locations—44

TABLE 1: OPERATIONAL AND CONSENTED OFFSHORE WIND FARMS IN DENMARK

	Site	Year	Capacity	Operator
Existing offshore wind farms by 2007				
1	Vindeby	1991	5 MW	DONG Energy
2	Tunø Knob	1995	5 MW	DONG Energy
3	Middelgrunden	2001	40 MW	DONG Energy and Middelgrunden Coop
4	Horns Rev 1	2002	160 MW	Vattenfall and DONG Energy
5	Rønland	2003	17 MW	Private and Cooperative
6	Nysted/Rødsand 1	2003	165 MW	DONG Energy and EON Sweden
7	Samsø	2003	23 MW	Samsø Kommune and Samsø Vind Coop
8	Frederikshavn	2003	8 MW	DONG Energy, MBD, and AU
Planned and consented offshore wind farms by 2008–2010				
9	Horns Rev 2	2009	200 MW	DONG Energy
10	Hvidovre	2009	10 MW	DONG Energy and Hvidovre Vind Coop
11	Nysted/Rødsand 2	2010	200 MW	New contract awarded to E.ON in 2008
12	Djursland (Anholt)	2012	400MW	Tender process initiated

Source: Garrad Hassan and Partners Limited compilation.

km² each—with an overall area of 1,012 km² divided among seven offshore areas.

Following an agreement in February 2008 between the government and the political opposition on the energy policy for 2008–12 (the 2008 Energy Bill), it was decided to build the two next 200 MW farms in accordance with the plan [52], with the alternative option of a single 400 MW offshore wind farm. Commissioning should occur by 2013. The grid operator has already stated very clearly that its preference is for a single project atDjursland-Anholt [56].

The Seven Offshore Areas

The committee has assessed society's interests in relation to grid transmission conditions, navigation, the natural world, the landscape, raw material exploitation, and so forth. The committee also assessed options for connecting major offshore wind farms to the national grid, including examining the engineering, economic, and planning options for landing power and the consequences for the underlying grid of the various potential areas for construction. At the same time, the committee described scenarios for technological development of wind turbines capable of installation at greater sea depths. Importance was attached to a planned and coordinated expansion of wind power and the transmission network with a view to obtaining the greatest possible economic benefits.

Taking into consideration the costs involved, the committee recommended that any expansion of offshore wind farm construction should take place in the order described next.

The first farms are recommended to be constructed at Djursland-Anholt in the Kattegat and Horns Rev in the North Sea. However, the prioritization of Horns Rev depends on the closer evaluation of nature conservation interests. From the economic standpoint, an expansion in Jammerbugten off the coast at Ringkøbing in the North Sea would be almost identical. Finally, the committee recommends locations at Store Middelgrund in the Kattegat and Kriegers Flak and Rønne Banke in the Baltic. The headline results for the recommended sites are presented in Table 2. The new energy bill [52] and the statement from the grid operator suggest that the next two farms will be located at Djursland-Anholt [56].

As when selecting potential areas, the majority of interests were taken into consideration; the recommendations for following a particular sequence in constructing sites are based primarily on the economic consequences regarding the additional costs for installation relative to water depths, the landing of power, the expansion of the land network, and the expected energy production.

The report also discusses a number of areas, several of which have been designated previously in [41], which the committee does not immediately believe to be suited to the installation of large-scale offshore wind farms.

TABLE 2: HEADLINE RESULTS FROM FUTURE DEA OFFSHORE RECOMMENDATIONS

Area	Installed capacity (MW)	Grid cost (millions of DKK/MW)	Construction cost (millions of DKK/MW)	Capital investment (millions of DKK/MW)	Mean wind speed (m/s)	Overall investment p.a. (DKK/kWh)
Djursland	2 * 200	3.3	12.7	16.0	9.7	3.98
Horns Rev	5 * 200	4.4	12.8	17.2	10.2	4.01
Jammerbugt	4 * 200	4.9	13.3	18.2	9.8	4.42
Ringkøbing	5 * 200	4.2	15.3	19.5	10.3	4.52
Store Middelgrund	200	3.3	16.1	19.4	9.7	4.80
Kriegers Flak	4 * 200	5.6	14.9	20.5	9.7	5.10
Rønne Banke	2 * 200	4.3	18.1	22.4	9.8	5.50

Note: Mean values cannot be added, since some of the grid costs would be counted twice [42].

Source: Garrad Hassan and Partners Limited.

Cumulative Offshore Capacity

The plans for establishing further offshore wind farms beyond 2012/13 could not be agreed on by the government and political opposition within the scope of the 2008 Energy Bill—hence a certain degree of uncertainty remains for the medium term. Following the completion of Horns Rev 2 and Nysted/Rødsand 2 at the end of 2011, total cumulative offshore wind capacity in Denmark will be 823 MW. Should the two further 200 MW projects, or the equivalent, be sanctioned as expected, the total operational capacity will reach 1,223 MW in 2013.

Germany

With more than 20 GW installed, Germany has the largest volume of wind energy–generating capacity in the world, almost twice as much as the two second-placed countries, Spain and the United States, and about 28 percent of the worldwide total [6]. However, the dedicated areas in the windiest on-land regions in the north of the country are now approaching saturation. This reflects the perceived capacity of the landscape to absorb new wind turbine construction. Hence, attention has been turning to less windy sites in the center and south of the country and to offshore..

Following on from Denmark, Germany was the second European country to encourage large-scale construction of onshore wind turbines in a similar manner, and it made its intentions clear very early that offshore wind would become a major source of power as well. The waters immediately adjacent to the German coastline, in particular in the North Sea, are considered a valuable natural habitat, and large parts have been designated as nature reserves. Hence, most of this area is off limits for wind farm development, and projects have had to be planned in deeper waters farther off the coast.

Although this announcement did inspire a hasty "land grab" for enough sites to more than double Germany's wind energy–generating capacity, the challenges of actually constructing wind farms at such deep and distant offshore sites means that experience has had to be built up elsewhere first at more accessible locations, and the financial incentives and conditions have had to be gradually improved, step by step, before investors could develop the confidence to start such major undertakings. The recent entry of experienced non-German wind farm developers into the German offshore market suggests that that time may have arrived.

To date, a number of single-turbine projects have been built very close to the shoreline (see Table 3), and several met masts (meteorological masts to take wind measurements for wind turbines) have been installed—so far two through a national research program and two by the project developers. There are also several masts in Danish waters close to the German border (Table 4).

In addition, the contracts for the first deepwater "test" wind farm, Alpha Ventus at Borkum West, were placed in 2008, and offshore construction started in 2009. This project is a prototype development and is not typical of the enormous projects that will follow in the future, since it consists of only 12 wind turbines with a total capacity of 60 MW. It was initiated by a private developer, PROKON Nord, which obtained permits for both the wind farm as well as the transmission cable. However, encouraged by the federal government, responsibility for the first phase has been taken on by a consortium of three German grid operators: EON, Energieversorgung Weser Ems (EWE), and Vattenfall, known as *Stiftung der deutschen Wirtschaft für die Nutzung und Erforschung der Windenergie auf See (Offshore-Stiftung)* (Institute for the Exploitation and Study of Offshore Wind Energy). The primary purpose of Alpha Ventus is to demonstrate the viability of offshore wind farms and test the next generation of 5 MW wind turbines in an exposed environment. Initially a number of wind turbine manufacturers were approached, with eventually the three largest German wind turbine suppliers—Enercon, MultiBrid, and REPower—being selected to provide four wind turbines each. However, Enercon subsequently withdrew, leaving MultiBrid and REPower to supply six machines each.

TABLE 3: INSTALLED PROJECTS

Site	Developer	Turbines	Details
Dollart/Emden [79]	Enova	1 x 4.5 MW Enercon	10 m from shore in 3 m water
Breitling/Rostock [58]	Wind-Projekt	1 x 2.5 MW Nordex	Within enclosed lagoon; 0.5 km from shore in 2 m water

Source: Garrad Hassan and Partners Limited, based on dena and BSH.

TABLE 4: METEOROLOGICAL MEASUREMENT MASTS

Site	Owner	Date	Location	Mast details
North Sea				
FINO 1	GL Wind	Sept. 2003	45 km from coast in 30 m waters	Jacket structure; 101 m above surface
Amrumbank West	Essent Wind and Amrum Bank West	April 2005	35 km from coast in 23 m waters	Monopiles; 90 m above surface
FINO 3	FH Kiel	Planned (2007)	45 km from coast	Monopiles
Horns Rev, DK	DONG	1999	3 masts: 2 km northwest, 2 km east, 6 km east	Monopiles: 62 m, 70 m, 70 m mast
Baltic Sea				
Sky 2000	Sky 2000	2003	13 km from coast in 21 m waters	Monopile, 22 m above surface
FINO 2	Schifffahrts-institut Warnemünde	May 2007	31 km from coast in 20 m waters	Monopile; 105 m above surface
Arkona-Becken	AWE	March 2007	35 km from coast in 24 m waters	Monopile; 95 m above surface
Nysted (Rødsand), DK	DONG	1997	Adjacent to wind farm	Monopile; 45 m above surface
Gedser, DK	—	1997	At Gedser reef; southeast of Nysted	Monopile; 48 m above surface

— Not available.

Source: Garrad Hassan and Partners Limited, based on dena and BSH.

The goals for the eventual capacity of offshore wind energy capacity remain extremely ambitious, although shorter-term targets are unlikely to be realized in the timeframe specified. Indeed, a previous target of 500 MW by 2006 has already been missed [83]. However, this lack of early progress has not dampened the political determination to make offshore wind farms happen, and consequently further support mechanisms have been put in place to achieve this goal. One of the reasons for this determination is that the German wind energy industry needs a stable home market in order to thrive, and this can only be offshore in the medium term. Onshore repowering is likely to expand over the coming decade, but it is unlikely to be sufficient on its own.

German offshore wind farms need both a construction permit for the wind farm itself, as well as the transmission cable. To date, 17 large wind farms, typically with 80 wind turbines, as well as two smaller projects, have been granted permits for construction. The wind farm size is currently limited to pilot phases with a maximum of 80 turbines, with the intention to gain experience with offshore wind farms and their impact on the environment and other commercial activities, shipping in particular, taking place offshore. The routing of the transmission cable is particularly critical where it has to cross the coastal nature reserve area, since construction activities are restricted there.

Tables 5–8 list projects under development in the North Sea; while Table 9 lists projects in the Baltic Sea. Up-to-date information on the permitting status of German offshore wind farms is available at the *BSH* [72] and dena [80] Web sites.

In addition, an application has been made for H2-20 (2,000 MW; 200 km; 40 m) in the far northwest of the German North Sea.

Predicting dates for construction and future capacities of offshore wind farms is notoriously prone to error, and the case of Germany is no exception. On the one hand,

TABLE 5: OFFSHORE WIND FARM PROJECTS IN THE NORTH SEA—BORKUM 1 GROUP

Site	Developer or investor	No. of WTGs	Permits granted: Wind farm	Permits granted: Cable	Comments (distance; depth)
Alpha Ventus (Borkum West)	Stiftung OWE and DOTI	12	Nov. 2001	Dec. 2004	43 km; 28–30 m
Borkum Riffgat	Enova and EWE	44			14.5 km; 16–20 m
Borkum Riffgrund	Plambeck NE and Vattenfall	77	Feb. 2004		34 km; 23–29 m
Borkum Riffgrund West	Energiekontor	80	Feb. 2004		40 km; 30–35 m
Borkum West II	Prokon Nord and Trianel	80	Jun. 2008		45 km; 25–35 m
North Sea Windpower	ENOVA Offshore and Delta (E.ON)	48	Feb. 2005		40 km; 25–33 m
Delta Nordsee (Enova 2)	ENOVA Offshore and Delta (E.ON)	80	Feb. 2005		40 km
Godewind	Plambeck Neue Energien and Econcern	80	Aug. 2006		45 km; 26–35 m
Godewind II	Plambeck Neue Energien	80			45 km; 28–34 m
MEG1	Prokon Nord	80			
OWP West	LCO and Econcern	80			40 km; 29–33 m
Nordergründe	EnergieKontor	25	Dec. 2003	Sep. 2004	13 km; 2–18 m

Note: No date implies that no permit had been issued as of time of writing.
Source: Garrad Hassan and Partners Limited, based on dena and BSH.

the conditions for the construction permits, feed-in tariff, and grid connection encourage construction within the next few years, but the lack of suitably large turbines, the need to wait for transmission lines to be completed, and the effort required to arrange the finances for construction of projects of such an unprecedented size suggest that further delays are likely. Figure 6 constitutes the authors' current best estimate for the future expansion of offshore wind energy in Germany. It assumes that the supply of 5 MW wind turbines will gradually ramp up from 2008 and that the ramp rate will be shallower than that seen on land in the late 1990s. The difference in size between on-land and offshore wind turbines means that the competition for the purchase of offshore wind turbines will primarily be with the offshore markets in other countries. Hence, major construction programs at sites with less challenging conditions or more generous incentives, such as the United Kingdom, may have an impact on progress. However, the German Renewable Energy Sources Act (EEG) is currently under review, and the offshore tariffs are expected to rise again. In the long term, a strong German market will provide turbine manufacturers with the confidence to ramp up manufacturing capacity for the home, as well as other markets.

The Netherlands

The Dutch offshore wind opportunity has not been fully exploited. For more than a decade, a mixture of governmental changes, delays in establishing the consenting process, and a tariff system that was stopped, started, stopped again, and then revised once more during 2006/07 has tended to slow development. The first offshore wind farm in The Netherlands was built as early as 1994, with a second one in 1996. Preparations for the first major offshore wind farm, at Egmond, were initiated in the late 1990s, but development was held back by various policy and process delays, so it has only just completed construction. It appears that the policy situation is still fluid, which is undoubtedly continuing to affect the confidence of potential investors and developers.

Continuing its centuries-long pioneering tradition in the development of wind energy technology, The Netherlands was the third country in the world to install offshore wind turbines offshore, at Lely in the sweet-water inland sea Ijsselmeer.. However, in a mannersimilar to the experience of modern onshore wind energy in the country, the development of offshore capacity has been slow, intermittent,

TABLE 6: OFFSHORE WIND FARM PROJECTS IN THE NORTH SEA—BORKUM 2 GROUP

			Permits granted		
Site	Developer or investor	No. of WTGs	Wind farm	Cable	Comments (distance; depth)
Aiolos	Eos	80			132 km; 39 m
Albatros	LCO and Econcern	80			75 km
Aquamarin	BARD	80			83 km; 38 m
Austerngrund	GWS and BARD	80			87 km; 40 m
BARD Offshore 1	BARD Engineering GmbH	80	Apr. 2007		87 km; 39–41 m
Bernstein	BARD	80			108 km; 41 m
Citrin	BARD	80			111 km; 41 m
Deutsche Bucht	Eolic and BARD	80			87 km; 40 m
Diamant	BARD	80			11 km; 41 m
GAIA (I-V)	Northern Energy	80 × 5			90–110 km; 30–41 m
Global Tech I	Nordsee Windpower	80	May 2006		75 km; 39–41 m
He dreiht	EnBW	80	Dec. 2007		75 km; 39 m
He dreiht II	EOS	28			103 km; 39 m
Hochsee Windpark Nordsee	EnBW	80	July 2006		75 km; 25.7–39 m
Notos	EOS	33			108 km; 39 m
Sea Storm	Northern Energy, Westerholt	80			110 km; 41 m
Sea Wind I and II	Northern Energy, Westerholt	80 × 2			90 km; 39 m
Skua	OPG Projekt	80			85 km; 38 m
Veja Mate	BARD (Cuxhaven SC)	80			85 km
Ventotec Nord 1	Arcadis (GHF)	80			132 km; 41 m
Ventotec Nord 2	Arcadis (GHF)	80			104 km; 41 m

Note: No date implies no permit at time of writing.
Source: Garrad Hassan and Partners Limited, based on dena and BSH.

and plagued with numerous delays. This has not been through lack of capability—since The Netherlands benefits from highly rated research institutions, as well as successful project developers and offshore contractors—but rather through lack of consistency of political support.

Lely wind farm is the world's first monopile supported offshore wind farm. It lies less than 1 km from the coast, near Medemblick. It consists of 4 x 500 kW NedWind wind turbines and has been in operation since 1994. Two years after that, a second "offshore" wind farm was built, also in the IJsselmeer, but this time much closer to shore, at Irene Vorrink in Lelystad. With the safety of much of The Netherlands depending on dykes holding back the sea, building regulations for construction on and around these structures are extremely strict, and the turbines had to be built a few meters offshore. Access to the turbines is via walkways, making operations and maintenance (O&M) straightforward, although construction was undertaken using floating barges and cranes.

In 1998, Grontmij was contracted to assess the potential for offshore wind power in the Dutch sector of the North Sea [92]. The resulting GIS model included an inventory

TABLE 7: OFFSHORE WIND FARM PROJECTS IN THE NORTH SEA—HELGOLAND 1 GROUP

Site	Developer or investor	No. of WTGs	Permits granted: Wind farm	Permits granted: Cable	Comments (distance; depth)
Amrumbank West	Amrumbank West	80	Jul. 2004	Feb. 2007	35 km; 21–25 m
Kaskasi	Essent	40			35 km
Meerwind Ost and Meerwind Süd	Windland and Blackstone	80	May 2007		15 km and 80 km; 22–32 m
Nordsee Ost	WINKRA and Essent	80	Jun. 2004	Feb. 2007	30 km; 19–24 m
Hochsee Testfeld Helgoland	GEO				ca. 35 km; 24 m

Note: No date implies no permit at time of writing.

Source: Garrad Hassan and Partners Limited, based on dena and BSH.

TABLE 8: OFFSHORE WIND FARM PROJECTS IN THE NORTH SEA—SYLT/HELGOLAND 2 GROUP

Site	Developer or investor	No. of WTGs	Permits granted: Wind farm	Permits granted: Cable	Comments (distance; depth)
Butendiek	OSB Offshore Bürger-Windpark Butendiek and Airtricity	80	Dec. 2002		35 km; 16–22 m
Dan Tysk	GEO; Vattenfall	80	Aug. 2005		45 km; 23–31 m
Nördlicher Grund	Nördlicher Grund	80	Dec. 2005	Jun. 2006	86 km; 23–40 m
Sandbank 24	Projekt	80	Aug. 2004	Feb. 2007	90 km; 30–40 m
Sandbank 24 extension		40			90 km; 25–34 m
Uthland	GEO	400 MW			49 km; 25 m; Natura 2000
Weiße Bank	Energiekontor	280 MW	Within Natura 2000 zone		83 km; Natura 2000

Note: No date implies no permit at time of writing.

Source: Garrad Hassan and Partners Limited, based on dena and BSH.

of current competing uses of the North Sea, such as shipping, dredging, and oil and gas. Table 10 shows the calculated total area available for wind farm deployment. Hence, it was concluded that a national target of 6,000 MW by 2020 could be built in depths of 20 m or less.

Existing long-term wind speed measurements taken on existing oil and gas exploration platforms in the Dutch sector of the North Sea show that the wind resource is excellent [103]. In the Energy Research Centre's (ECN's) atlas from 2004, the mean wind speed at 50 m above sea level is calculated to range between 9 m/s at nearshore locations, and 10 m/s close to the Doggersbank [89].

However, the early promising start for offshore wind entered a period of uncertainty when, following the March 2002 elections, the incoming government announced drastic changes in policy and subsidy support for RE. A new RE support scheme was set up: Environmentally Friendly Electricity Production (Milieukwaliteit Elektriciteitsproductie; MEP).[4] This provided subsidies to support the Dutch target of 9 percent of electricity to be sourced from renewable sources by 2010. However, the conditions

4. Editor's note: The MEP scheme was discontinued in 2006, and a new regulation was introduced in 2007 for a feed-in premium called SDE.

TABLE 9: BALTIC SEA WIND FARMS

Site	Developer or investor	No. of WTGs	Permits granted: Wind farm	Permits granted: Cable	Comments (distance; depth)
Arcadis Ost 1	Arcadis and GHF	70			12 nm zone; 17 km; 41–46 m
Arcadis Ost 2	Arcadis and GHF	—			40 km; 40–45 m
Arkona Becken Südost	E.ON	80	March 15, 2006		34 km; 23–36 m
Baltic I	EnBW	21	April 5, 2006	August 23, 2006	12 nm zone;[a] 15 km; 15–19 m
Beltsee	Plambeck	125 MW			9 km; 25–36 m
GEOFReE	GEO	5			12 nm zone; 20 km; 20 m
Klützer Winkel	Arcadis and GHF	1			12 nm zone;
Kriegers Flak	EnBW	80	April 6, 2005		31 km; 20–35 m
Sky 2000/Beta-Baltic	E.ON	175 MW			12 nm zone; 13 km; 21 m
Ventotec Ost 2	Arcadis and GHF	80	May 16, 2007		33 km; 36–41 m

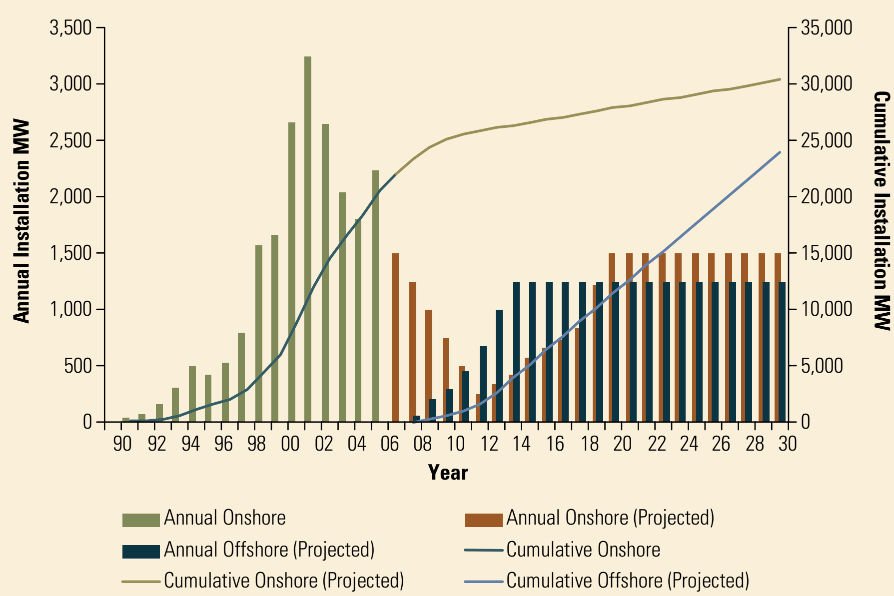
— Not available.

Note: No date implies no permit at time of writing.

a. Within territorial waters (12 nautical mile zone).

Source: Garrad Hassan and Partners Limited, based on dena and BSH.

FIGURE 6: WIND ENERGY INSTALLATION IN GERMANY—HISTORIC DATA AND PROJECTIONS



Source: Garrad Hassan and Partners Limited and [2], [66], [85], and [86].

TABLE 10: AVAILABLE AREA FOR OFFSHORE WIND IN THE DUTCH EXCLUSIVE ECONOMIC ZONE

	Depth < 20 m	Depth < 40 m
Distance to coast > 8 km	1,700 km²	22,000 km²
EEZ (distance to coast > 20 km)	680 km²	20,000 km²

Source: Garrad Hassan and Partners Limited.

and applicability of the scheme have been changed several times without warning, apparently depending on how confident the government feels in reaching the target.

Hence, unsurprisingly, development has been slow during this period, and currently only four projects, totaling 249 MW, are in operation, Table 11.

None of these four constructed projects has followed the current offshore wind regulating regime, with the first two being locating in an inland sweet-water lake, the Egmond-NSW project being a special demonstration project, and the Q7 project being submitted before announcement of the new regulation regime and receiving a special exemption within it.

The Egmond project [98], also called the Offshore Windpark Egmond aan Zee (OWEZ) and formally known as the Near Shore Wind Farm (NSW), is *the* Dutch offshore wind demonstration project and is situated within the Dutch Territorial Sea (12 nm zone) off Egmond. The project was originated by the government, which arranged the necessary permits, with approval awarded in March 2004 [97]. At the same time, the project was put out to tender, with a consortium of Shell and Nuon being successful, with Ballast Nedam to perform the contracting work and NEG-Micon to supply their Dutch-designed DOWEC 2.75 MW wind turbine. The subsequent merger of NEG-Micon with Vestas resulted in this being replaced with the more powerful but slightly smaller 3 MW Vestas V90 wind turbine. The project has been accompanied by an intensive government-funded technical and environmental research program, which started before installation and which is due to cover the first five years of operation, with the resulting reports being freely available over the Internet at references [98] and [104].

The second major wind farm at Q7 [102] (the name of the sector in the North Sea) has also been developed under unusual circumstances, however, without any specific government encouragement. At the time of the original application in December 1999, the development of the current permitting regulations for offshore wind farm had not started; hence, an exception has been made for this project. The permit application, including EIA, was submitted in August 2001, with the licenses for the wind farm and transmission cable being awarded in February and March 2002, respectively [96]. Construction was delayed for several years because of uncertainty about whether a sufficient tariff would be applicable, during which time the project was sold by the original developer E-Connection (with Vestas, Mammoet van Oord, Smulders, and Fabricom initially supporting the development) to E-Concern (with ENECO joining later on) in October 2004. Construction started in late 2006, with Vestas supplying 2 MW V80 wind turbines, the use of a relatively small model being necessary because of conditions in the license [102]. This is the world's first offshore wind farm to be built with nonrecourse debt facilities [101].

The permitting of offshore structures, such as offshore wind farms, is governed by the Wet beheer rijkswaterstaatswerken (Wbr), *Public Works and Water Management Act* [109]. This was extended to the Exclusive Economic Zone (EEZ) in December 2000, and a new offshore wind farm licensing system implementing the Wbr in the EEZ was initiated on December 29, 2004. This was accompanied by an Integrated Management Plan for the North Sea, which identified suitable locations, but did not include a full Strategic Environmental Assessment (SEA) [94]. The Directoraat Generaal Rijkswaterstaat (*General*

TABLE 11: OPERATIONAL OFFSHORE WIND FARMS IN THE NETHERLANDS

Project	Wind turbine	Capacity	Location	Year
Lely, IJsselmeer	4 x NedWind 40/500	2 MW	800 m to shore in 4–5 m waters	1994
Dronten, IJsselmeer	28 x Nordtank 43/600	18.8 MW	30 m to shore in 1–2 m waters	1996
NSW Egmond, North Sea	36 x Vestas V 90 (3 MW)	108 MW	10 km to shore in 18 m waters	2006
Q7-WP, North Sea	60 x Vestas V 80 (2 MW)	120 MW	23 km to shore in 19–24 m waters	2008

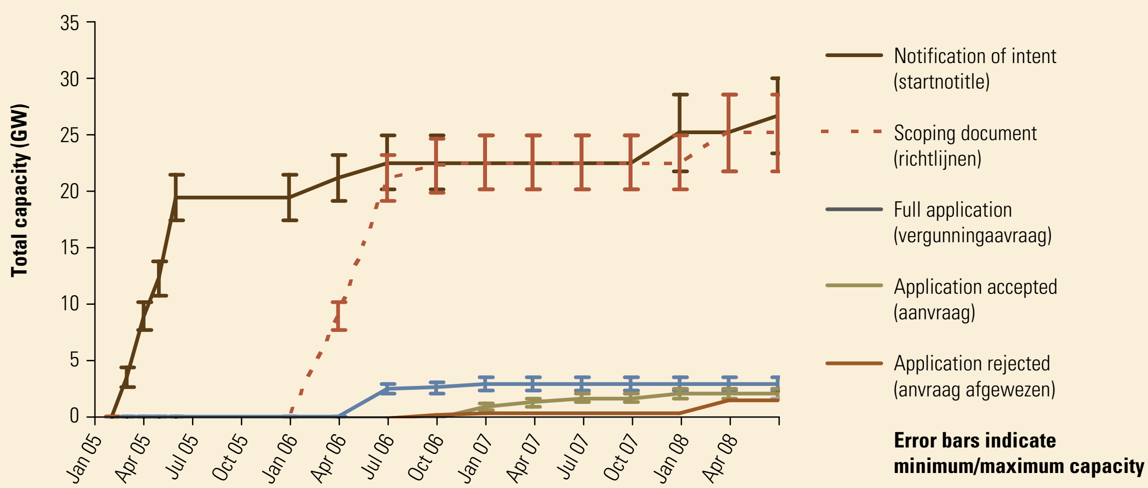
Source: [110].

Directorate of Waterways and Public Works) of the Ministerie van Verkeer en Waterstaat (*Ministry of Transport, Public Works and Water Management*) operates a GIS model of the Dutch EEZ, which is used in the planning decisions and can be accessed via the SenterNovem Web site [104].

Within six months, preliminary applications (*startnotie* or notification of intent) for 57 projects had been submitted that requested permits for a total but overlapping area of 2,230 km^2 and a total generating capacity of between 17.5 and 21.5 GW.[5] At that point, a temporary moratorium was put in place, which lasted about six months. In the subsequent six months, another eight projects were submitted, with an additional capacity between 1 and 1.5 GW (Figure 7). The total realizable potential is actually about half of this, since there is significant overlap among sites.The scoping documents (*richtlijnen* or guidelines) for the first set of projects were returned after about one year, with the process speeding up subsequently to six months for the later submissions. Full applications by project developers, which include an EIA, have been slower, and to date between 2.5 and 3.5 GW have been submitted. Of these, applications for 0.9 GW have been accepted and being evaluated (see Table 12), while 1.3 GW were rejected summarily or rejected following assessment (see Table 13). A decision has not yet been made for the other 1.0 GW project on whether to proceed with application or summarily reject it (see Table 14). An overview of the application process is shown in Figure 8.

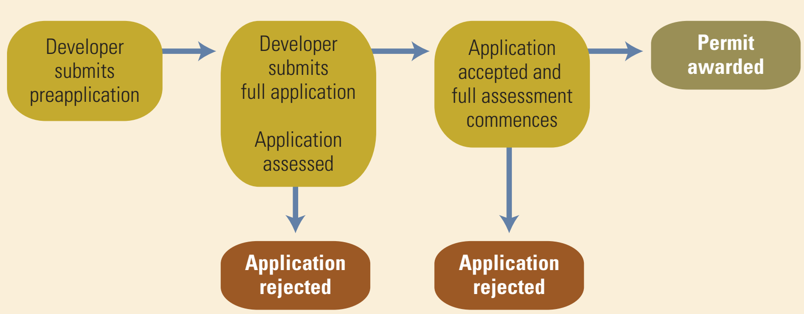
5. This range represents the minimum and maximum capacities stated in the application.

FIGURE 7: OVERVIEW OF OFFSHORE WIND PROJECT PROGRESS IN THE NETHERLANDS



Source: Garrad Hassan and Partners Limited.

FIGURE 8: OVERVIEW OF APPLICATION PROCESS IN THE NETHERLANDS



Source: Garrad Hassan and Partners Limited.

TABLE 12: ACCEPTED WIND FARM APPLICATIONS UNDERGOING ASSESSMENT

				Capacity MW				Application	
No.	Site	Developer	Area (km^2)	Min.	Max.	Start memo	Scoping guide	Submit	Accept
11	Scheveningen Buiten	Evelop	39.4	369	369	Mar. 2005	Mar. 2006	Apr. 2006	May 2007
24	West Rijn	Airtricity	45	250	353	Mar. 2005	Mar. 2006	May 2006	Nov. 2006
27	Breeveertien II	Airtricity	42	300	403	Apr. 2005	Apr. 2006	Nov. 2006	Nov. 2007

Source: Garrad Hassan and Partners Limited.

TABLE 13: REJECTED OR WITHDRAWN WIND FARM APPLICATIONS

				Capacity MW				Application		
No.	Site	Developer	Area (km^2)	Min.	Max.	Start memo	Scoping guide	Submit	Assess	Reject
1	IJmuiden	WEOM (Nuon and Shell)	17	140	246	Feb. 2005	Mar. 2006	Jun. 2006	Nov. 2006	Feb. 2008[c]
4	Katwijk	WEOM (Nuon and Shell)	50	400	705	Feb 2005	Mar 2006	May 2006	Nov. 2006	Feb. 2008
5	Den Haag I	WEOM (Nuon and Shell)	25	215	381	Feb 2005	Mar 2006	Jun. 2006		Jul. 2006[a]
6	Den Haag II	WEOM (Nuon and Shell)	43	270	480	Feb 2005	Mar 2006	May 2006	Jan. 2007	Feb. 2008[c]
25	Q4-WP	E-Connection	21	100	100	n.a.	n.a.	Feb. 2005	n.a.	Nov. 2006[b]
26	P12-WP	E-Connection	21	100	100	n.a.	n.a.	Feb. 2005	n.a.	Nov. 2006[b]

n.a.= Not applicable.

a. Expected relocation of shipping lanes.

b. Insufficient information supplied by the developer to enable the evaluation to be carried out.

c. Application repealed.

Note: These applications are undergoing assessment.

Source: Garrad Hassan and Partners Limited.

TABLE 14: WIND FARM APPLICATIONS CURRENTLY UNDER REVIEW

				Capacity MW				
No.	Site	Developer	Area (km^2)	Min.	Max.	Start memo	Scoping guide	Application
10	Katwijk Buiten	Evelop	40.6	329	329	Mar. 2005	Mar. 2006	May 2006
16	Helmveld	Evelop	50	432	432	Mar. 2005	Mar. 2006	Sep. 2007
28	Rijnveld Noord	E-Connection	10	60	60	Apr. 2005	Apr. 2006	Sep. 2007
29	Rijnveld Oost	E-Connection	17	102	102	Apr. 2005	Apr. 2006	Sep. 2007
55	Okeanos	Arcadis	13	40	120	May 2005	May 2006	Sep. 2007
57	Thetys	Arcadis	16	50	159	May 2005	May 2006	Aug. 2006

Source: Garrad Hassan and Partners Limited.

Information on the status of the projects, together with the preliminary applications (startnotie), scoping guidelines (richtlijnen), and final permits (that is, for NSW [97] and Q7 [96]), is available at the SenterNovem [105] and NoordZee Loket [99] Web sites.

The large sweet-water IJsselmeer also provides opportunities for offshore wind farms, so the district of Noord-Oostpolder decided in 1999 that all wind parks should be in the IJsselmeer rather than on land [100]. This inland sea falls outside the scope of the current on- and offshore wind legislation, and prolonged discussions were needed before the decision that the Economic Ministry would lead the permitting procedures could be reached in 2006 [107].

Spain

To date no offshore wind farms have been built in Spain despite some of the major Spanish developers, such as Gamesa and Accíona (formerly EHN), having shown interest in offshore developments. In 1997, a large project called Mar de Trafalgar developed by EHN of about 1,000 MW (270 wind turbines) was rejected because of the pressure exerted by fishermen and political, social, and ecological groups. Following this early failure, less ambitious projects have been rejected for similar reasons.

Before July 2007 there was no specific legislation for offshore wind installations. Royal Decree 1028/2007 [117] is the first step for developing a comprehensive regulatory framework for offshore wind in Spain. In addition, in December 2007 the government published the "Estudio estratégico ambiental del litoral español para la instalación de parques eólicos marinos" [111], a Strategic Environmental Assessment (SEA) in which the territorial sea is classified into regions taking account of the suitability of installing offshore wind farms with respect to significant environmental impacts and the existence of conflict with other users of the marine environment, such as the shipping industry. The aim of this study was to guide developers at an early stage of project development when there was more room to maneuver. This should help to accelerate administrative procedures later in the life of the project.

The classification consists of three categories:

1. **Suitable areas:** No environmental impact has been detected as of the date of the study. This does not mean that the area will pass the final environmental evaluation.
2. **Exclusion areas:** Significant environmental impact and conflicts with other sea uses have been detected. These areas should be discarded when scouting for potential offshore wind farm sites.
3. **Environmental determinants areas:** Areas where environmental impact or conflicts must be analyzed later in the design stage of the project.

According to government estimates, 42 percent of Spanish coastal seas are suitable for offshore installations. On the other hand, a number of the most technically promising areas, such as the Strait of Gibraltar and the Ebro River Delta, have been classified as exclusion areas.

There is very limited opportunity for developing bottom-mounted offshore wind farms off the Spanish coast, with a single large site at Cabo de Trafalgar, west of the Strait of Gibraltar, potentially being able to support ~1,000 MW of capacity. The other sites are small, very close to the shore, or both.

Should a floating wind solution become feasible and economically viable, the long-term potential for developing offshore wind farms in 200 m waters is excellent off the Iberian Peninsula.

In 2007, 3.5 GW of onshore wind farms were installed in Spain—23 percent of the total installed capacity. This rapid capacity increase in 2007 is in part a result of the change of tariff established in Real Decreto 661/2007 [99], which applies to all wind farms commissioned after 2008. Current projections are to continue growing at a rate of 1,700 MW each year to reach current targets for 2010. Nonetheless, offshore wind energy is becoming a real option for developers.

Although Spanish manufacturers have been able to export significant volumes of wind turbines, as in Germany, a stable and significant national market is a prerequisite for a successful indigenous manufacturing industry. Hence, there has been sustained pressure to establish an offshore wind market that will be ready when saturation of the onshore market is reached.

It is too early to learn lessons from the Spanish offshore wind experience. However, it is clear that they have attempted to learn from the experiences of other countries.

The United Kingdom

Blyth

The first offshore wind project to be constructed in the United Kingdom was at Blyth Offshore in the North Sea, 1 km off the coast of Northumberland. The project consists of two Vestas V66 wind turbines, each with a rated capacity of 2 MW, and was completed in December 2000. At the time, these were the largest offshore wind turbines in operation—an honor soon shared with the Middelgrunden Project in Denmark, which was also completed in December 2000.

Blyth was primarily an R&D project, with significant capital support from the European Union through the European Commission's Thermie Programme. It was developed by a consortium comprising AMEC Border Wind, Powergen Renewables, Nuon UK, and Shell Renewables. The UK government has some involvement with the project, funding a monitoring and evaluation program through the Department of Trade and Industry (DTI) [132] that included themes such as health and safety, installation, commissioning, navigation aids, capital, and operational costs. Above and beyond the R&D value and technical innovation emerging from the project, its outcomes were to inform policy toward offshore wind development in the United Kingdom.

Details on all currently operating wind farms in the United Kingdom can be found in Table 15.

Round 1

The body that holds ownership of the seabed in the United Kingdom, the Crown Estate, launched the first "round" of offshore wind development in the United Kingdom in late 2000. Companies were invited to put forward bids for development rights for sites of up to 30 km^2 containing no more than 30 wind turbines, all within UK territorial waters (<12 nautical miles from the national coastal baseline). Following an evaluation process, all 18 projects were awarded leases for development in April 2001, which constituted a potential installed capacity of up to ~1.5 GW. It should be noted that some of the projects were colocated in order to form "double" projects, and in one case a "triple" project was awarded.

Round 1 was conceived as an initial proving ground for offshore wind in the United Kingdom, and wind farms were limited in size and sited mostly in shallow, near-shore waters. Compared to the onshore experience in the United Kingdom, planning approval rates have been very high and reasonably fast. However, realization of projects has been slower than the government had hoped. There have been a number of reasons for project delays, but weak economics because of high costs has been primarily to blame The critical factors were corporate reluctance over project costs and unwillingness on the part of contractors to take turnkey risk. However, some developers have begun to accelerate projects into construction.

TABLE 15: DETAILS OF CURRENT AND CONSENTED UK PROJECTS

	Site	Round	Capacity
Operational offshore wind farms (2008)			
1	Blyth	Other	4 MW
2	North Hoyle	1	60 MW
3	Scroby Sands	1	60 MW
4	Kentish Flats	1	90 MW
5	Barrow	1	90 MW
6	Beatrice	Other	10 MW
7	Burbo Bank	1	90 MW
Offshore wind farms under construction (2008)			
8	Robin Rigg, Solway Firth	1	180 MW
9	Lynn and Inner Dowsing	1	194.4 MW
10	Rhyl Flats	1	90 MW
Consented offshore wind farms with principal contracts in place			
11	Gunfleet Sands	1	100 MW
12	Greater Gabbard	2	500 MW
Consented offshore wind farms			
13	Scarweather Sands	1	90 MW
14	Teesside	1	90 MW
15	Ormonde	Other	150 MW
16	London Array	2	1 GW
17	Thanet	2	300 MW
18	Sheringham Shoal	2	315 MW

Source: Garrad Hassan and Partners Limited.

The first Round 1 project to be completed was North Hoyle (60 MW), which came into operation in 2004 and was followed by Scroby Sands (60 MW) that same year. Both of these projects were developed by large utilities that used the project to gain early experience in offshore wind. There followed the construction of Kentish Flats (90 MW) and Barrow (90 MW), completed in 2005 and 2006, respectively. The Burbo Bank project (90 MW) in the Irish Sea completed commissioning in the autumn of 2007. At earlier stages of construction were Lynn and Inner Dowsing (194 MW), Robin Rigg (180 MW), and Rhyl Flats (90 MW).[6] Gunfleet Sands (108 MW) was scheduled for construction starting in 2008, with completion planned for 2009.

In total, this will lead to a total installed capacity of 962 MW for Round 1 before 2010, which constitutes approximately two-thirds completion of the original Crown Estate lease sanction some nine years after issue. This slow delivery has resulted in a poor message being sent to the government.

Round 2

The UK Department of Trade and Industry (DTI) produced a framework document in 2002 entitled "Future Offshore" [133], in which plans were set out for the development of offshore wind beyond Round 1. Following stakeholder consultation on this document, SEAs were commissioned by the government for three regions identified as promising for development to address broad environmental issues: the Thames Estuary, the Greater Wash, and the North West. Following completion of the first phase of the SEAs, the Crown Estate issued a request for expressions of interest for the second round of offshore wind development in the United Kingdom in February 2003, which was followed by a formal Initiation to Tender in July 2003 [121] to those companies that registered an interest.

Round 2 was designed to be much more ambitious than its predecessor, with no limit on size and with some proposals outside of territorial waters. Of the 70 proposed projects, a total of 15 were granted leases for development. Unlike Round 1, the successful companies were dominated by large utilities and international oil and gas firms.

6. Editor's note: Lynn and Inner Dowsing were completed in July 2008, with full generation achieved in March 2009. Construction of Robin Rigg has been completed, but commissioning of its turbines is still ongoing. Rhyl Flats started partial generation in July 2009.

At the time of writing, the most advanced of the Round 2 projects were in receipt of statutory consents, but none had started construction. About half had yet to submit consent documents.[7]

Although projects are progressing, there is considerable uncertainty over their financial viability, and the allocation of responsibility for timely delivery of a cost-effective grid connection is a pressing matter for most projects. The government has not announced any additional capital support for Round 2 projects. However, the additional support offered to offshore wind through Renewables Obligation Certificate (ROC) banding, as discussed in the section on the United Kingdom in Chapter 3, is likely to stimulate the acceleration of development and construction activity within Round 2.

Construction on at least one of the Thames Estuary Round 2 projects is likely to start before 2010.

Non–Round 1 and 2 Projects

Although the vast majority of offshore wind development within the United Kingdom has centered on the two successive Crown Estate rounds, there are some notable exceptions. In addition to the Blyth offshore project, four other offshore projects have been developed outside of the rounds.

- **Ormonde Offshore Wind Farm**
  Eclipse Energy has submitted a proposal for a ~100 MW wind farm in conjunction with extraction of marginal gas reserves. Consent for the wind farm portion of the project was granted in February 2007.
- **Tunes Plateau Offshore Wind Farm**
  A consortium has developed an offshore wind farm within the waters of Northern Ireland for an up to 180 MW scheme. Following vociferous local opposition to the scheme, one of the project partners, E.ON, pulled out of the project. Since then, it is understood that the scheme has been shelved.
- **Beatrice Offshore Wind Farm**
  The Beatrice Offshore Project is currently in the late stages of construction and consists of two 5 MW wind turbines installed in approximately 45 m of water off the east coast of Scotland. The Beatrice project has received a significant amount of research funding from the European Union, the UK government, and the Scottish Executive.

7. Update: DONG Energy announced in April 2009 that the Round 2 turbine was installed at the Gunfleet Sands Offshore Wind Farm project in the Thames estuary off the east coast of England.

- **Aberdeen Offshore Wind Farm**
  An offshore wind project of up to 115 MW is currently under development in Scotland near Aberdeen by a partnership between the Aberdeen Renewable Energy Group (AREG) and Amec Wind.

Although the Ormonde and Tunes Plateau projects were not granted lease rights under the Crown Estate rounds, they are considered by the DTI to be Round 1 projects and are therefore eligible for Capital Grant support.

Round 3

In December 2007, the Secretary of State for Business, Enterprise and Regulatory Reform, John Hutton, announced a significant expansion for offshore wind, declaring a target total capacity of 33 GW by 2020. In order to begin to address this ambitious target, the Department for Business, Enterprise and Regulatory Reform (DBERR) indicated that a further round of development is likely to be announced in 2008, with leases granted in 2009/10 [122].

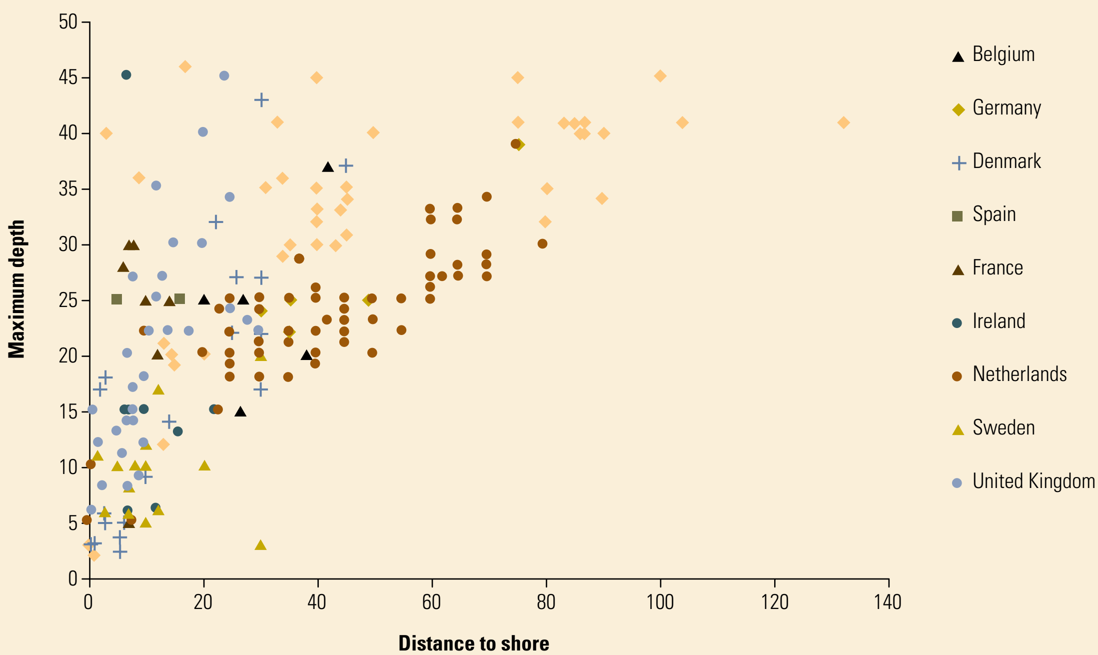
More information on current and future concessionary issues in the United Kingdom is provided in the section on the United Kingdom in Chapter 3.

Comparative Summary

Table 16 provides a brief comparative summary of market development for offshore wind for the five countries considered.

Concerning project characteristics, Figure 9 illustrates project water depth and distance to shore for projects in the key European markets. No distinction is made between operating and planned wind farms, but it is clear that German and Dutch projects are located significantly farther from the coast than those in the other principal countries.

FIGURE 9: PROJECT DEPTH AND DISTANCE TO SHORE



Source: Garrad Hassan and Partners Limited.

TABLE 16: COMPARATIVE SUMMARY—MARKET DEVELOPMENT

Country	Market development summary	Historical pedigree	Future prospects
Denmark	Denmark has led the development of offshore wind technology, with early R&D deployments throughout the 1990s. Construction of the large demonstration projects at Horns Rev and Nysted cemented Denmark's position at the leading edge of the industry. Despite cancellation of offshore projects in the early part of this decade because of political upheaval, the recent announcement of a string of future sites based on long-term strategic spatial planning has reinvigorated offshore wind activity in Denmark.	Good	Good
Germany	Germany has just two offshore wind turbines installed at present, although the potential for massive future deployment is high, with a national aspiration of 25 GW installed by 2030. Currently, 1.8 GW of offshore wind projects are in receipt of all necessary consents to build with a further 4.8 GW awaiting a cable permit.	Poor	Good
Netherlands	The Netherlands played a significant early role in offshore wind with two deployments during the 1990s. This was followed by two demonstration projects (one of which is under construction). A large volume of applications for future projects has been made, although to date their success rate has been poor. The regulatory regime and level of political support are at present considered insufficient to achieve the national target of 6 GW by 2020.	Moderate	Moderate
Spain	Spain has played a major role in the development of onshore wind energy, being the third European country (after Denmark and Germany) to develop significant levels of generating capacity. The presence of several major wind farm developers and wind turbine manufacturers means that, once onshore sites have been developed, there will be a strong impetus to develop offshore projects. With the announcement by the Spanish government of regulatory and tariff regimes for offshore wind, the first steps have been made. However, the prognosis can only be good in the long term, since no Spanish manufacturer has developed an offshore wind turbine. The permitting regime expects the first projects to be built around 2014, and the long-term expansion will require deepwater technology to be developed and proven.	Poor	Good (long term)
United Kingdom	The first deployment of offshore wind in the United Kingdom occurred in 2000, which was followed by the announcement of a first demonstration round of offshore projects comprising ~1.6 GW (18 projects). Of these, four are in operation, with a further six under construction. A second round of schemes was announced in 2003, resulting in 15 site awards comprising ~7.2 GW. The first Round 2 project is likely to be in operation by 2010. A third concessionary round was announced in June 2008.	Good	Good

Note: A poor historical rating in Germany and Spain represents the lack of offshore deployment to date. Of course, the historical success of onshore wind in Germany should be considered when looking forward to offshore deployment.

Source: Garrad Hassan and Partners Limited.

3

Targets and Incentives

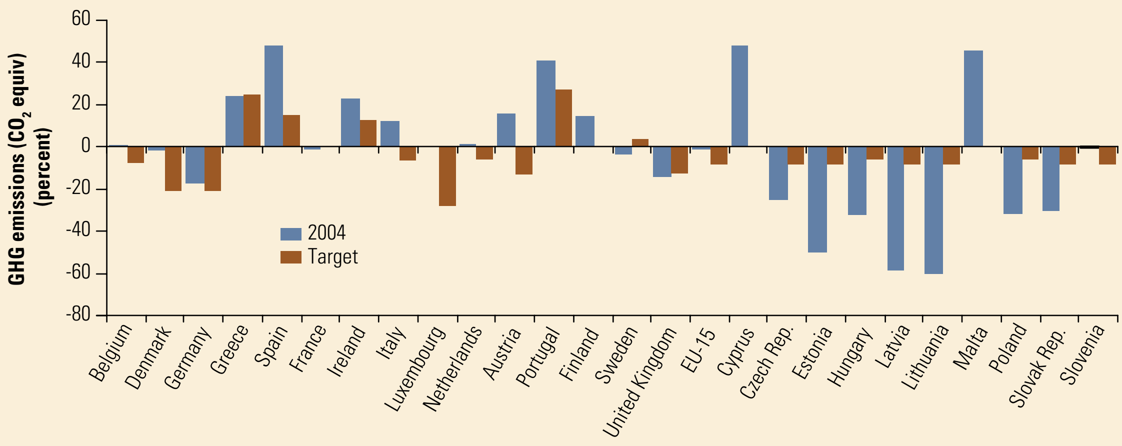
This chapter explores the overall national RE deployment targets for each of the national markets of interest. The international commitments and national policy initiatives driving these targets are also discussed. Specific targets for offshore wind technology are discussed, as is the likelihood of achieving these in each case.

National incentive schemes for RE production are discussed, as well as any specific provision of wind energy and/or offshore wind energy. Any firm future plans for the revision or replacement of these schemes are also outlined for each country.

The European Union

The prospects for offshore wind energy within the European Union are dependent on how the strategic objectives of reducing dependence on imported energy and reducing greenhouse gas (GHG) emissions are implemented at a national level. Hence, success will depend on the specifics of the directives, in particular the level of target assigned to each country, the strength of the legislation, the response at a national level, and the availability of different types of RE in each country.

FIGURE 10: GREENHOUSE GAS EMISSION REDUCTION TARGETS ACROSS EUROPE



Note: Target refers to average emissions during 2008–12 compared with the respective base year. Values exclude a Kyoto Mechanism adjustment.

Source: Garrad Hassan and Partners Limited.

TABLE 17: GREENHOUSE GAS EMISSION REDUCTION TARGETS ACROSS EUROPE (ORIGINAL AGREEMENT; EU 15 COUNTRIES)

Country	2008–12 target (%)	2004 actual (%)
Belgium	-7.5	0.7
Denmark	-21.0	-1.7
Germany	-21.0	-17.5
Greece	25.0	23.9
Spain	15.0	47.9
France	0.0	-0.8
Ireland	13.0	22.8
Italy	-6.5	12.1
Luxembourg	-28.0	0.0
Netherlands	-6.0	1.6
Austria	-13.0	15.7
Portugal	27.0	40.8
Finland	0.0	14.5
Sweden	4.0	-3.6
United Kingdom	-12.5	-14.1
European Community	-8.0	-0.9

Note: Target refers to average emissions during 2008–12 compared with the 1990 base year. Values exclude the Kyoto Mechanism adjustment.

Source: [23].

Two principal directives are of relevance to RE, including offshore wind:

1. That requiring reductions in GHG emissions [36]
2. That requiring increase in use of RE as a percentage of total energy used [35] draft of revised directive [29].

Greenhouse Gas Emissions

Tables 17 and 18 and Figure 10 illustrate the currently applicable target reductions in GHG emissions for each of the original countries in the burden-sharing agreements, together with the progress achieved at the end of 2004. It is worth noting the following:

TABLE 18: GREENHOUSE GAS EMISSION REDUCTION TARGETS ACROSS EUROPE (ADDITIONAL AGREEMENT; SELECT EU 10 COUNTRIES AND MALTA AND CYPRUS)

Country	2008–12 target (%)	2004 actual (%)
Cyprus	No target	48.3
Czech Republic	92.0	-25.1
Estonia	92.0	-50.0
Hungary	94.0	-32.0
Latvia	92.0	-58.7
Lithuania	92.0	-60.1
Malta	No target	45.5
Poland	94.0	-31.6
Slovak Republic	92.0	-30.3
Slovenia	92.0	-0.5

Note: Target refers to average emissions during 2008–12 compared with the respective base year. Values exclude a Kyoto Mechanism adjustment.

EU 10 refers to the 10 former communist countries in Central and Eastern Europe. These are Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia.

Source: [23].

- Targets were set through negotiation among the member countries, and the levels depended on the particular circumstances in each country, including relative wealth, absolute levels of emissions, ease of achieving reductions, and strength of the desire within the country to reduce emissions.
- In 2004, Germany, Greece, and the United Kingdom were the only countries that appeared to have a realistic chance of meeting their respective targets.
- Countries with relatively high per capita emissions include Belgium, Finland, Ireland, Luxembourg, and The Netherlands, which reflects, among other factors, level and type of industrialization, source of electricity generation, and general wealth.
- Countries with relatively low per capita emissions include France, Italy, Portugal, Spain, and Sweden.

With the period 2008–12 covered by the Kyoto Agreement approaching its end, attention is now turning to the post–Kyoto Agreement. The European Union is proposing a new, more ambitious target of a 20 percent reduction (once more with respect to the 1990 base level) in GHGs continent-wide by 2020 [30].

Renewable Energy

As can be seen, the recently published draft targets for RE are both challenging and impressive (Table 19 and Figure 11). The countries assessed within this study are highlighted in bold text. The following should be noted about these targets:

- They refer to total energy and not just electricity usage.
- They are measured in terms of "Final Consumption of Energy."
- The targeted rise in use of renewable energies is unprecedented.

Examining the national targets in greater detail, the following can be seen:

- Tremendous variation exists between the use of renewables in different countries. In general, some Baltic and Eastern European countries have higher penetrations. The countries lying in the extremes at the other end include Belgium, Ireland, The Netherlands, and the United Kingdom.
- The growth targets vary significantly as well. Among the most challenging are the following:
    - The United Kingdom is expected to increase the penetration by 13.7 percentage points, a factor of 11.5 over the current level.
    - Denmark is targeted to increase its use of RE by 13 percentage points, from eighth to sixth in the ranking—hence a relatively substantial effort.
    - Spain currently sources relatively little of its energy from renewables in spite of its leading position in both wind and solar energies. The low penetration reflects the difficulty of developing bioenergies in hot, dry climates, although the target specifies an increase of 11.3 percentage points, which will more than double the presence of renewables.
    - In spite of Germany's prominence in most RE technologies, in fact it sources currently less than 6 percent of energy from renewable sources, which should increase by a factor of 3.

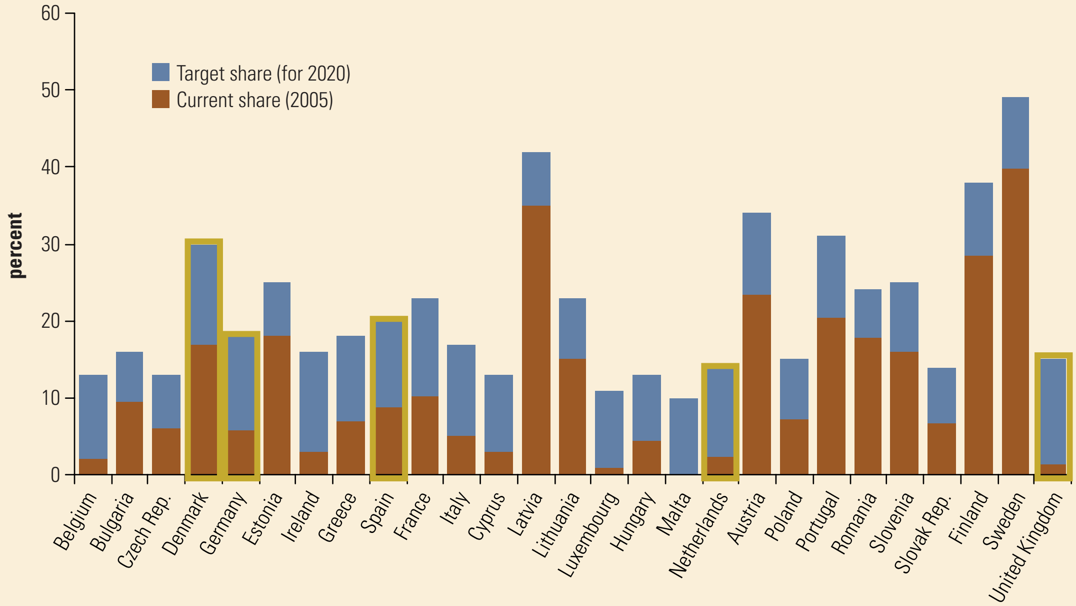
TABLE 19: DRAFT TARGETS FOR NATIONAL RENEWABLE ENERGY IN EUROPE

	RE share of total energy (%)			RE share of total energy (%)	
Country	2005	2020	Country	2005	2020
Belgium	2.2	13	Luxembourg	0.9	11
Bulgaria	9.4	16	Hungary	4.3	13
Czech Republic	6.1	13	Malta	0.0	10
Denmark	**17.0**	**30**	**Netherlands**	**2.4**	**14**
Germany	**5.8**	**18**	Austria	23.3	34
Estonia	18.0	25	Poland	7.2	15
Ireland	3.1	16	Portugal	20.5	31
Greece	6.9	18	Romania	17.8	24
Spain	**8.7**	**20**	Slovenia	16.0	25
France	10.3	23	Slovak Republic	6.7	14
Italy	5.2	17	Finland	28.5	38
Cyprus	2.9	13	Sweden	39.8	49
Latvia	34.9	42	**United Kingdom**	**1.3**	**15**
Lithuania	15.0	23			

Note: At the time of writing, the national RE targets were in draft form. Directive 2009/28/EC was officially agreed on in April 2009 and was published on June 5, 2009, in the official journal. The list of individual country targets is available in Annex 1 of the Directive, which can be downloaded at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF.

Source: [29].

FIGURE 11: NATIONAL RENEWABLE ENERGY TARGETS ACROSS EUROPE



Note: This compilation was a draft at the time of writing.
Source: [29].

- The Netherlands is in a similar position to the United Kingdom with low current usage of RE, including wind. It also has an impressive target of increasing usage, by a factor of almost 6 or 11.6 percentage points.
- Also of interest to offshore wind are Belgium, Finland, France, Ireland, and Sweden.
- Of lesser interest because of its small size, but worth noting, is Malta. It currently has no RE at all and limited space for onshore RE, but is targeted to reach 10 percent.

Denmark

Energy Policy

It is the responsibility of the DEA to lay down guidelines for the best possible production and distribution of energy, while considering such issues as security of supply, cost efficiency, and international commitments. By means of feasibility studies, cross-cutting analyses are performed in order to establish the way in which a given objective can be fulfilled in the most flexible and cost-efficient manner.

Since the first oil crisis in 1973, energy policy has occupied a relatively significant position in the political debate in Denmark. The DEA was established in 1976, primarily as a reaction to the problem of security of supply, but gradually the focus also was brought to bear on domestic energy production (for example, North Sea oil and gas and RE), on energy supply and distribution (such as the natural gas grid, and combined heat and power, or CHP), and on energy savings (such as insulation and labeling schemes). In addition, international sustainability targets—not least the reduction of CO_2 emissions—and economic considerations have had a significant role to play in recent years, during which the DEA has administered, for example, subsidies for energy savings and green energy taxes, liberalization of the electricity and gas markets, and introduction of CO_2 quotas.

Renewable Energy Policy before 2001

The main objective is to phase out the use of coal by 2030 [43]. RE and gas were the main instruments chosen to achieve this goal. Offshore wind was expected to grow to150 MW (projections were based on 1997 figures not imagining the fast growth in turbine size). In 2001 there was a change in government, and offshore wind was put on hold until 2006.

Renewable Energy Policy after 2001

An energy policy report is submitted each year to the Danish Parliament; the latest is from 2007 [45]. Based on this, the following observations are made in relation to RE in Denmark.

The promotion of renewable sources of energy is a crucial aspect of the government's future vision of fossil fuel–free energy supplies. Today, the primary sources of RE are wind and biomass. A great deal of electricity and heating is also produced from waste, which is a valuable resource that would otherwise be lost.

Wind power technology plays a crucial role in current RE supplies, and is undergoing constant development. Thus, there are many indications that wind power will continue to make a very important contribution to Danish energy supplies, and allowances must be made for this when drawing up plans for the future energy infrastructure. As a result, the government appointed two committees earlier—one to examine the future location of offshore wind turbines [42] and the other to plan future onshore wind turbines.

In recent years, the government has implemented a number of specific initiatives to reform subsidy schemes and promote the increased application of market mechanisms in the RE area, under which public subsidies for RE will be applied considerably more efficiently in the future than is the case today.

The government is seeking to set up a flexible and efficient model for ensuring conversion to RE while at the same time ensuring that such conversion is underpinned by efficient and competitive energy markets.

In its proposed "Visionary Danish Energy Policy 2025" [46], the Danish government proposes the following measures: reforming and enhancing the efficiency of the subsidy system for promoting the use of RE. The present RE subsidy scheme (Public Service Obligation; PSO) must be reformed to reduce the unit cost of RE below today's level.

The government's long-term vision involves the following main components:

- Promoting the most possible RE for the available (monetary) resources
- Increasing the use of tenders and encouraging as much competition as possible
- Increasing the transparency and predictability of subsidy levels
- Promoting biogas use: The government wishes to promote the use of biogas, which could contribute to reducing the consumption of fossil fuels and emissions of the GHG, methane, and solve a waste disposal problem for the farming industry.
- Promoting wind energy through strategic planning: The government will seek to establish a good framework for Danish wind capacity, including through the promotion of onshore and offshore demonstration and trial sites and the drawing up of an infrastructure plan for offshore wind turbines.
- Improving the exploitation of energy from waste: The government will work to promote the use of the increasing amounts of waste in central power stations for the highly efficient combined generation of power and heating.
- Rationalizing the levy system to promote the cost-effective use of RE: The government wishes to promote the cost-effective reduction of CO_2 emissions by ensuring that the incentives for reducing the burning of fossil fuels are in principle uniform within and outside of the quota subject sectors. The government will draw up specific proposals.
- Promoting the use of more heat pumps for households: The government wishes to initiate a campaign aimed at promoting the use of energy-efficient heat pumps as replacements for worn-out, oil-fired boilers.
- Increasing flexibility in the choice of fuels: The government will continue to promote liberalization of the current rules for the use of fuels for the generation of electricity and heating, so as to increase gradually the use of biofuels in combined power and heating generation in a manner that is justifiable from the socioeconomic and energy standpoints.
- Increasing the use of biofuels for transport: The proportion of biofuels used in transport will increase to 10 percent by 2020. The government is ready to set up partial targets earlier than 2020, provided that technologies that are adequately socioeconomically competitive and environmentally sustainable have been developed.
- Providing tax exemption for hydrogen-powered cars: With a view to promoting the conversion of energy consumption in the transport sector from fossil fuels to alternative fuels, the government will exempt cars powered by hydrogen from tax.

These initiatives will be assessed and supplemented or replaced by additional initiatives following the regular reappraisal of the energy strategy every four years.

The agreement of February 2008 covering the period 2008–12 focuses on the following [52]:

- Increase of wind energy capacity, partly onshore but mostly offshore, encouraged with bigger incentives
- Increase of biomass usage by bigger incentives
- Increase of heat pump usage
- Special support for development of solar photovoltaics (PV) and wave energy
- Reduction in total energy consumption by provision of incentives to encourage energy saving.

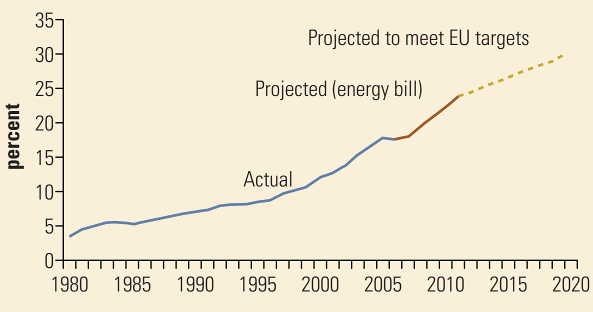
International Commitments

Denmark is a signatory to and has ratified the Kyoto Protocol. In addition, the Danish government signed up to the EU Energy Policy for Europe at the spring summit on March 8–9, 2007, which committed the 27 member states to a reduction of CO_2 emissions of 20 percent by 2020 (referenced to 1990 levels).

In addition, the Danish government helped to formulate and is a key supporter of the Copenhagen Strategy on Offshore Wind [47], which sets out a blueprint for the development of a European Union–wide framework for the successful deployment of offshore wind technology.

One of the main provisions of the EU policy plan is the target of 20 percent of all energy consumption to be supplied from renewable sources by 2020. Denmark currently has set a national contribution of 30 percent by 2025. However, the new draft EU Energy Policy for Europe of January 2008 sets a target for Denmark of sourcing 30 percent of all energy from renewable sources by 2020 (Figure 12).

FIGURE 12: DEVELOPMENT IN RENEWABLE ENERGY USE IN DENMARK AS PERCENTAGE OF TOTAL ENERGY CONSUMPTION



Source: [52].

Denmark plans to meet part of the Kyoto Protocol commitments through Joint Implementation (JI) and Clean Development Mechanism (CDM) projects, specifically in Eastern Europe [53]. However, financial support to wind farms has been provided elsewhere, including China [55] and Egypt [54].

Incentives for Wind Turbines

Subsidies for wind turbines depend on the date that each machine is connected to the grid and the age of the machine.

Turbines bought before the end of 1999 are eligible for a subsidy that, together with the market electricity price, ensures a tariff of DKK 0.60 per kWh until the full load hour allowance is used up, and thereafter DKK 0.43 per kWh until the turbine is 10 years old. A premium of DKK 0.10 per kWh until the turbine is 20 years old is subsequently eligible. The premium is regulated in accordance with the market price, since the total of the two must not exceed DKK 0.36 per kWh.

Turbines connected to the grid in the period 2000–02 are eligible for a subsidy that, together with the market electricity price, ensures a tariff of DKK 0.43 per kWh for 22,000 full-load hours. A premium of DKK 0.10 per kWh until the turbine is 20 years old is subsequently eligible. The premium is regulated in accordance with the market price, since the total of the two must not exceed DKK 0.36 per kWh.

Turbines connected to the grid in the period 2003–04 are eligible for a premium of DKK 0.10 per kWh until the turbine is 20 years old. The premium is regulated in accordance with the market price, since the total of the two must not exceed DKK 0.36 per kWh.

Turbines connected to the grid from January 1, 2005, to February 20, 2008, are eligible for a premium of DKK 0.10 per kWh until the turbine is 20 years old, as well as an allowance of DKK 0.023 per kWh for balancing power costs.

Turbines connected to the grid from the February 21, 2008, are eligible for a premium of DKK 0.25 per kWh 22,000 full-load hours and after this period DKK 0.10 per kWh until the turbine is 20 years old, as well as an allowance of DKK 0.023 per kWh for balancing power costs.

It should be noted that additional installed capacity in Denmark onshore has been very limited since 2002, because the tariff provided insufficient income. There has been a limited level of activity concerning repowering (replacement of the oldest wind turbines with new models) because that tariff is marginally more attractive.

Offshore wind farms financed by electricity utilities or subject to tender are subsidized according to separate rules following the principle mentioned below:

- Plant owners are responsible for the sale of production on the electricity market and for related costs.
- Owners are eligible for a subsidy that combined with the market price comprises DKK 0.453 per kWh. The subsidy is payable for 42,000 full load–equivalent hours.8 If production is subject to a grid tariff, it is eligible for additional compensation of up to DKK 0.007 per kWh.
- Once the specified full load–equivalent hours have been generated (typically 10 years), a premium of up to 0.10 DKK per kWh can be paid until the turbine is 20 years old. The premium is regulated in accordance with the market price, in that the total tariff must not exceed DKK 0.36 per kWh.
- Grid connection is provided by the grid utility at no cost to the project (see the section, Grid Access, in Chapter 4).

The number of full-load hours and the price for these are subject to negotiation or competitive tender for each offshore wind farm.

- For the first two projects (Horns Rev and Nysted), the tariff was set at the designated offshore rate of DKK 0.453 per kWh, but the applicable period was extended to 42,000 full load–equivalent hours following negotiation on a cost-plus basis.
- For the subsequent pair of projects (Horns Rev 2 and Nysted 2), the tariff was determined by a competitive bidding process, the winning bids being DKK 0.518 per kWh for 50,000 full load–efufudquivalent hours at Horns Rev 2 and DKK 0.629 per kWh for 50,000 full load–equivalent hours at Nysted/Rødsand 2 (note that the original bid for Nysted/Rødsand 2 was DKK 0.499 per kWh [8], but the successful bidder abandoned the project because the general increase in capital expenditures damaged its financial viability).

Where the wind farm is *not* following the government Action Plan, the grid connection must be paid by the developer.

8. Full load-equivalent hours (unit of energy): number of hours to generate energy, assuming that the turbine operates continuously at rated power. That is, 1,000 hours generating at 50 percent of rated capacity produces 500 full load–equivalent hours.

Where the wind farm is not following the site selection and timing specified in the government Action Plan [42], that is, the project is being submitted under the "Open Door Principle," the grid connection must be paid by the project developer, and the tariff will be set at the same level as for onshore wind farms.

Expectation for Revision of Incentives

The ongoing negotiation at the government level about the future incentives for wind is not expected to change the incentives for offshore wind. That is, the price will be negotiated through competitive tender based on the model described above.

For onshore turbines, a compensation of DKK 0.20 per kWh on top of the market price for electricity is expected for the first 25,000 full-load hours [50].

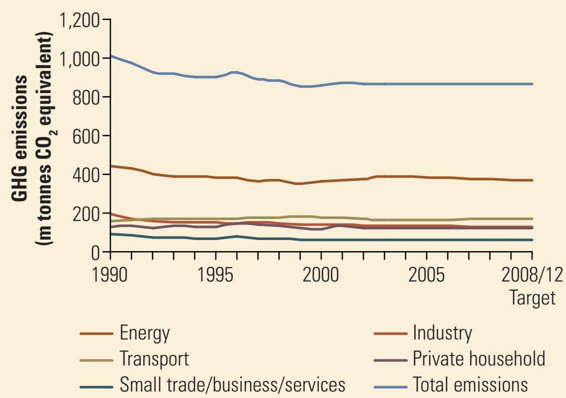
Germany

Germany has one of the most ambitious RE targets in Europe, underpinned by broad and steady support within the population to increase the use of RE. This is driven by a cocktail of factors, some emotional, ranging from an antinuclear sentiment and concerns over global warming to concerns for security, reliability, and availability of energy supplies. The success of German industry in the field of environmental technology and the consequent economic benefits that can be reaped now and in the future also play an increasingly important role in the political decisions.

Under the Kyoto protocol [20], Europe agreed to reduce emissions by 8 percent, although Germany's individual contribution is significantly higher, reflecting (a) the wealth of the country, (b) the maturity of the economy, (c) the high per capita emissions, (d) the inevitable reduction in emissions in eastern Germany that accompanied the modernization of industry there, and (e) the great importance placed on environmental issues in general within the country. Germany has committed to reducing GHG emissions by 21 percent between 1990 and the 2008–12 period [36]. In the early years, Germany's emissions diminished rapidly, from the 1990 value of 1.248 billion tons of CO_2 equivalent, and appeared to be on target to reach the goal of 1.017 billion tons of CO_2 equivalent. However, the acceleration in growth of the German economy at that time is likely to have resulted in some increase in emissions; hence the need for additional efforts [23]; [24]. It can be argued that increased general national economic well-being does allow greater political leeway for additional funds to be found, and the presence of the two main political parties in the coalition government reduces the risks of future political U-turns.

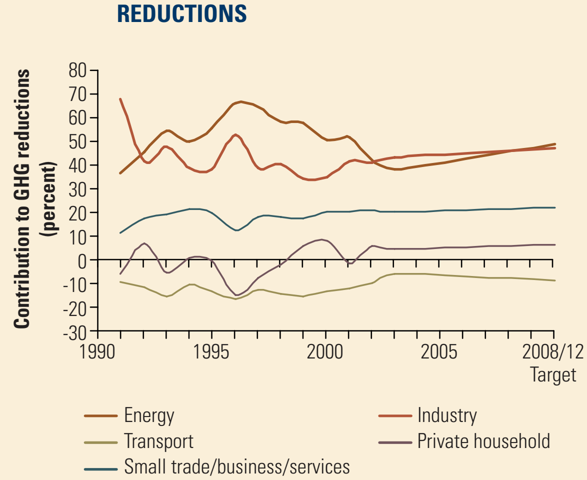
The first National Climate Protection Programme was established in October 2000 [67]. It set a national goal of a 25 percent reduction in CO_2 by 2005—in fact more ambitious than the Kyoto target, although it focuses on a single gas. The review five years later reported that the 2003 GHG emissions were 18.5 percent down from the 1990 figure, hence within reach of the Kyoto target, although not of the national goal, with energy and industry contributing the most toward achieving this (Figures 13 and 14) [68]. Under the second National Climate Protection Programme, the energy and industry sectors are jointly expected to achieve most of the further reductions in emissions necessary to meet the Kyoto target of around 21 million tons CO_2-equivalent, as well as compensate for a projected rise in emissions from the transport sector. The expectation is that the flexibility allowed by emissions trading will ensure that the targets are met, since renewables, including offshore wind, are not expected to expand fast enough within the 200812 timeframe. These GHG emission targets were an important reason behind the 2010/11 deadlines for the offshore wind energy support mechanisms, although it is now evident that offshore wind will not be able to contribute significantly toward meeting this specific target. However, subsequent emissions targets are certain to be even more stringent and the availability of alternative policies limited; hence the resulting extension and expansion of support for offshore wind.

FIGURE 13: GHG EMISSIONS



Source: [68].

FIGURE 14: CONTRIBUTION TO CO_2 EMISSIONS REDUCTIONS



Source: [68].

The total annual savings of CO_2-equivalent emissions by RE is estimated to be around 101 million tons, with wind energy contributing around 26 million tons of CO_2-equivalent [69]—around 11 percent of the total reduction needed and hence clearly a significant contributor to reaching the Kyoto targets. Wind energy now makes a larger contribution to CO_2 emissions reductions than hydropower, although outside the electricity sector biomass continues to have the greatest impact overall.

Hence, it can be expected that support for RE, in particular wind both on-land and offshore, will continue. For example, the new European Energy Policy calls for a target of 20 percent of all energy to come from renewables by 2020 [26]; [27], an increase over the targets of 12 percent by 2008/12 set in 2001 [35]. In parallel with this, the revised EU objective for reducing GHG emissions in developed countries is 30 percent by 2020 rising to the 60–80 percent by 2050, with a commitment of 20 percent by 2020 for the European Union as a whole.

For Germany, the long-term national target for RE is now 50 percent of primary energy by 2050 [86]. In the shorter term, targets are much less certain, in particular for offshore wind energy, since it is not clear yet exactly when construction will commence in a major way. However, projections published by BMU in 2009 suggest around 1,500 MW by 2011 and 20–25 GW by 2030. This would supply between 85 and 100 TWh per year, or around 15 percent of today's national electricity demand [66].

To facilitate this, Germany has one of the world's most successful financial support schemes for RE in the amount of electricity supplied for the marginal cost to the public [3]; [22]; [11]. The regulations have evolved over the years. The key stages of the development since 1991 are summarized in Table 20, with the gradual reduction of the wind feed-in tariff illustrated in Figure 15.

Following the revision of the EEG in 2004 [60], the *theoretical* basic offshore wind tariff was €c6.19 per kWh, with an additional premium payable (of €c2.91 per kWh) for projects commissioned before the end of 2010 providing a total payment of €c9.1 per kWh. A number of other conditions applied, which are described below, although this offshore wind tariff can be termed *theoretical*, since it is likely that no offshore wind farms will be commissioned before it is superseded, with the possible exception of the first phase of Alpha Ventus. However, the form of structure was essentially maintained within the 2009 revision.

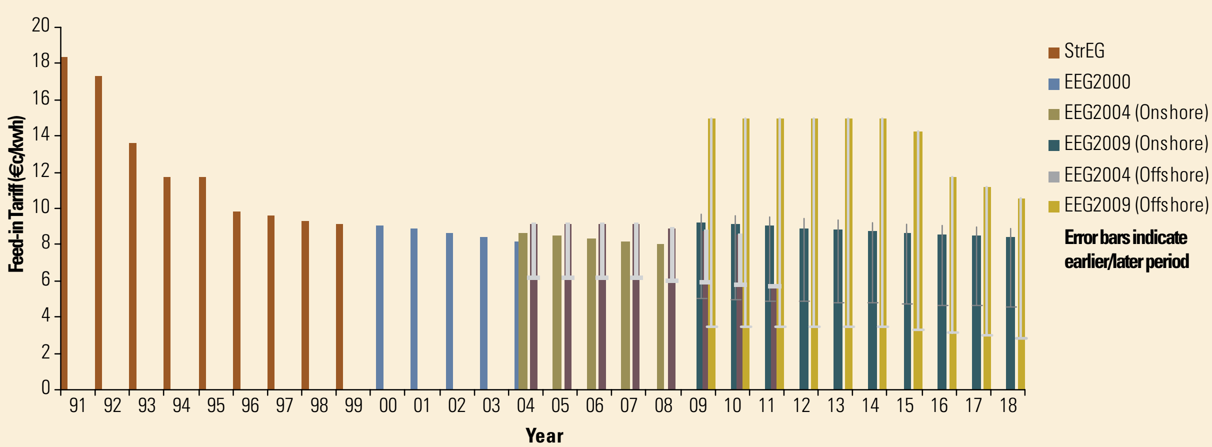
The 2009 revision set the basic offshore wind tariff at €c13 per kWh, with an additional premium payable of

TABLE 20: OVERVIEW OF GERMAN TARIFF LAWS

Date	Law	English translation of law	Comment
1991	Stromeinspeise-gesetzes (StEG)	Electricity Feed Act	Tariff set at 90% of consumer prices
January 1997	Baugesetz-buches	Change to Building Code	Smoothes planning process; wind turbines recognized as being in the public interest
April 2000	Erneuerbare-Energien-Gesetz (EEG)	Renewable Energy Act	Annual reduction in tariff of 1.5%; applicability of 9 years [59]
August 2004	EEG modified	Small one-off reduction in tariff, annual reduction of 2% from 2008 in the case of offshore wind, higher rate applicable for minimum of 12 years [60]	
December 2006	Infrastrukturplanungsbeschleunigungsgesetz	Infrastructure Planning Acceleration Law	Utility responsible for on- and offshore transmission cable[61]

Source: Garrad Hassan and Partners Limited.

FIGURE 15: FEED-IN TARIFF



Source: Garrad Hassan and Partners Limited.

€c2 per kWh for projects commissioned before the end of 2015 providing a total payment of €c15 per kWh for the first offshore wind farms. This tariff is only applicable to projects at least three nautical miles from the coast[9] and will be paid for a limited period, a minimum of 12 years, after which the payments will be reduced to the basic tariff of €c3.5 per kWh. To support projects farther from the coast and in deeper water, the 12-year stage will be extended by half a month for each nautical mile beyond the 12 nautical-mile boundary and by 1.7 months for each additional full meter in depth beyond 20 m on a turbine-by-turbine basis. Other conditions are a 5 percent reduction per year after 2014 and that the premium will not be payable in nature conservation zones or bird protection zones [60].

The history of offshore wind tariffs leading to the current status is summarized in Table 21 and Figure 15.

The most recent improvement in incentives has been the decision to socialize the offshore grid costs by the transmission system operators (TSOs) for projects within the EEZ where construction commences before the end of 2011 [61]. This will have a major impact on project finances, reducing the capital costs by around 30 percent with the income remaining the same. The decision appeared to trigger a number of sales of offshore wind projects, which suggests that the incentives may finally now be at a sufficient level.

9. Coastline defined by maps No. 2920, "Deutsche Nordseeküste und angrenzende Gewässer," edition 1994, XII., and No. 2921, "Deutsche Ostseeküste und angrenzende Gewässer," edition 1994, XII; scale 1:375.000.

The EEG undergoes review and revisions at regular intervals. Discussions on the future strategy continue and, given the number of interest groups and decision makers competing to influence the final outcome, the final decision is hard to predict. For example, the 2009 EEG [71] differs from the initial proposals [70]. However, to date it can be argued that the modifications to the production incentives and support schemes have tended to be broadly appropriate and proportionate to the requirements of the industry at that time. Although it is not known whether any particular recommendations will be realized, there is confidence that incentives will be maintained at an appropriate level.

The Netherlands

International Commitments

The Dutch contribution to the European Union Kyoto Protocol [20] commitments is an unambitious 6 percent reduction of GHG emissions between the 1990 and the 2008/12 accounting period [36]. The Netherlands aims to achieve this through both energy savings and RE, inside and outside The Netherlands (for example, through Joint Implementation and CDM instruments).

TABLE 21: OFFSHORE FEED-IN TARIFF

Tariff	Operational	Earlier period years 1–12[a]	Later period years 12–20a
Current (EEG 2004) [60]	2008	€c6.19 + €c2.91 premium = €c9.10	€c6.19
	2010	€c5.83 + €c2.74 premium = €c8.57	€c5.83
Previous BMU Proposals [70]	*2010–13*	*€c11–14 reduction 5–7% per year*	€c3.50
Draft Revised Law [71]	…–2013	€c14	€c3.50
	2014	€c12	
	2015–…	€c11.4, etc. i.e., reduction 5% per year	
Forthcoming EEG 2009 Law passed by German Bundestag June 6, 2008, [71] in conjunction with [81], legally valid from January 1, 2009	…–2014	€c13 + €c2 = €c15	€c3.50
	2015	(€c13*95%) + (€c2*95%) = €c14.25	€c3.50*0.95 = €c3.33, etc. i.e., reduction of 5% per year
	2016–…	€c13*95%*95% = €c11.73, etc.; i.e., reduction of 5% per year	

a. Additional 0.5 month per full nautical mile beyond 12 nm plus additional 1.7 months per full meter water depth beyond 20 m.

As elsewhere, energy policy in The Netherlands undergoes regular review and is likely to change further in the coming years, in particular in response to any international agreements that will follow the Kyoto Protocol and in response to the 2020 RE target that the European Union is in the process of setting.

National Targets for Renewable Energy

The Netherlands has targets with respect to the proportion of total energy that should be derived from renewable sources (which can include ground source heat and biomass) by 2010 and 2020, which are 5 percent and 10 percent, respectively. Since much RE comes in the form of electricity, it is expected that that share will be higher, at around 9 percent, in 2010. In 2006, the contribution of renewables to electricity production was 6.5 percent, with wind providing 2.36 percent [8].

The target for onshore wind power capacity is 1,500 MW by 2010, which was passed during 2007. Hence, this figure could be seen as much as a cap as a goal, which illustrates the *relative* lack of commitment in the country to onshore wind energy. The reasoning usually follows arguments about the small size and high population density of The Netherlands, although the northeast, which is relatively unpopulated by Dutch standards, has very few wind farms, certainly fewer than immediately across the border in northwestern Niedersachsen in Germany. The consequences are that the main focus of future policy has and will remain offshore.

Specific Offshore Wind Target

A target of 6,000 MW of offshore wind energy capacity by 2020 has been articulated by the Dutch authorities since 2001 [9], this being the third highest goal in Europe, following Germany and the United Kingdom. Wind resources in the Dutch sector of the North Sea are very good, and there is sufficient space to extend this in the future, in spite of heavy demands from shipping.

Incentives

Historically, incentives for electricity production from offshore wind have been provided in up to three forms in The Netherlands [101]:

- As a fixed, feed-in tariff to top up the market price for power, Milieukwaliteit Elektriciteits Productie (MEP)
- Exception from ecotax, REB 36i (discontinued)
- As tax benefits, Energie-Investerings-Aftrek, *Energy Investment Deduction*. [106]

The total value of the incentives has gradually risen to €97/MWh since January 2005. They were initially set at €68/MWh from July 2003 and then fell slightly before gradually rising at the six-monthly revision to €67/MWh, then to €68/MWh before reaching the current figure, which has been stable for three years now [90]. Developers, however, need to ensure that they apply when there are funds available in the budget. At least twice, the scheme has been temporarily terminated when that year's budget was used up—on May 10, 2005, and August 18, 2006. The level of the subsidy varies between technologies, and onshore wind receives less, currently €65/MWh for the first 20,000 full-load hours [8]; [91]. The levels are calculated annually from an estimate of current costs and what financial return the government believes investors need [108]. Hence, this is a volatile scheme, and developers need to consider whether the tariff is likely to rise or fall. If, for example, the market price of power has risen during the year, the developer may feel the need to apply immediately, before the incentives are reduced, to compensate.

In the past, offshore wind farms received a similar level of subsidies, but part of it was as tax incentives. The exemption from the ecotax, REB 36i, was initially worth €60/MWh in 2002 [5], but gradually was reduced first to €29/MWh in 2003, then to €15/MWh in mid-2004, and finally was terminated in 2005 [10]. The total value of the incentives was maintained, however, by a compensatory increase in the MEP tariff.

In addition, under the Energy Investment Deduction scheme, investors in RE in The Netherlands were able to obtain a tax exception for 55 percent of the taxable profit [5]. This incentive was used by the investors in the Q7 wind farm, which contributed to the complexity of the financial arrangements and possibly contributed to the high headline capital costs [4].

TenneT is the national grid administrator and TSO in charge of the Dutch high-voltage grid. It is also the administrative body for implementation of the MEP scheme, through its subsidiary EnerQ, with the Minister of Economic Affairs overseeing the expenditure of MEP funds.

Spain

Kyoto Commitments

Because of its particular circumstances, Spain is permitted to increase GHG emissions by 15 percent above the 1990 baseline during the 2008–12 averaging period as part of the Europe-wide agreement to achieve an overall reduction in emissions [23]. The Estrategia Española de Cambio Climático y Energía Limpia (Strategy on Climate Change and Clean Energy) [112] establishes the basis to achieve this target by means of energy efficiency, reducing energy consumption, and generating clean energy. In 2005 GHG emissions were 440.6 million tons of CO_2-equivalent, which means a 52.2 percent increase based on 1990 levels. The reasons for this increase are in part historic: until recently, Spain had been less economically developed than its main European neighbors, but has experienced rapid economic growth in recent years.

Figure 16 shows the evolution of CO_2 emissions.

As a result of this increase, a review of the Spanish Strategy on Climate Change and Clean Energy has been undertaken. As part of this review, called Urgent Measures for the Spanish Strategy on Climate Change and Clean Energy (*Medidas Urgentes de la Estrategia Española de Cambio Climático y Energía Limpia*) [115], a revised goal of limiting the increase of GHG emissions to 37 percent compared with the 1990 levels was set for the period 2008–12. This represents 22 percentile points in higher emissions than the original figure committed to by Spain under the European implementation of the Kyoto Protocol.

Renewable Generation Targets

The Spanish government, in line with European policy, has set the following targets for RE generation for 2010 (*Plan de Energías Renovables 2010*) [114]:

- 12 percent of primary consumption as minimum
- 29.4 percent of electric generation
- 5.75 percent of bio-oil for transportation.

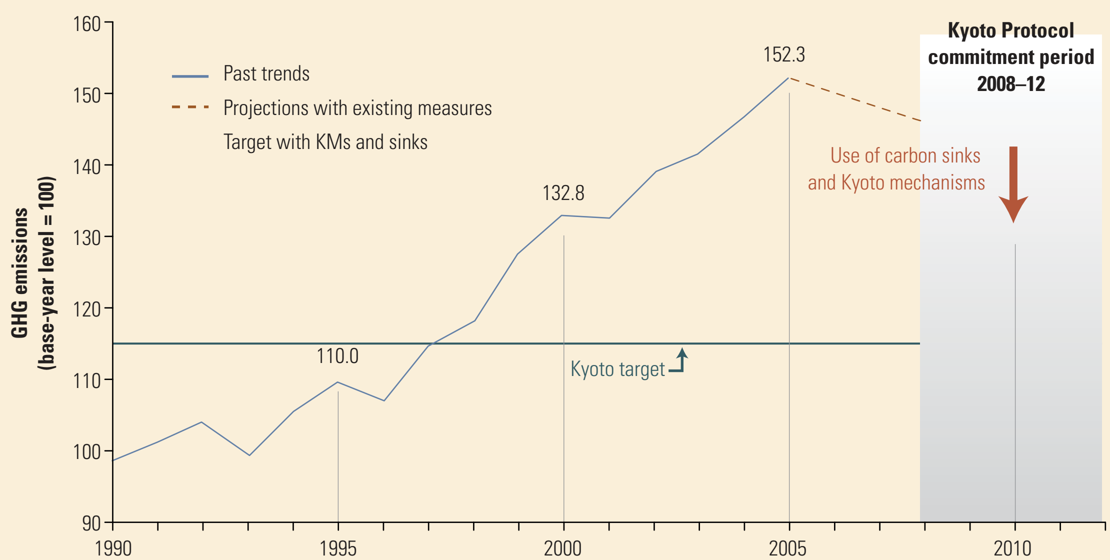
Wind energy is currently the main renewable source of power generation, although biogas and bio-oil contribute to these goals to a minor degree. All other sources have not grown as expected.

Offshore wind energy is considered by the government to be a decisive source of RE for the medium and long term to achieve these and future targets. Currently, no target has been set for this renewable source.

Spain has good reasons to support everything related to renewables:

- Kyoto Protocol
- Huge annual increases in energy consumption
- High energy dependence (80 percent of the energy necessary to cover necessities)
- General concern about climate change and sustainability.

FIGURE 16: GREENHOUSE GAS EMISSION TRENDS AND PROJECTIONS IN EUROPE, 2007



Source: [113].

The national government has responded by including offshore wind in the revised tariffs [116] and establishing a consenting regime for offshore wind farm sites [117]. The main details are as follows:

- Competitive price among applicants for the same site, with a maximum feed-in tariff of €c16.4/kWh
- Minimum project size of 50 MW
- Ministry of Industry, Tourism and Commerce awards construction permit
- Ministry of Environment awards concession
- Details to be included in the application are specified
- Other users are specified and the impact on their rights needs to be assessed
- Procedures for dealing with competing applications for the same site, with a deposit payable of 1 percent of the estimated capital investment at the start of assessment and a further 1 percent payable by the successful applicant
- Application evaluation criteria
- Two-year exclusivity to assess wind resources and undertake environmental studies, with a maximum of one-year extension possible
- Permitted flexibility in the characteristics of the wind farm.

It appears that the tariff has been set sufficiently high to support pilot and demonstration plants, for both the first bottom-mounted projects of the Spanish wind turbine manufacturers and the first floating offshore wind sites. The competitive element in the regulations means that the Cabo de Trafalgar site should be developed at a relatively low cost to the public purse.

The United Kingdom

Policy Drivers

The United Kingdom is a signatory to the Kyoto Protocol, which can be considered the most important international commitment for the UK government in the context of climate change, although it has limited direct relevance to RE in this particular national market. The protocol commits the United Kingdom to reducing a basket of six GHGs by 12.5 percent (compared with 1990 levels) by 2012. Despite a gradual rise in CO_2 emissions since signing the protocol, the United Kingdom is on course to meet the Kyoto target largely because of a move away from coal-fired to gas-fired electricity generation throughout the 1990s.

From the point of view of RE, perhaps a more important recent development was the agreement in February 2007 of all 27 EU states to cut CO_2 emissions by 20 percent before 2020. This overall binding target is to be achieved through more stringent cuts on developed countries to allow the economic impact of the cuts to be mitigated for less developed countries. In this context, the United Kingdom has committed to a 30 percent reduction in CO_2 emissions by 2020 (based on 1990 levels). This constitutes a very challenging target for the United Kingdom and is broadly expected to require a substantial shift in the electricity generation framework away from carbon-intensive technologies.

Another important recent legislative driver in a longer-term timeframe is the UK government's Climate Change Bill, which was published in draft form in March 2007. As it stands, the bill will commit the United Kingdom to cutting CO_2 emissions by 60 percent before 2050 (again referenced to 1990 levels). It also includes an intermediate target for 2020, which is in line with the EU agreement described above. An important assumption of the Climate Change Bill is that the United Kingdom may purchase emissions reductions from overseas, if necessary, to contribute toward meeting the targets. However, in general the draft bill is an indication of the UK government's commitment to cutting carbon emissions substantially in the coming decades.

In December 2007, the government announced a new target specifically for offshore wind of a total installed capacity of 33 GW by 2020. Although currently not tied to the primary mechanism for encouraging the expansion of RE generation (the Renewables Obligation), the new target will pave the way for future rounds of site awards.

The Renewables Obligation

The Renewables Obligation (RO) was implemented in Britain in 2002 as the primary mechanism for achieving the UK government's target of 10 percent renewables-generated electricity before 2011. It has been sanctioned in law by the Renewables Obligation Order 2002 [134]. A further order in 2005 extended the RO to a level of 15.4 percent by 2016.

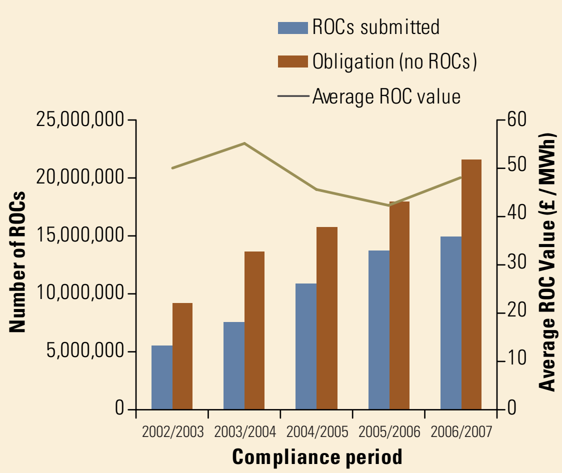
The RO places an obligation on electricity suppliers to source an increasing percentage of their demand from eligible renewables. Suppliers must prove compliance through purchase or generation of ROCs. These certificates are issued to licensed generators at the rate of 1 ROC per MWh of RE produced. Currently, there is no technology banding or differential, and hence on its own it favors the cheaper RE technologies—currently onshore wind.

An alternative to procuring ROCs to meet an electricity supplier's RO is to pay the "buyout" price, which for a recent "compliance period" (2006/7) was £33.24 per MWh and for the most recent compliance period (2007/8) was £34.30 per MWh. This price is linked to the retail price index (a national measure of inflation) and is revised annually. All such payments feed into the buyout fund that is redistributed (or "recycled") to licensed ROC producers in proportion to their RE contribution to the RO in the given compliance period.

The price of a ROC is the driving force behind the market for renewables in the United Kingdom. Factors determining the price of a ROC are the buyout price and the so-called recycle benefit, as well as the scale of renewables deployment in any given year. Electricity suppliers can opt to meet their obligation by paying the buyout price, and the funds accrued in this way are paid to suppliers complying through purchase of renewables. The less the obligation is met through bona fide renewables, the more a ROC is worth, and vice versa.

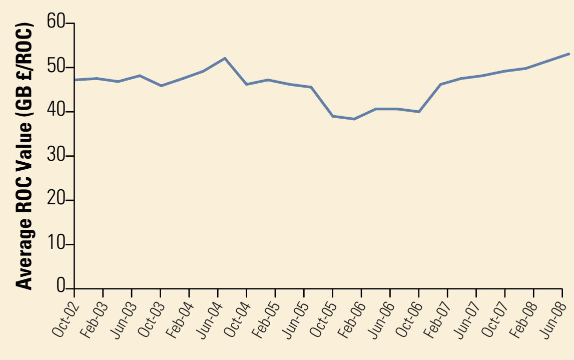
Figure 17 presents an overview of the performance of the RO to date with the overall obligation, compliance to that obligation, and the average ROC value (to the electricity supplier) plotted against the four compliance periods completed to date. As can be seen, the level of compliance is in the range of 60–75 percent, which serves to keep the ROC value relatively high and stable throughout this period.

FIGURE 17: AVERAGE ROC VALUE AND RO COMPLIANCE, 2002/3–2006/7



Source: Garrad Hassan and Partners Limited.

FIGURE 18: AVERAGE ROC SALE PRICE AT AUCTION, 2002–08



Source: Non-Fossil Purchasing Agency.

As well as the annual recycling of the buyout fund, quarterly auctions of ROCs are held by the Non-Fossil Purchasing Agency offering the opportunity for electricity suppliers to buy ROCs rather than opting for the buyout route. Figure 18 presents the average ROC sale price achieved at the 20 ROC auctions that have taken place to date under the RO. As can be seen, to date the market price of the ROCs has remained relatively stable.

As the obligation nears its target, and as more projects develop, the value of ROCs from a project drops as it becomes a buyers' market. Because of this effect, and the general uncertainty surrounding the nature of the market beyond 2010, concerns were expressed as to the financeability of projects the payback time for which would extend beyond 2010. The government's response to these concerns was to implement further progressive increases in the RO, culminating in 15.4 percent by 2015, after which time this level would be held out to 2027.

Reform of the RO

Industry has alluded to the need for additional increasing targets to at least 2020, to give some security for longer-term projects, but it seems that the government is not at present amenable to further increases before substantial progress is made on existing targets. However, to alleviate concerns related to the long-term stability of the ROC market, as part of the proposed reforms to the RO an extension of the obligation in each year, known as "headroom" of 6 percent of the expected ROCs within a given compliance period, has been put forward.

The intention of this measure is to create a viable ROC market in the scenario that deployment of renewables is higher than anticipated in the period beyond 2015 and to prevent the penalization of a successful industry because of the mechanism of the RO. However, if the RO is not met through generation of ROCs in the period 2015–20, it will remain at 2015 levels throughout this period and beyond to 2027. In essence, implementation of headroom in the obligation is thought to be a means for the government to avoid the extension of the RO to ~20 percent by 2020 in order to side-step allegations of huge subsidies to RE in a low-build, high–ROC value scenario between 2015 and 2020.

The government recognized early in the process that onshore wind alone would not be sufficient to meet its targets, and that technologies such as offshore wind and wave power would be required in volume. Initial market support for offshore wind was therefore provided through additional capital grants to kick-start the industry for a long-term future. To date, capital grants have been awarded to UK projects once they are in receipt of all the relevant consents. Only Round 1 offshore wind projects in the United Kingdom are eligible for such support at present, with each project eligible for grants of up to £10M from a total fund of £102M.

Following the slower-than-expected build-out of Round 1 and in the face of rising capital costs for offshore wind projects, the UK government amended the RO to provide differential support to various renewable technologies as part of the Energy White Paper 2007 [123] (and associated consultation exercise [135]). In the future, generators will receive a "ROC Multiple" of an RO certificate for each MWh generated, with that multiple being technology-specific, as summarized in Table 22.

Reform such as this requires primary legislation (a change in the law) to bring the proposals into realization.,There are signs that the industry has already gained some level of confidence in response to the proposals, with increased activity in the offshore industry in the United Kingdom. The impact of these reforms on the market value of ROCs has been of some concern, in particular for onshore wind developers who perceive the risk of a price crash as a result of the overstimulus of the offshore wind market. The proposal for headroom in the RO as described above has been designed to alleviate such concerns.

Other Benefits and Incentives

The Climate Change Levy (CCL), introduced in April 2001, is essentially a tax on business and public sector energy users in the United Kingdom. Renewably generated electricity is exempt from this tax, which initially provided a value of up to £4.3/MWh to such electricity and £4.56/MWh for the year 2008/9.

All generators of electricity in the United Kingdom are subject to charges levied by the network operator. Such "use-of-system" charges are applied either by distribution or transmission network operators, or by both depending upon the location of the grid connection point for the project. Given their size, the vast majority of Round 2 projects plan to connect directly to the transmission network in the United Kingdom, whereas Round 1 projects are typically scheduled for connection into the distribution network. The magnitude of the system usage charges depends on the region of interest and can in some cases be negative, with the project owner receiving payments from the network operator. This system is designed to help pay for additional infrastructure costs associated with accommodating additional generation in areas of low demand.

Power sales can account for more than 50 percent of an offshore wind project's revenue to date, which is usually

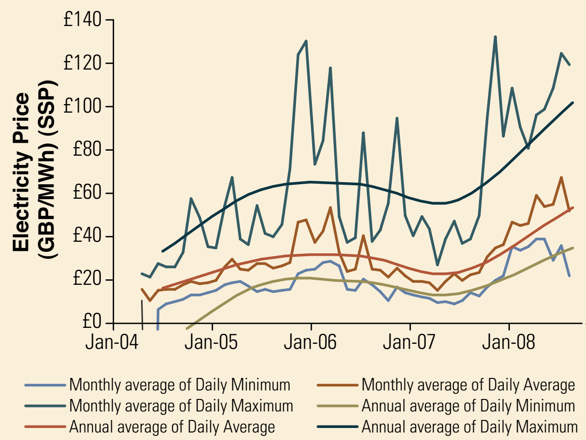
TABLE 22: SUMMARY OF PROPOSED UK ROC BANDING

Band	Technologies	ROC multiple
Established	Sewage gas, landfill gas, cofiring of nonenergy crops	0.25
Reference	Onshore wind, hydro, cofiring of energy crops, energy from waste with CHP	1
Postdemonstration	**Offshore wind**, dedicated regular biomass	1.5
Emerging	Wave, tidal stream, advanced conversion, biomass (energy crops), regular biomass with CHP, solar PV, geothermal	2

Source: Garrad Hassan and Partners Limited.

facilitated through a fixed-term (typically 3–5 years) Power Purchase Agreement with a utility that will typically also include a package price for ROC- and CCL- derived value. This agreement may include some risk-sharing mechanism in relation to the ROC recycle benefits. To date, there has been little or no direct trading of electricity produced by wind farms in the United Kingdom on the spot market (Figure 19). However, prices can be expected to track each other, albeit with an appropriate discount to reflect volatility-associated risk.

FIGURE 19: UK SPOT POWER PRICES



Source: Elexon.

Comparative Summary

Table 23 provides a comparative summary of targets and incentives for offshore wind for the five countries considered.

TABLE 23: COMPARATIVE SUMMARY—TARGETS AND INCENTIVES

Country	Summary of targets and commitments	Tariff summary	Assessment
Denmark	• 30% RE supply by 2025 • ~150 MW offshore wind installation per year • Goal of 4.6 GW offshore wind by 2025 • Grid connection provided and paid for by utility	• Competitive tender: 0.518 and DKK 0.629/kWh (first 50,000 full-load hours) for recent projects; DKK 0.36/kWh subsequently • Competitive tender price could be higher and for longer **TOTAL ~ €67/MWh**	Low to moderate
Germany	• 50% RE supply by 2050 • Plans for 25 GW offshore wind by 2030 • Grid connection provided and paid for by utility (commence construction before 2015)	• €c12/kWh (basic EEG) • + €c2/kWh (premium for projects coming into operation before 2014) **TOTAL ~ €140/MWh**	Very good
Spain	• Regulatory regime and feed-in tariffs specified • Grid connection provided and paid for by project	• Competitive feed-in tariff **TOTAL ~ €164/MWh (maximum)**	Good *(long-term prospects)*
Netherlands	• 10% RE supply by 2020 • Target of 6 GW offshore wind by 2020 • Grid connection provided and paid for by project	• MEP tariff for renewable electricity (adjusted annually by government) • Tax benefits (EIA) **TOTAL ~ €97/MWh**	Moderate
United Kingdom	• 15.4% renewable electricity supply by 2016 • Aspiration of 20% RE supply by 2020 • Achieved through certificate trading system • Grid connection provided by independent TSO and paid for by project	• Market electricity price • RE certificates • Tax break (climate change levy) • Upward adjustment for offshore wind likely **TOTAL ~ €115/MWh**	Good

Note: Currency conversion assumptions: €/DKK = 0.134, €/SEK = 0.109, and €/£ = 1.45.

The EEG is regularly amended to adapt tariffs to current market conditions and new technological developments. The most recent amendment took place in 2008 with new tariffs and regulations that took effect on January 1, 2009.

Source: Garrad Hassan and Partners Limited.

4

Regulatory Framework

This chapter reviews the regulatory framework for offshore wind in each of the five countries of interest, specifically the following topics:

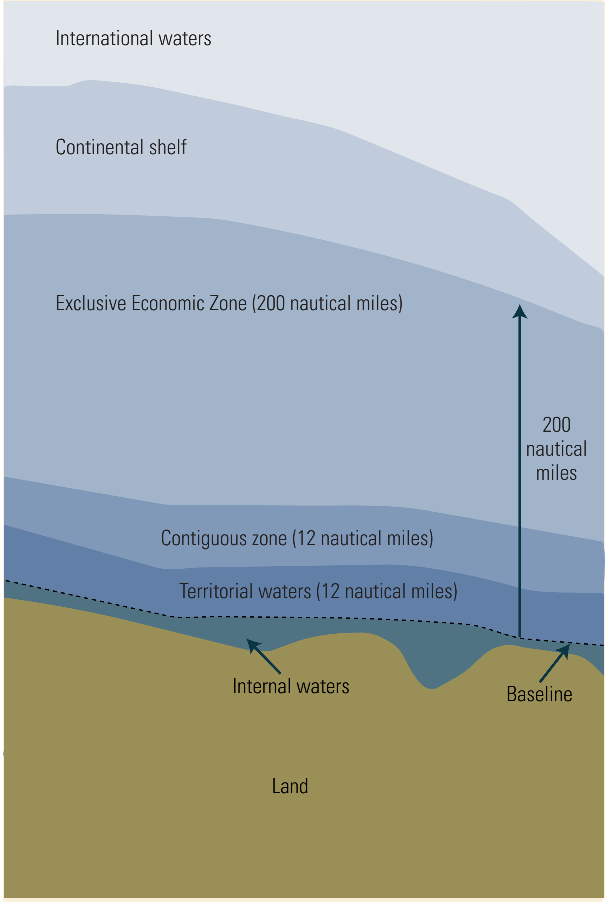
- Key applicable laws and conventions
- Concession award and seabed ownership
- Licensing and consenting
- Government bodies
- Grid access
- Power offtake
- Specific environmental regulations.

Key Applicable Laws and Conventions

Perhaps the most important international convention affecting the development of offshore wind farms for all five countries of interest is the United Nations Convention on the Law of the Sea (UNCLOS) 1982 [21]. The convention sets out rules for the use of the world's oceans, defines the rights and responsibilities of nations, and includes provision of guidelines for businesses. Of principal importance in the context of offshore wind project development is the delineation of zones extending from the coastline of a country out to sea and the rights that country has in each zone. These zones as defined in UNCLOS are reproduced in Figure 20.

Within *territorial waters* the coastal state has the right to set laws and regulate the use of any natural resources. Between 12 and 24 nautical miles from the coastal baseline is defined as the *contiguous zone* within which

FIGURE 20: ZONES FROM UNCLOS, 1982



Source: Reproduced under GNU Free Documentation License.

countries may enforce certain specific regulations with respect to smuggling and immigration. Beyond this and out to 200 nautical miles[10] from the baseline is the EEZ, within which the coastal state has sole exploitation rights over natural resources.

In practice, this means that offshore wind projects may be built anywhere within the EEZ, although its location will determine which *national laws* the development is subject to. In addition, the nation in question will need a legal framework in place to deal with such proposals. However, the scope of national law will, in some aspects, be more restricted than in territorial waters, including most notably the inability to establish rights of navigation.

The European Union

As identified in the section on the European Union in Chapter 3, which examined targets and incentives at the European level, European Directives are the principal measure for implementing Europe-wide policy. The principal directives of relevance are those

- Relating to GHG emissions [36], which specify how the overall target of reductions in emissions will be allocated between the countries; this is achieved through negotiations between the countries—in general once the overall target has been set and publicized
- Relating to promoting use of RE; this is currently undergoing revision with new targets for 2020 being set [29].

In addition, there are numerous laws and conventions relating to how the environmental impact needs to be assessed. These are described in the section on specific environmental regulations in the European Union in Chapter 4.

Denmark

Wind farms close to the coast can be accepted only in exceptional cases and only where a concrete assessment can demonstrate that the project has a minor impact on the landscape and will not affect areas with significant cultural monuments or marine-biological and geological interests. Such exceptional cases may, for example, be in direct proximity to technical installations the size of which matches the dimensions of the wind turbines. In general, an Environmental Impact Assessment is required for any proposed offshore wind project. The DEA will issue the consent in three steps before an offshore wind farm can be established:

1. A scoping (preinvestigation) permission must be obtained before environmental and technical surveying work can start.
2. Permission for constructing the wind farm is granted after application delivering the preinvestigation reports.
3. Permission for energy production must be obtained before commissioning of the farm, typically for 25 years. The application must be followed by a documentary report demonstrating that the conditions given have been followed. When a project is larger than 25 MW, the operator needs a concession to produce electricity.

All permissions are granted by the DEA, which consults all relevant parties in the consent process. The Danish consenting process for offshore wind can in this sense be called the "one-stop-shop" approach, as espoused in the Copenhagen Strategy [47]. The rules are formulated in the Act of Energy Supply [44]. A one-stop-shop implies that the project developer has a single point of contact within the government for all consenting issues and that this government department is then responsible for communication with all other interested government bodies (Figure 21).

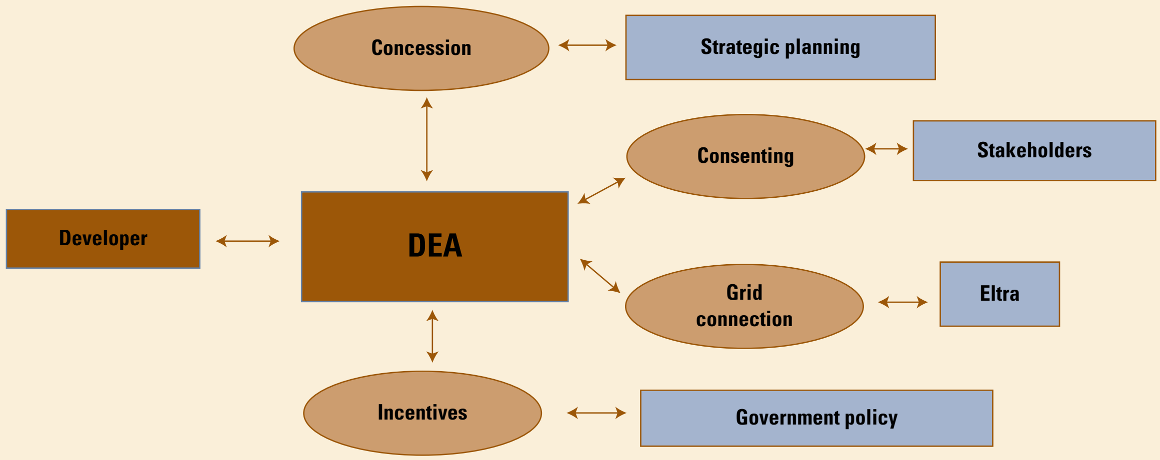
Germany

The authority responsible for the offshore wind farm permitting process depends on the location. Within the territorial sea, it is the regional (Bundesländer) authorities, that is, Mecklenburg-Vorpommern, Schleswig-Holstein, or Niedersachsen, while in the EEZ, it is the federal (national) authorities. Hence, a wind farm in the EEZ will require a wind farm and cable permit from the federal authorities, as well as a cable permit from the regional authorities.

The federal permitting process (for projects in the EEZ) is relatively clear today and is led by the BSH (Bundesamt für Schifffahrt und Hydrographie; *Federal Maritime and Hydrographic Agency*), which also coordinates the application for the cable permit within the territorial sea. The regional permitting process (for projects in the territorial sea) depends on the law within the particular region and is based on the on-land wind farm permitting process.

10. In cases where there are fewer than 400 nautical miles between two or more countries' coastal baselines, nominally the median line is taken as delineating the respective EEZs. However, it is worth noting that some areas have specific agreements deviating from this, and others are the subject of disputes between countries.

FIGURE 21: DENMARK'S "ONE-STOP-SHOP" CONSENTING MECHANISM



Source: Garrad Hassan and Partners Limited.

Turning to the EEZ procedures, the permitting process follows the regulations set within the following federal laws:

- Seeanlagenverordnung (SeeAnlV) (*Marine Facilities Ordinance*) [62], which allows permission to be granted for construction and operation of commercial structures offshore, and a revision, article 3a, which allows regions to be specified as suitable for offshore wind farms. However, this does not remove the need for the developer to demonstrate that the impacts are acceptable. The main reasons an application could be rejected are the following:
  - If navigational installations and markings would be affected
  - If shipping lanes or airspace would be disrupted. The criteria are a minimum distance of 2 nautical miles to the main shipping routes and the installation of an AIS (automatic identification system) on wind turbines
  - If the marine environment could become polluted
  - If bird migration would be endangered. The criteria are the number of birds likely to be a casualty of the wind farm, bearing in mind that migration itself causes a high casualty rate.
- The duration of the permit is 25 years, and construction must begin within 2.5 years; however, delays in obtaining the grid connection usually make this impossible. The license itself is a substantial document, on the order of 100 pages, and details conditions concerning
  - Safety in all components of the projects and throughout the lifetime
  - Use of state-of-the-art technology for surveys and technology
  - Visual markings
  - Design of the structure to minimize the consequences of ship collisions
  - Minimization of noise (impact on fauna)
  - Financial guarantees to ensure decommissioning.
- Seeaufgabengesetz (SeeAufgG); *Maritime Federal Responsibilities Act*, which ensures that new construction offshore does not impair navigation [63]
- Infrastrukturbeschleunigungsgesetz (InPBeschlG); *Infrastructure Acceleration Law*, December 2006, which assigns the costs of the offshore and onshore transmission cable to the utilities for offshore wind farms where construction commences before the end of 2011. [61]

Turning to the territorial sea procedures, the permitting process follows the regulations set within the relevant regional laws:

- Raumordnungsverordnung (ROV), *Regional Planning Act*, which specifies the laws that must be complied with to obtain permission; 13 December 1990 [64].
- Bundesimmissionsschutzgesetz (BimSchG); Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge, 1974, *Federal Pollution Control Act*; permitting of wind farms on land and

within territorial waters where permission is granted by the regional authorities (Bundesländer) [65].

The BSH has published three legally binding standards to guide the site surveys, environmental studies, and design processes. In general, the conditions in the permits will specify compliance with the following:

- Standard for Geotechnical Site and Route Surveys—Minimum Requirements for the Foundation of Offshore Wind Turbines and Power Cable Route Burial Assessments, *Standard Baugrunderkundig, Mindesanforderungen für Grundungen von Offshore-Windenergieanlagen*, 2003 [76]
- Standards for Environmental Impact Assessments of Offshore Wind Turbines in the Marine Environment, which was revised in 2007. An English translation of the old edition (2003) is available, *Standard—Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (stUK 3),* February 2007 [77]
- Construction of offshore wind energy plants, *Standard—Konstruktive Ausführung von Offshore-Windenergieanlagen,* June 2007 [78].

The wind farm permit is given following completion of the surveys, which must be undertaken according to the standards specified. The BSH is obliged to grant permission, unless the wind farm or related activities represent a danger to the marine environment or to marine traffic.

The Netherlands

The key applicable laws and conventions for the North Sea are as follows (the inland IJsselmeer falls under different regulations):

- Dutch law governing federal waters (Wet beheer rijkswaterstaatswerken or Wbr), including the whole EEZ [91]
- Dutch Ministry of Economic Affairs, MEP Scheme, until August 2006, followed by the Sustainable Energy Incentive Scheme (Stimuleringsregeling duurzame energieproductie; SDE), which became effective in April 2008.

Spain

The principal laws governing the administrative procedure for developing an offshore wind farm are:

- Royal Decree 1028/2007: Establishes the administrative procedure for installing offshore wind farms. The authority responsible is the Ministerio de Industria, Turismo y Comercio, through Dirección General de Política Energética y Minas. This Royal Decree involves the following:
  - Royal Decree 661/2007, which regulates energy production for renewable and nonconventional sources of energy. The authority responsible is the Ministerio de Industria, Turismo y Comercio.
  - Royal Decree 1995/2000, which regulates the transport, distribution, trade and supply activities, and authorization procedures for electrical energy installations. The authority responsible is the Ministerio de Economía. Three other organizations take on important responsibilities in this matter: Operador del Mercado Ibérico de Energía (OMEL), Red Eléctrica Española (REE), and Comisión Nacional de Energía (CNE). Details are given in the section on power offtake in Spain in Chapter 4.
  - Royal Decree 1302/1986, which guides the environmental impact assessment process. The authority responsible is the Ministerio de Obras Publicas y Urbanismo.
  - Law 22/1998 concerning coastal regulation. The relevant authority is the local authority with responsibility for the affected part of the coast.

Royal Decree 1028/2007 was the first legal statute to specifically mention offshore wind energy at its creation in July 2007. No further laws specifically mention offshore wind, apart from governing the feed-in tariff.

The United Kingdom

Three key areas of law are of importance to the development of offshore wind farms—those affecting concessionary rights, consenting, and health and safety.

Concessionary Legislation

The most important legislation affecting concessionary rights for offshore wind farms in the United Kingdom are the Energy Act 2004 and the Marine Bill 2007. In addition, the Renewables Obligation Order 2005 is the key piece of legislation driving the development of RE in the United Kingdom, which is described in the section on the United Kingdom in Chapter 3.

Consenting Legislation

A number of laws affect consenting for offshore wind projects in the United Kingdom, which are described in the section on licensing and consenting in the United Kingdom in Chapter 4.

Health and Safety Legislation

Many laws and regulations in the United Kingdom are relevant to health and safety for offshore wind farm development, construction, and operation. An exhaustive description of these is not provided here, for the sake of brevity, and only the most important are outlined below. A more extensive summary is provided by the British Wind Energy Association [118].

- **Health and Safety at Work, and so forth, Act 1974**
  This legislation, known as the HSW Act, covers employers' legal responsibilities to ensure that the health, safety, and welfare of their employees are protected. Importantly, the act is applicable to all contractors engaged to work on a wind project, such that they must ensure that their activities are not endangering their employees or third parties.
- **Construction (Design and Management) Regulations SI 1994 No.3140**
  These regulations, referred to commonly as CDM, are relevant to many aspects of offshore wind development and are in particular designed to ensure coordinated management of health and safety issues across the various companies and individuals involved in the project. Guidelines are published by the UK Health and Safety Executive on the CDM Regulations [136].
- **The Docks Regulations SI 1988 No.1655**
  These regulations impose health and safety requirements for all dock operations in Great Britain and within territorial waters.
- **Diving at Work Regulations SI 1997 No. 2776**
  These regulations enforce health and safety practices for all commercial diving operations and outline the steps required of employers and employees to mitigate risks associated with diving operations.
- **Electricity at Work Regulations SI 1989 No. 635**
  These regulations specify the principles of safety in relation to electricity generation and transmission. They stipulate the precautions that should be taken against the risk of death or injury from electricity and the duties of relevant persons to ensure that such precautions are taken.

Concession Award and Seabed Ownership

Concessionary award, sometimes referred to as a "lease," provides a company with the right to exploit defined natural resources within a specified area of the sea. Such award is principally administered by the national body that retains ownership of the seabed. In some national markets, this process is closely linked to or conditional on the developer's obtaining all statutory consents for the project, whereas in others the processes are less closely related.

Denmark

The Danish government has the sole right to utilize wind energy within territorial waters, the contiguous zone, and the EEZ. Consent can be awarded to projects on the basis of the Act of Electricity Supply [44].

Two ways of applying for establishing a project exist:

1. Applying at the tender issued by the DEA
2. Applying via the "open door principle," where after the DEA is open to interest shown in a particular site and, if interest is shown, a tender will be established between the parties.

The main differences between the two procedures are that the cable connection to shore from the wind farm in situation 2 must be carried by the operator and that the revenue will be based on the onshore rules. In situation 1, the grid operator will cover the cost to the defined farm grid connection point, and the revenue will be subjected to negotiation (tender).

Both methods have been used by developers in Denmark. The most important limitation experienced has been the requirements for financial strength of the applicant to cover risks during construction and the 25 years of operation.

Germany

In Germany, the concession to the site is awarded as part of the construction permit. Hence, the same authorities apply: the federal authorities for the seabed in the EEZ and the regional (Bundesländer) authorities for the nearshore band between the coast and the 12 nautical-mile limit.

An initial claim to the site is achieved once a fully complete application has been lodged with the BSH authorities. The BSH authorities process applications through a number of stages, which are entered once the application is compliant and all necessary documentation is complete. Applications are processed in the order in which they are accepted into the system, not necessarily the order in which they are received, with the application needing to be final and complete to enter the queue. Hence, an earlier application will be processed first and will receive a decision on the merits of its details before any other application for the same area can be decided on, but an early incomplete or noncompliant application will result in the authorities requesting additional information, during which other applicants could apply for the same site and obtain priority.

The Netherlands

The Dutch EEZ covers an area of 58,619 km^2, with water depths mainly between 20 and 40 m. The whole of the North Sea (not just the Dutch part) is intensively used for many different purposes and has important ecological value. In addition to the existing economic exploration (fishing, oil and gas exploration, sand and gravel extraction, cabling and pipelines) development of offshore wind energy generates additional pressure on the area. Rules to allow installations outside the 12-mile zone were finally established in December 2004 after several years in preparation under the Dutch law governing federal waters (Wbr), when it was extended to the whole EEZ. The Wbr now guides the central government (specifically the Ministry V&W, see the section on government bodies in The Netherlands in Chapter 4) in spatial planning in the EEZ. It is mandatory to perform an EIA for offshore wind farms.

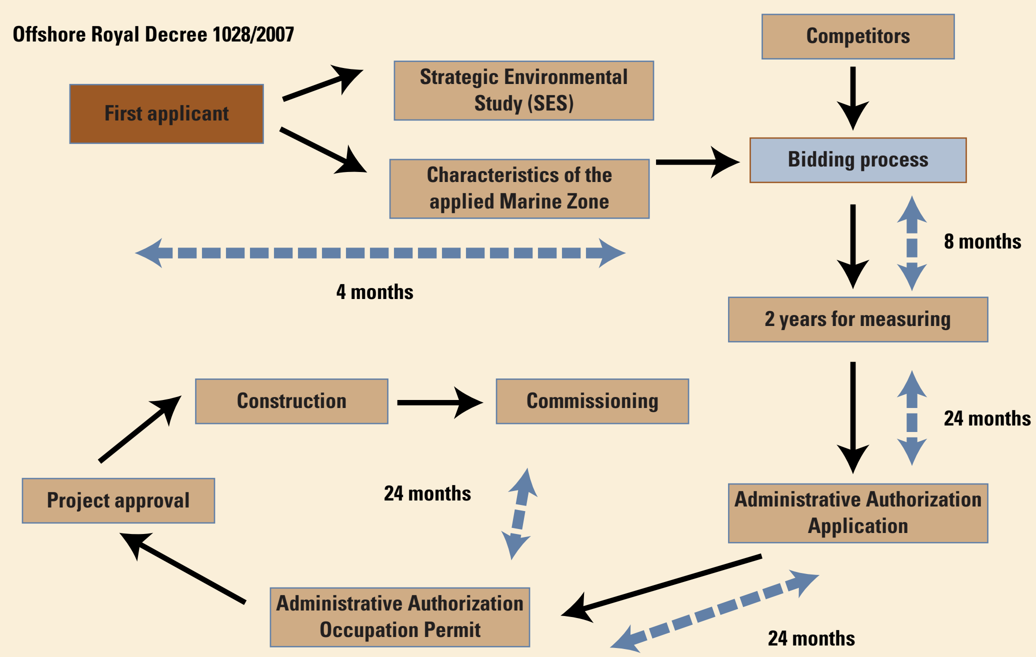
The process for applying for full consent for an offshore wind farm involves the following main steps:

- Submit inception memorandum (*startnotie*)
- Receive guidelines (*richtlijnen*)
- Apply to The Netherlands Commission for Environmental Assessment for permits
- Enter inspection and consultation procedure.

Seabed concessions are awarded on an exclusive basis, and consents are awarded through the same broad process outlined above. In this sense, only a single process need be followed to gain all necessary permits to construct, commission, and sell power from a wind farm.

It has been recognized in The Netherlands that a number of other detailed permits will have to be issued, for example, for landing ships during installation and maintenance, cabling through the dunes, and working conditions. As far as possible, a "one-desk" policy has been developed to streamline the process.

FIGURE 22: PERMITTING PROCEDURE IN SPAIN



Source: Garrad Hassan and Partners Limited.

Spain

As mentioned above in the subsection on Spain in Key Applicable Laws and Conventions, the administrative procedure (Figure 22) for offshore installations in Royal Decree 1028/2007 can be divided in two steps:

1. Initially, the government gives permission to the developer to study the area in depth in order to carry out a characterization of the zone report that will be publicly accessible to all. In this report, there must be an estimation of the capacity factor. It should be noted that the preparation of this report occurs before the beginning of the measurement campaign.
2. After that, the bidding process starts, and any others developers can apply for the exploitation of the area already studied. There is a commission formed by representatives of all authorities involved. This commission will decide which project is the best, based on the following:
    - Legal, technical, and economical capacity of the developer
    - Installed capacity (which cannot be changed in a later stage of the project)
    - Proposal of the price of the energy output
    - Estimation of the capacity factor
    - Description of the technology considered in the project
    - Economic, environmental, and social impact of the project.

Finally, the government licenses the developer for building and awards the public sea area.

The following chart summarizes the administrative process detailed in RD 1028/2007:

The United Kingdom

Concessionary Awards and the Crown Estate

In the United Kingdom an organization called the Crown Estate (CE) owns the seabed within territorial waters, as well as rights to exploit resources throughout the UK continental shelf, which encompasses the EEZ. The role of the CE is to enhance its assets and generate revenue for the UK government. The CE is a department within the UK Treasury.

In conjunction with the DTI, the Crown Estate has played a central role in the creation of a viable regulatory framework in the United Kingdom for offshore wind. This has been implemented primarily through two successive rounds of site awards in 2000 and 2003. The section on the United Kingdom in Chapter 2 provides more information on the rollout of both of the CE rounds.

Round 1 was designed to provide a demonstration phase for offshore wind in the United Kingdom, and projects were restricted as follows:

- Number of wind turbines: up to 30 per project
- Minimum installed capacity: 20 MW
- Project location: within UK territorial waters (<12 nautical miles)
- Project footprint: up to 10 km^2

The restrictions on size and location led to the award of relatively shallow sites close to the coast, with no project exceeding a maximum water depth of 20 m or a distance from the coast greater than 12 km.

No development regions or zones were defined for Round 1, and developers were given freedom to apply for leases anywhere within territorial waters. Arguably, this lack of control over the geographic location of proposals has led in at least one instance to the award of technically or environmentally unfavorable sites. This deficiency in the process was addressed to some degree in Round 2 through the restriction of site awards to specified strategic areas (albeit very extensive areas), the definition of which was informed by some degree of technical feasibility study and, crucially, an SEA. The results of the SEA for the three areas in question led the DTI to recommend an exclusion zone 8–13 km from the coast in order to mitigate visual impact and specific environmental concerns relating to certain bird species.

No capacity limit was placed on lease applications for Round 2 sites leading to substantially larger sites—the maximum planned installed capacity of the successful project applications being 1.2 GW. A maximum spatial area limit of 250 km^2 was set for any one project.

For Round 2, the Crown Estate charged successful applicants a one-off option fee that varied according to the spatial area of the seabed for each site. This varied from £25,000 for a small extension up to £0.5 million for a project with an area of between 150 and 250 km^2. Once operation commenced, Round 2 projects were to be subject to rental payments for their lease based on an index linked rate of £0.88 per MWh, which was likely to constitute approximately 1 percent of gross revenues from power sales plus incentives.

No firm announcements have yet been made with respect to the arrangements for Round 3 of site awards, although the timetable for this is expected to involve new site awards during 2009.

The Energy Act 2004

In order to establish a legal framework for RE projects outside of UK territorial waters, new legislation was required. This was enacted in the Energy Act 2004 [124], which established a Renewable Energy Zone adjacent to territorial waters and encompassing the UK EEZ. The act requires developers to apply for consents under the Electricity Act 1989 and extended the jurisdiction of the CE to encompass the granting of leases within the Renewable Energy Zone.

The Marine Bill

The concessionary regime in the United Kingdom is likely to be affected to some degree by Marine Bill 2007, a white paper that is currently the subject of consultation with stakeholders [137]. The bill itself is designed to consolidate existing legislation affecting the marine environment, as well as to facilitate strategic planning that takes into account both environmental and economic concerns. At this time, the direct implications for wind farm concessions are unclear, since the current white paper outlines the framework for future marine spatial planning at a strategic level rather than the plans themselves.

Licensing and Consenting

Denmark

These issues are largely covered in the sections on key applicable laws and conventions in the European Union and on concession award and seabed ownership in Denmark in Chapter 4. However, the following comments are made in addition to this.

It should be recognized that, because of the uncertainty associated with the environmental impact of offshore wind farms, the DEA has practiced the following strategy for larger applicant farms. If the project is relatively large (size not defined, but if the level of the demonstration projects in the first Action Plan is used, the figure is larger than 150 MW), the developers have to carry out an intensive, in-depth follow-up study focusing on a few characteristic issues relevant for the actual site. An international panel of scientists is asked to oversee the programs through a monitoring panel. The cost of these programs is paid for by the developer, who is expected to recover the cost through the tariff awarded for the project (see the section on the European Union in Chapter 3).

There have not been any follow-up studies connected to the last two large projects to achieve consent (Horns Rev 2 and Nysted/Rødsand 2), which may be because the two projects are neighbors to the first demonstration projects, where no critical issues were found.

Germany

The primary consent for a wind farm in the EEZ is the Seeanlagenverordnung (SeeAnlV) *Marine Facilities Ordinance* [62], which will also require the facility to comply with the requirements of the Seeaufgabengesetz (SeeAufgG); *Maritime Federal Responsibilities Act* [63]. This involves the following procedures:

- Application is submitted to BSH.
- BSH assesses whether application is complete, including whether sufficient detail is included. If not, applicant has the opportunity to make a revision.
- First round of consultations is initiated with other interested agencies: regional shipping authority and federal mining, environment, and nature conservation authorities.
- Second round of consultations is undertaken with additional consultees.
- A conference is held where the applicant presents the project and the scope of the studies that are necessary.
- The applicant undertakes an EIA (for projects with more than 20 wind turbines) and shipping impact studies, and submits reports. At this point, the applicant has priority.[11]
- BSH coordinates assessment of the application by relevant authorities in the form of comments and discussions.
- BSH publicizes the application and invites public comment.
- BSH assesses the application, in particular the environmental impact study and shipping impact study (which is carried out by the Waterways and Shipping Directorate).
- The permit is issued, including conditions.

The approval for the onshore leg of the cable is given by the regional administration agency that is coordinating the various regional and federal agencies to be consulted or asked for approval. The particular issues to consider are nature conservation; conservation of cultural heritage; and crossing of federal, regional, or locally owned

11. Previously, an applicant had priority from the point of initial submission to allow sites to be blocked. This changed on November 15, 2001, with a change to BNatSchG, which consequently modified SeeAnlV.

roads, railway lines, dikes, and rivers. It can be laborious, since ownership is spread widely. For example, the 70 km-long onshore transmission cable for the ENOVA North Sea project traverses 700 plots of land owned by 400 different people. The Infrastrukturbeschleunigungsgesetz [61] transferred responsibility for the permitting, as well as the costs, of the transmission cable to the utility. Since it is unclear whether failure by the utility to provide a grid connection on time will be sufficiently compensated, some developers are continuing to pursue their transmission cable application. Once complete, the permits would be passed on to the utility, which would compensate the developer for the costs it has incurred.

Appendix B to this report provides summary details of how a number of offshore wind farms have experienced the planning and consenting process. Generally, the procedures were slow, no doubt because of the enormous volume of applications coupled with a scarcity of ability to carry out the extensive environmental impact studies and a lack of experience within the authorities of processing this type of application.

To date, two offshore projects have been rejected, both in the Baltic Sea, and both because they were located on seabed that has been incorporated into a Natura 2000 site.

Following SEAs, in December 2005 three regions were declared as being particularly suitable for offshore wind energy: one in North Sea at Nördlich Borkum [73] and two in the Baltic Sea at Kriegers Flak [74] and Westlich Adlergrund [75]. Dedicating specific areas for offshore wind energy is a tool of proactive planning on the part of the government to ensure a planned and orderly development rather than react to individual applications that are launched. It is easier to obtain planning permission within these dedicated areas, since a general environmental impact assessment has already been carried out by the federal government. Permits outside the dedicated areas are significantly more difficult to obtain, and in the equivalent onshore areas, wind farm development is strictly limited to such dedicated areas. Offshore, the particularly suitable areas are seen by BSH as areas where wind farms with more than 80 turbines may be permissible in the future.

The Nördlich Borkum site consists of three separate regions and covers four projects: Borkum Riffgrund West, Borkum Riffgrund, Borkum West/Alpha Ventus, and Godewind. The Kriegers Flak region covers a single project, Kriegers Flak, while Westlich Adlergrund covers two projects, Arkona Becken Südost and Ventotec Ost 2. All these projects have received wind farm construction permits, although in some cases, this was before the region was declared.[12] In addition, construction permits have been awarded to sites outside these regions.

The Netherlands

Through the Dutch law governing federal waters, Wbr, offshore wind energy must take into account the environment and ecosystem of the North Sea, as well as consider areas of other types of dedicated use (such as military areas, shipping routes, disposal sites, search areas, coarse sand resources, and cable routes). The law in principle opens up the entire EEZ to the permitting of wind farms. In practice, however, in a number of areas wind farms will simply not be permitted (or possible).

The Wbr policy describes the building permit requirements that a request must satisfy, and the information required as a minimum will be as follows:

- Coordinates of the wind farm boundaries
- Type and design of the wind farm
- Information about the "utility and necessity" of the wind farm
- Information about the impact on the rightful use of the sea by others
- Information about the impact on the environment
- An erection and construction plan
- A maintenance plan
- A safety plan
- A marking plan based on the International Association of Lighthouse Authorities (IALA) recommendation on the marking of offshore wind farms
- An emergency plan
- The intended time of use
- A decommissioning plan
- A certificate of the design assessment of the wind turbines.

The relevant permit documentation can be found in Dutch at [109]. The consents experience in The Netherlands is overviewed in Appendix C.

Spain

These issues are included in the administrative procedure described in RD 1028/2007 and included in the flowchart in the section on concession award and seabed ownership in Spain in Chapter 4.

12. For example, Alpha Ventus (Borkum West) received the wind farm permit on November 9, 2001, and the cable permit on December 15, 2004, and both Borkum Riffgrund and Borkum Riffgrund West were permitted on February 25, 2004. All dates were earlier than the declaration in December 2005 of the offshore wind energy regions.

The developer must submit the licensing for building to the Ministry of Industry, Tourism and Trade together with the Environmental Statement and the request to be considered as a special generator in order to benefit from the bonus system. Following this and if the environment impact study has a positive result, the awarding of the public sea areas will be considered by Coastal General Direction.

The United Kingdom

Achieving planning consents for offshore wind farms in the United Kingdom has been a relatively positive experience for developers, with reasonably high success rates and short evaluation periods. Although this section deals with the specific regulatory requirements, the relevant government bodies and the process associated with consenting offshore wind projects in the United Kingdom are discussed further in the section on government bodies in the United Kingdom in Chapter 4.

Principally, developers can choose to consent their projects through one of two routes, each requiring conformances to several laws, as depicted in Table 24. It should be noted that in some cases project specifics may require additional consents to be obtained, particularly for onshore works.

TABLE 24: ALTERNATIVE CONSENTING ROUTES FOR UK OFFSHORE WIND PROJECTS

Act	Route 1 (EA or FEPA)	Route 2 (TWA or FEPA)
Electricity Act 1989—Section 36	✓	n.a.
Food and Environmental Protection Act 1985	✓	✓
Transport and Works Act 1992	n.a.	✓
Coast Protection Act 1949—Section 34	✓	n.a.
Town and Country Planning Act 1990	(✓)	(✓)
Electricity Act 1989—Section 37	(✓)	n.a.
Water Resources Act	(✓)	(✓)

n.a.= Not applicable.

Note: Route 1 is applicable to projects within territorial waters or the Renewable Energy Zone. Route 2 is applicable only to projects within territorial waters. ✓ means that consent is required under this act. (✓) means that consent may be required under this act.

Source: Garrad Hassan and Partners Limited.

A brief summary of each relevant piece of legislation follows.

Electricity Act 1989 (EA)—Section 36 [125], as Amended by the Energy Act 2004

Consent is required for all offshore wind developments that are within territorial waters and above 1 MW installed capacity. At the same time that this consent is being granted, the Secretary of State for Trade and Industry can, upon application by a developer, extinguish public rights of navigation through the generating station (section 36B). This consent cannot be granted if the generating station will interfere with recognized sea lanes essential to international navigation. The act applies in the UK EEZ since amendments from the Energy Act 2004 were enacted.

Food and Environment Protection Act (FEPA) (Part II) 1985 [126]

This legislation aims to protect the marine ecosystem and human health and to minimize nuisance and interference to legitimate sea uses. A license under the FEPA is required for the following:

- Installation of a meteorological mast and foundations
- Installation of turbine masts and foundations
- Depositing scour protection
- Rock armoring and burial of cables at the site and connection to the shore
- Associated construction works (such as junction boxes and cable landings involving coastal defense modifications).

Transport and Works Act 1992 (TWA) [127]

A TWA Order provides an alternate route for authorizing offshore wind farm projects in territorial projects only. An order can extinguish or temporarily change public rights of navigation and authorize ancillary works, and it gives powers for compulsory acquisition of land.

Coastal Protection Act 1949 (CPA) [128]

Section 34 of the CPA deals with the effects on navigational safety that the offshore project may have. The CPA consent will not be required where consent was given under Section 36 of the EA, after commencement of Section 36B.

Electricity Act 1989 (EA)—Section 37 [125]

Where a new overhead power line is included in the development of an offshore wind farm, consent is likely to be required under section 37 of the EA. When these cables are connected to an offshore wind farm covered under section 36 of the same act, a decision on both applications is usually made at the same time.

Water Resource Act 1991—Section 109 [129]

A consent is required from the Environment Agency to erect a structure in, over, or under a watercourse that is part of a main river. This will be relevant to onshore cabling infrastructure if a watercourse is to be crossed to access the grid connection point for the project.

Town and Country Planning Act 1990—Section 90 or Section 57 [130]

Planning consent may be required for onshore elements of the offshore wind farm development. Two approaches are possible:

1. Section 90—Planning permission is sought either as part of Section 36 application or as part of an application for an order under the Transport and Works Act 1992.
2. Section 57—Planning permission is sought separately from the relevant local planning authority.

Appendix A contains examples that illustrate the consent timing process, from application to award, for a series of projects in the United Kingdom.

Government Bodies

The European Union

Legislation is generally developed by the appropriate department of the European Commission, invariably under some guidance of the Council of Ministers, which has the greatest influence on whether the initiative will ultimately be successful.

Directives of interest to offshore wind include those under the following three broad headings:

1. *Environmental*, in terms of impact
2. *Climate Change*
3. *Energy Policy*, in terms of security of supply.

The directives need to be approved by the Council of Ministers and the European Parliament, after which the national parliaments need to formally authorize them, so that they enter into national law. This later process can take considerable time, but it can be as short as a year for critical legislation.

The European Commission also sponsors various coordination, lobbying, or advisory bodies, the most important currently being TPWind, the European Wind Energy Technology Platform.

Denmark

The central player for the regulation of offshore wind development in Denmark is the Danish Energy Authority (DEA), as explained in the section on Denmark in Chapter 2.

All other bodies involved in the consenting process in Denmark follow the procedure administered by the DEA, and all communication among the various stakeholders in the process is also channeled through this body.

Table 25 lists the areas of interest that should be considered as part of the consenting process. This list includes two main priority criteria:

1. Field of interest, where different options exist that must be balanced with each other
2. Field of interest, where priority already exists.

TABLE 25: AREAS OF INTEREST THAT MUST BE ADDRESSED BY THE DANISH CONSENTING PROCESS

Area of interest	Priority
Sailing routes; sailing safety	B
Existing offshore wind farms	B
Extraction of raw material or future interest for such	A
Digging large stones or boulders	A
Extraction of sand	A
Existing international nature protection areas at sea	B
Potential international nature protection areas at sea	A
Nature; environment protection	A
Sea depth	A
Oil and gas pipelines; subsea cables	B
Visual impact	A
Fishing	A
Defense considerations	A&B
Radio links	A
Archaeological interests	A
Meteorological interests	A
Ferry routes	B
Deposits for earth; deposits for everything (refuse, dump)	A

Source: [[Source needed]]

During the consenting process, the developer must conduct communications with all parties relevant to these fields of interest: private, government, and local organizations. Finally, however, the decision and the weighting of the interest for the society is the responsibility of the DEA.

No contentious conflicts of interest among the various stakeholders have emerged during the consenting process for the Danish offshore wind projects that have proceeded through the system to date. The government bodies that have a statutory involvement in the consenting process are given in Table 26.

Germany

Tables 27 and 28 list the federal and regional authorities and institutes of relevance to offshore wind in Germany, respectively.

The Netherlands

Two main government departments are involved in the offshore wind permitting process and planning [88]:

1. The Ministry of Transport, Public Works and Water Management (Verkeer und Waterstaat, V&W), the body responsible for the issuing permits in the North Sea
2. The Ministry of Housing, Spatial Planning and the Environment (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer VROM), the body responsible for the spatial planning in the Dutch EEZ.

The Ministry of Transport, Public Works and Water Management is responsible for all transport in The Netherlands, including on inland waters and the sea. This includes coastal protection and the issuing of permits in relation to activities within the Dutch EEZ.

TABLE 26: GOVERNMENT BODIES WITH RESPONSIBILITY FOR OFFSHORE WIND ENERGY, DENMARK

Name	Role
Danish Energy Authority www.ens.dk	Primary responsibility for regulation of offshore wind farms; responsible for coordination with other government agencies, thus providing a single point of contact to the developer Within Danish Ministry of Climate and Energy (founded in 2007)
Danish Maritime Authority http://www.frv.dk/en/index.php	Contributes to the safety of navigation at sea in Danish, Faroese, and Greenland waters
The Royal Danish Administration of Navigation and Hydrography	Within the Danish Ministry of Defence (Forsvarsministeriet)
Danish Environmental Protection Agency http://www.mst.dk/English/	Improve protection of people, the environment, and nature Within the Danish Ministry of the Environment
Municipal and Regional County Councils	Local planning
Danish Forest and Nature Agency www.skovognatur.dk/International/English/	Develop, establish, and restore nature, and undertake practical management measures for wild flora and fauna. Within the Danish Ministry of the Environment.
Cultural Heritage Authority http://www.kum.dk	Within Ministry of Culture
The Fisheries Inspection http://www.fd.fvm.dk/English.aspx?ID=16472	Responsible for administration, regulation, monitoring, and inspection of fisheries activities in Denmark Within Ministry of Food, Agriculture and Fisheries
EnergiNet.dk www.energinet.dk	Danish TSO and super-grid owner (400 kV)

Source: Garrad Hassan and Partners Limited.

TABLE 27: FEDERAL AND REGIONAL GOVERNMENT BODIES WITH RESPONSIBILITY FOR OFFSHORE WIND ENERGY, GERMANY

Abbreviation	Name	Role
BfN	Bundesamt für Naturschutz www.bfn.de	Federal agency for environmental protection; belongs to BMU
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit www.bmu.de	Developing RE tariffs; federal department responsible, among others, for RE and the environment
BSH	Bundesamt für Schifffahrt und Hydrographie www.bsh.de	Federal agency and leading permitting authority for offshore wind energy projects
UBA	Umweltbundesamt www.umweltbundesamt.de	Federal agency for the protection of people in the environment; belongs to BMU
	Ministerium für Technologie und Energie des Landes Schleswig-Holstein www.bmwi.de	Technology and energy department in Schleswig-Holstein
	Umweltministerium Niedersachsen www.mu.niedersachsen.de	Lower-Saxony government environmental department

Source: Garrad Hassan and Partners Limited.

Within this ministry is the *North Sea Directorate* (Directie Noordzee, DNZ). The DNZ is mandated with the governance of North Sea business related to shipping, fishing, dredging, sand mining, the ocean environment, and recreation. It has a fleet of ships that are tasked with performing certain hydrographic surveys (for example, surveys of navigational hazards), demarcation of shipping routes and harbor approach routes, and pollution clean-ups. It is responsible for implementing the Bonn agreement of 1983, which relates to regional management of pollution in the North Sea. Other relevant activities led by the DNZ include maintaining a major information system in the North Sea and managing seabird counts.

TABLE 28: STAKEHOLDER COMMITTEES AND FEDERAL AND REGIONAL DEVELOPMENT AGENCIES, GERMANY

Abbreviation	Name	Role
dena	Deutsche Energie-Agentur www.dena.de	Federal agency aims to provide know-how and coordinate projects in the energy sector
wab	Windenergie-Agentur Bremerhaven, Bremen www.windenergie-agentur.de	Regional business support agency
	Offshore Energies Competence Network Rostock e.V. Gesellschaft für Wirtschafts- und Technologieförderung www.offshore-energies.de	Regional business support agency
FINO	Forschungsplattformen in Nord- und Ostsee www.fino-offshore.de / www.fino-offshore.com	Research program of met masts in the North and Baltic Seas
	Stiftung Offshore Windenergie www.offshore-stiftung.de	Federal agency for the development of a pilot offshore wind farm at Alpha Ventus
StAOWind	Ständiger Ausschuss Offshore Windenergie der Bundesregierung mit den Küstenländern; Koordination der Genehmigungsverfahren	Joint federal and regional committee for the coordination of planning activities in the sector of offshore wind energy
FOWEUM	Forum Offshore Windenergie und Umweltschutz	Committee
FoNeOWind	Forum Netzanschluss Offshore Windenergie	Committee
MonNetz	Monitoring Netzausbau	Committee

Source: Garrad Hassan and Partners Limited.

The Ministry of Housing, Spatial Planning and the Environment sets and implements spatial planning policy for the whole of The Netherlands. This covers both land-based planning of housing development and offshore development. The ministry "promotes a strong role for municipalities," implying that it will leave some planning decisions to local authorities.

More broadly, the Dutch North Sea interests are coordinated by IDON Interdepartementaal Directeuren Overleg Noordzee, *Interdepartmental Directorate for North Sea Policy and Governance*. This grouping includes the following:

- Ministry of Transport, Public Works and Water Management
- Ministry of Defense
- Ministry of Economic Affairs
- Ministry of Agriculture, Nature Managements and Fisheries
- Ministry of Foreign Affairs
- Ministry of Housing, Spatial Planning and Environment.

Spain

The national organizations involved in the administrative process explained above are presented in Table 29.

The United Kingdom

There are a number of government departments that have a role in consenting for offshore wind projects in the United Kingdom.

Government Departments and the Consenting Process

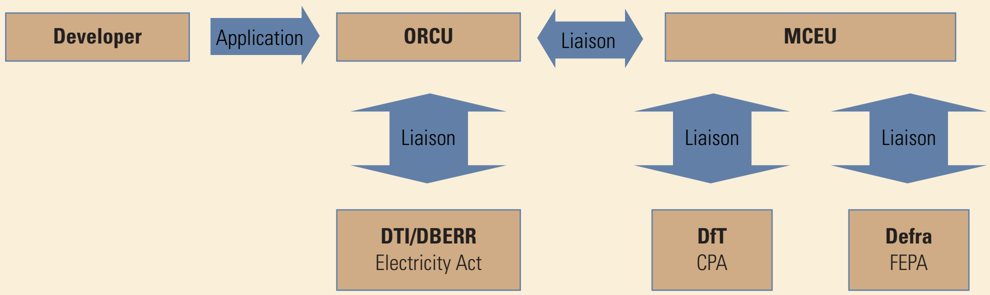
- **DTI and Offshore Renewables Consents Unit (ORCU)**
  The DTI was recently disbanded and replaced with the DBERR. However, the functions of the DTI with respect to energy matters have simply been translated to DBERR. The ORCU was created as a body within the DTI to serve as a focal point for offshore wind farm consent applications. It is responsible for consents received under the Electricity Act and the Transport and Works Act. The unit handles applications and provides developers with a single liaison point for questions regarding all of the consent applications.
- **Defra, DfT, and MCEU**
  The ORCU work closely with the Marine Consents and Environment Unit (MCEU), which coordinates requests for consent over the full range of marine works in respect of those consents for which the Department for Environment, Food and Rural Affairs (Defra) and the Department for Transport (DfT) are responsible—FEPA and CPA, respectively.

TABLE 29: SPANISH GOVERNMENT BODIES WITH RESPONSIBILITY FOR OFFSHORE WIND ENERGY

Ministry	Department	Ministry	Department	
Spanish		English translation		Responsibility
Ministerio de Industria, Turismo y Comercio		Ministry of Industry, Tourism and Trade		Authorization of licenses and leases
	Dirección General de Política Energética y Minas		Department of Energy Policy and Mines	
Ministerio de Medio Ambiente		Ministry of Environment		Authorization of licenses and leases
	Dirección General de Costas		Department for Coasts	
Ministerio de Obras Publicas		Ministry of Public Works		Maritime safety, navigation, and human life at sea
	Dirección General de la Marina Mercante		Department of Merchant Navy	
Autoridades Portuarias		Port authorities		Fishing protection and regeneration
Ministerio de Agricultura, Pesca y Alimentación		Ministry of Agriculture, Fisheries and Food		

Source: Garrad Hassan and Partners Limited.

FIGURE 23: STRUCTURE OF UK CONSENTING BODIES



Source: Garrad Hassan and Partners Limited.

The relationship between these bodies in the context of the UK consenting process is summarized in Figure 23.

It is worth noting that projects pursuing the TWA/FEPA route, as described in the section on licensing and consenting in the United Kingdom, will require the involvement of parliamentary agents in order to handle issues relating to the Transport and Works Act. The timeline of the process itself is outlined in Table 30.

EIA and Statutory Consultees

Implementation of an Environmental Impact Assessment for an offshore wind project constitutes a significant body of work, including substantial desk study and field work. Typically, the following issues should be addressed in some depth:

- Land use
- Conservation
- Landscape and seascape
- Dredging and disposal
- Oil and gas
- Submarine cables
- Mariculture
- Fishing
- Birds
- Archaeology
- Coastal processes
- Other RE
- Ports and navigation
- Marine recreation
- Military activities
- Mineral extraction
- Culture
- Cumulative impact.

Consultation with stakeholder groups for each of these issues should be undertaken throughout the process following completion of the scoping phase, through the EIA and, of course, during negotiations that occur in parallel to the evaluation of the consent application by the licensing authorities. With a few notable exceptions, the consenting experience in the United Kingdom has been generally positive, provided that effective consultation is undertaken. The British Wind Energy Association provide best-practice guidelines on this subject [119], which

TABLE 30: TYPICAL UK CONSENTING TIMELINE FOR OFFSHORE WIND PROJECTS

Stage	Description	Typical duration
Prepare scoping report	Broad technical definition of project and potential impacts on environment—issue to stakeholder	6–12 months
Prepare EIA and consent documents	Detailed survey work, better defined technical description, mitigation measures	18–24 months
Consultation and negotiation	Post submission of application, detailed discussions with stakeholders and licensing authorities	12–18 months
Determination	Ministerial decision	12–36 months

Source: Garrad Hassan and Partners Limited.

include details of relevant consultee organizations and bodies in the United Kingdom.

Other Governmental Bodies

Outside the realm of consenting, perhaps the most important other governmental organization is the Health and Safety Executive (HSE), which is an organization with the UK Department of Work and Pensions. The primary role of the HSE is to administer and enforce the Health and Safety and Work Act, which is described in the section on key applicable laws and conventions in the United Kingdom. This means that the HSE plays a central role in ensuring that health and safety issues are adequately dealt with in the design, construction, and operation of offshore wind projects in the United Kingdom.

Another important group is the Renewables Advisory Board (RAB), which is sponsored by the DTI. RAB is made up of representatives from relevant government departments, the RE industry, and the unions and is intended to foster a greater understanding of all issues affecting and affected by RE development in the United Kingdom.

Local Government

Any application for onshore works under the Town and Country Planning Act 1990 [130] must be to the relevant district council. The application will initially be adjudicated by the local planning committee advised by the planning officers. Failed applications may be appealed to a public inquiry in front of a planning inspector whose recommendations would then be presented to the Minister of State at DBERR (formerly the DTI) for determination.

Grid Access

The European Union

Grid access is determined at a national level, although much of the European grid is synchronized. Hence, power flows in a controlled, as well as uncontrolled, manner between countries. This has resulted in a gradual increase in communication and coordination between neighboring national transmission grid operators, to date most notably in terms of Europe-wide R&D studies, including the following:

- SmartGrids [37], European Technology Platform—with the group's guiding vision being that "future trans-European grids must provide all consumers with a highly reliable, cost-effective power supply, fully exploiting the use of both large centralized generators and smaller distributed power sources throughout Europe." The group's objective is to aid the development of Europe's electricity networks to become
  - Flexible—fulfilling customers' needs while responding to the changes and challenges ahead
  - Accessible—granting connection access to all network users, particularly for renewable power sources and high-efficiency local generation with zero or low-carbon emissions
  - Reliable—assuring and improving security and quality of supply, consistent with the demands of the digital age with resilience to hazards and uncertainties
  - Economic—providing best value through innovation, efficient energy management, and "level playing field" competition and regulation.
- TradeWind [38]—European R&D project focusing on how large numbers of wind farms, including offshore, can be integrated into the European grid. For example, one task has been to identify regulations in national market trading rules that might discriminate disproportionately against variable sources of power, such as wind energy, and develop recommendations to alleviate this.
- UpWind [39]—a wide-ranging R&D project that includes Work Packages to focus on grid integration issues at the wind turbine technology level and at the network level, where accurate forecasting brings major benefits in terms of a more stable operation of the grid with large amounts of wind energy, as well as an improvement to the general perception of wind energy within the wider electricity industry.

Integration of large amounts of wind energy in the grid requires good cooperation between national grids since the stochastic nature of the wind energy production means the proportion of wind energy that can be supplied to a electrical grid increases with the size and diversity of the grid. Wind energy will be a principal beneficiary of improved cooperation between national electrical networks.

Denmark

There are two options for the grid connection to shore from an offshore wind farm:

1. If the project is following the action plan established by the DEA, the grid operator will cover the cost to a defined farm grid connection point. Here the system operator typically will establish a step-up transformer.
2. If the project is proposed by the developer ("the open door principle"), the operator has met the cost to the nearest, relevant, defined shore connection

point for the voltage used. Establish a step-up transformer, if needed. Considerable cost of reinforcement of the grid system can be expected if a large quantity of power (probably more than 50–100 MW) is to be delivered into the grid.

The three private offshore wind farms established to date in Denmark—(Samsø [23 MW], Rønsland [17 MW], and Middelgrunden [40 MW]—have followed procedure 2, and no special problems have been noted.

Germany

There are no payments for system usage in Germany. The utility is responsible for grid connection, maintenance, and reinforcement. The wind farm owner pays for the transmission line up to the nearest suitable grid connection point. The Infrastructure Acceleration Law [61] placed that connection point for offshore wind farms inside the wind farm for a limited duration. Hence, the utilities are now financially and legally responsible for expanding the grid infrastructure to connect the offshore wind farm.

General guidelines for the connection of wind farms to the transmission system have been published by VDN, the association of power system operators in Germany. Moreover, the transmission code is applicable [87].

In general, the German grid already operates close to capacity in northern Germany, because the grid was traditionally weak in that region (because the necessary transmission grid upgrades have been delayed), and that is where most of the onshore wind turbines have been located. A program of transmission upgrades is being undertaken, in particular to relieve bottlenecks to the load centers of Rhein/Ruhr, Frankfurt, Stuttgart, and Munich [84]. The unprecedented capacity of the new offshore transmission lines means that new solutions may be needed, with even novel technologies, such as gas insulated lines, being considered.

Table 31 lists the available capacity at coastal substations.

The projected offshore wind turbine capacity will have a major impact on how the grid behaves. This is the subject of intense scrutiny. A major grid study commissioned

TABLE 31: ELIGIBLE SUBSTATIONS FOR THE GRID CONNECTION OF OFFSHORE WIND FARMS

Area	Substation	Voltage [kV]	Power [MW]	Date
Open North Sea	Brunsbüttel (Vattenfall)	380	4,540	2020
	Conneforde	380	3,200	2020
	Moorriem	380	3,200	2020
Sylt	Böxlund	380	125	2007
			640	2010
	Brunsbüttel (Vattenfall)	380	1,110	2010
Helgoland	Brunsbüttel (E.ON)	380	750	2010
Borkum	Maade	220	240	2007
	Emden/Borßum	220	60	2007
	Diele	380	1,630	2010
			4,900	2020
Rügen	Bentwisch	380	226	2007
			611	2010
			1011	2020
Rostock	Lubmin	380	400	2010
			700	2020

Source: [84]; [13].

by dena that was completed in 2005 concludes that the offshore wind farms could be integrated into the grid, although there would be costs. The key points are [84] as follows:

- Assumption of 20 percent of the electricity supplied from renewable sources (5 percent offshore wind [27.9 GW], 7.5 percent onshore wind [20.4 GW], and 7.5 percent other renewables).
- Onshore strengthening of the electricity network would require 850 km of new high-voltage (220/380 kV) cables (equivalent to 5 percent of the total length nationwide), as well as 400 km of upgrading of existing lines before 2015, at a total cost of €1.1 billion. This will increase the cost of electricity to consumers by around €c0.025/kWh.
- The offshore cables are likely to cost significantly more.
- The UTCE safety criteria would have been violated in 2003 if certain conditions had developed (strong winds together with specific failures in the grid or conventional power stations), although the strengthening of the grid code requirements for wind turbines means that this is already being resolved.
- The capacity credit for 36 GW of wind turbines in 2015 was calculated to be 6 percent for a 99 percent reliability level.
- Between 2015 and 2020, possibly as much as another 1,000 km of new high-voltage lines will be needed. This will be examined in the second phase of this study, which will extend the time horizon to 2020/25 and which is planned for completion at the end of 2008 [82].

The Netherlands

The Netherlands has a well-developed electricity grid with respect to security of supply and cross-border interconnections. The system does include some aging components, and there is a distinct lack of space onshore for more high-voltage lines and underground cables, which raises the question of how grid upgrade can be implemented in the longer term.

The current grid does not provide a level playing field for all power generation technologies, and more established or conventional energy sources tend to fare better. The technical structure of the Dutch grid is as follows:

- Very high-voltage grid for transmission at the country level: 380 and 220 kV
- High-voltage grid for transmission at the regional level: 150, 110, and 50 kV
- Intermediate voltage grid for supply to large users and for distribution: 3–30 kV
- Low-voltage grids for connection of retail customers and small enterprises: 230–400 V.

The TSO is TenneT, which operates the 380 kV and 220 kV transmission systems. Regional operators then distribute power at 150 kV and lower. With an offshore wind target of 6 GW by 2020 and a total generating capacity of around 21 GW (mainly fossil fueled plant), The Netherlands will require good control of the grid and sound interconnections with the rest of Europe, including a new 700 MW link with Norway, NorNed, which is under construction, and a planned interconnector with the United Kingdom, BritNed, to be operational by 2010.

To understand how The Netherlands could connect 6,000 MW of offshore wind, the Ministry of Economic Affairs commissioned the project, Connect 6,000 MW, between July 2003 and May 2004. The project team included representatives from the Ministry of Economic Affairs, and Novem carried out a survey for which ECN, KEMA, and Royal Haskoning conducted the necessary technical background studies. The final Connect 6,000 MW report [95] was finished in July 2004, and the Ministry of Economic Affairs has since been implementing the findings as follows:

- Likely locations for wind farms lie in a strip 25–50 km off the coasts of the central Dutch provinces of South- and North-Holland.
- The 380 kV substations, Maasvlakte and Beverwijk, are identified as the most suitable grid connection points, and there is a strong preference for bundling of cables at both points of connection.
- Investments of around €300 million over a timescale of 9 to 15 years are required to update the grid.
- Approximately 3,000–3,500 MW could be connected without reinforcement of the onshore grid, assuming the present levels of supply and demand for power. This consists of 1,000–1,500 MW connected to the 150 kV grid and about 2,000 MW connected to Beverwijk and Maasvlakte.
- The onshore grid must be reinforced if 5,000 MW or more is to be connected.
- The Electricity Act of 1998 does not apply for connections, grids, grid operators, and tariffs outside the 12-mile zone. Transparency is required concerning the connections that pass this zone but that do not continue outside The Netherlands EEZ.

The report recommends that, in the short term, individual wind farms provide their own cable to shore, but that in the longer term, projects be able to deliver power to offshore connection points: "TenneT grid at sea." There is no published offshore grid code, and connections must be negotiated individually with TenneT. The issues were examined further in a follow-up study with similar conclusions [93].

Spain

There are no specific requirements for the grid connection for offshore wind farms in Spain yet. The Royal Decree RD1028/2007 regulates the administrative issues concerning the procedures for the authorization of the construction of offshore projects, but it does not state anything on the subject of grid connection.

Thus, the same regulation for onshore wind farms is currently in force. RD 1955/2000 develops Law 54/1997, the main electrical sector law, and regulates the different activities and relationships between the different agents operating in the electricity sector. This Royal Decree entitles Red Eléctrica (REE) to be the grid operator and enables it to establish the grid connection requirements based on the principle of quality and continuity of supply and system security.

According to RD 1955/2000, REE releases the operational procedures as "Resoluciones de la Secretaría de Estado de Energía y Recursos Minerales." This format gives the character of law to the correspondent Operational Requirement and, therefore, compliance with these Operational Procedures is obligatory.

The United Kingdom

Grid Connection

In the United Kingdom, the basic process for obtaining a grid connection is to submit an application to the relevant network operator. This may be the local distribution network operator for relatively low-voltage connections or the national grid for direct connection to the transmission system. In broad terms, the process is similar in either case.

Following submission of an application to the network operator, it is assessed (for a fee), and an agreement offer is developed on the basis of the required capacity, the nature of the generating plant, and the status (current and planned future) of grid infrastructure in the region. The network operator is then obliged to issue the offer to the applicant within a statutory three-month period that is normally followed by a meeting to establish whether the proposed agreement is satisfactory. If there is a dispute in relation to the offer that cannot be settled between the two parties, the case is referred to the regulatory body, Ofgem, for determination.

Uncertainty and Final Sums Liabilities

Obtaining a viable grid connection for offshore wind projects in the United Kingdom has been a major source of difficulty and has presented a significant barrier to the acceleration of the offshore wind sector. In this context, it is important to recognize that in contrast to Denmark and Germany, renewable energy sources have no priority for access to the grid. In addition, developers in the United Kingdom are required to pay the network operator an upfront security bond (known as final sums liability) in order for any upgrade works to commence. The problem has been that the long lead time associated with such work has forced developers to attempt to secure a grid connection at a relatively early stage in the development process and in many cases before the award of planning consents. Such securities, which have escalated massively because of the volume of applications from offshore wind projects, would therefore be at risk if a project were to be rejected during the consenting process or for some technical or economic reason. The reluctance of developers to take on such a risk has led to disputes over several offers.

An alternative option has recently been introduced by the network operators for developers known as the "Interim Generic User Commitment Methodology," whereby the annual use of system charge for the future connection is paid for the first 10 years of operation upfront, as part of the grid connection agreement. This route may substantially reduce the level of the at-risk security required to be raised by the developer for some projects.

Offshore Transmission Licensing

At present, the regulatory regime for offshore electricity transmission is in a state of formal consultation among Ofgem (the UK gas and electricity regulator), the DTI, and relevant interested parties. Two options were put forward for consultation for the offshore regulatory framework—a "Price Control Regime" (much the same as the existing onshore arrangement) and a "Merchant Approach." In March 2006 the government's decision was to regulate the offshore system by means of the price control option. Thus, in general, the capital cost of connections will be recovered by spreading the payments out over a number of years through the application of an annual use-of-system charge.

Another consultation that has recently concluded relates to the options for licensing transmission owner activities offshore. The two options put forward were as follows:

1. A nonexclusive system where an offshore transmission owner license is granted
2. A single transmission owner that would be responsible for connection requests.

The government has announced that the licensing of offshore electricity will be a nonexclusive competitive activity and that the regime will be in full operation by October 2009. The scope of licensing, in terms of assets, will encompass the infrastructure at 132 kV or above between the offshore generating station and the connection to the National Grid Electricity Transmission Plc (NGET) transmission system onshore.

This new regulatory regime is likely to have a significant impact on the feasibility of offshore renewable generation. It will essentially allow developers to convert the high capital costs of offshore electrical assets into an operational cost. Furthermore, being a price-controlled asset, the net present value of those operating costs would be significantly lower than if financed by the project. Another upside may be having output metered at the offshore substation, thus avoiding line losses from the shorelink cable. As a downside in the short and medium term, the process brings uncertainty on technical specifications and program, and perhaps undue capital expenditure.

Power Offtake

Denmark

Power offtake in Denmark is largely handled through the DEA as part of the incentive scheme. In some cases, the owner may choose to sell the electrical power to utilities or other power suppliers through a Power Purchase Agreement (PPA).

The system operator has established rules where he can demand the wind power plant to switch on and off in a smooth and timely manner, which means that the wind turbine must have such capabilities. The grid operator can also, for a short period, demand a lower production than the wind farm is able to yield if the security of the grid is in danger as regulated by law [44].

Germany

The feed-in tariff is set by law, and a grid connection is obligatory. Thus, an agreement with the utility is not strictly necessary. However, in practice, connection agreements are still required to define operational details and to take account of the reality that unlimited and immediate connection capacity is never available.

The Netherlands

Under the MEP program, renewable electricity generators receive subsidies that are based on the calculated difference between the market price and the estimated levelized production cost for the specific type of generation technology, with a maximum subsidy level of €c10/kWh.

The renewables eligible for the MEP subsidies are wind, photovoltaics, bioelectricity (including waste incineration), hydropower, and wave and tidal energy. Feed-In tariffariffs are reviewed annually and will decline over time as costs reduce through learning effects. The feed-in tariff is guaranteed for 10 years. To date, the various and frequent changes to this tariff system have not been applied retrospectively, and no existing projects have suffered a reduction in the PPA price level.

The MEP is administered by the Dutch TSO, TenneT, with the Minister of Economic Affairs overseeing the expenditure of MEP funds.

Spain

The principal authorities responsible for managing and regulating the Spanish Electricity market are as follows:

- OMEL, Operador del Mercado Ibérico de Energía: Its role is to balance the supply and demand of electricity through a market-based mechanism.
- REE, Red Eléctrica Española: Its role is the management and operation of the electric system in order to coordinate generation and distribution and to guarantee the provision.
- CNE, Comisión Nacional de Energía: It is a public body that acts as a regulator of energy systems, watching over the objectivity and the transparency of the energy system.

Wind farms have a PPA and connection agreement with the local distribution company, or the network operator, REE, depending on the location of the network connection and the voltage at which the wind farm is connected. For Special Regime producers, the PPA has an initial five-year term, thereafter automatically renewed annually. Spanish financiers do not see a risk with this five-year term, since the Electricity Law ensures automatic renewal. Special Regime producers have priority access for generation over conventional generators.

The Spanish electricity market has implemented for all sort of generators a system of clearing price based on supply and demand annulment. For special generators (those under RD 661/2007 application), such as offshore wind farms, a bonus is added to this clearing price, which was fixed by the developer that won the bidding process (for a specific area) just before the beginning of the measuring campaign and which will be applied along the life of the installation. The final income will be €c16.4/kWh as a maximum.

The United Kingdom

In the United Kingdom, off-takers (or purchasers) of renewably generated energy are electricity supply companies that are dominated by six large utilities: Centrica, E.ON, EDF, RWE npower, Scottish and Southern Energy, and Scottish Power. In addition, several specialist "green" domestic electricity suppliers also offer PPAs to wind farm owners.

For wind farms in the United Kingdom, there are typically two types of PPAs:

1. Purchase of "brown" electricity only (in the electricity market; brown refers to the source of the majority of this power)
2. Purchase of "brown" electricity, ROCs (Renewables Obligation Certificates—UK tradable "green certificates"), and LECs (Climate Change *Levy Exemption Certificates*—UK tax incentive) (combined price).

Usually these are agreed for a fixed (per MWh) rate over a fixed future period. Since both the brown power and ROC components are subject to fluctuating markets, option 2 can present a means of mitigating revenue risks, thus improving conditions for financing. In addition, some upside sharing can be built into option 2 by splitting the ROC-buyout recycle payments at the end of each compliance period (more information on this mechanism is provided in the section on the United Kingdom in Chapter 3). The duration of the PPA will also affect conditions for financing. To date, they have ranged from three to five years for offshore wind projects.

The majority of PPAs for offshore wind farms in the United Kingdom have been between the project company and a utility equity owner (presumably with a Renewables Obligation to fulfill).

Specific Environmental Regulations

The European Union

Four main European Union Directives affect the development of offshore wind projects for the five EU countries considered in this study.

Environmental Impact Assessment (EIA)

European Union Directive 85/337/EEC [32] (as amended by 97/11/EC) requires that developers of offshore wind farms that are likely to have a significant effect on the environment undertake an EIA. The results of this are presented in an Environmental Statement and submitted with license and consent applications.

As part of the EIA process, developers are required to take into account other projects and activities to form a Cumulative Impact Assessment. Included in this should be the following:

- Existing completed projects
- Approved but incomplete projects
- Ongoing activities (such as dredging)
- Plans or projects for which an application has been made
- Plans and projects which are "reasonably foreseeable."

Particular attention should be paid to cumulative visual impact.

Strategic Environmental Assessment Directive

EU Directive 2001/42/EU [34] requires national governments to examine the broad environmental impact of planned national or regional programs for specific sectors, including energy. This may be addressed through the commissioning (by the government) of Strategic Environmental Assessments for a particular region before formal adoption of a national program for the development of offshore wind.

Habitats and Birds Directives

Under the EU Habitats Directive 92/43/EEC [33], any project that is likely to have a significant effect on a Special Area of Conservation will be subject to an appropriate assessment of its implications on the site's conservation objectives. In addition, under the EU Birds Directive 79/409/EEC [31], any project falling within zones defined by member states as a Special Protection Area, known as the Natura 2000 network, will be subject to protection measures defined by the directive.

Regional Agreements

In addition, a number of regional agreements aim to protect the environment, such as the following [12]:

- OSPAR Convention (1992), *Convention for the Protection of the Marine Environment of the North-East Atlantic*, a combination of two existing conventions: the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (1972), and the Paris Convention for the Prevention of Marine Pollution from Land-Based Sources (1974). It entered into force in March 1998. It covers three main areas of pollution in the first three annexes: (1) from land-based sources, (2) dumping or incineration, and (3) from offshore sources. The final two annexes cover assessment of the quality of the marine environment, and protection and conservation of the ecosystems and biological diversity [18].
- Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992): The *Helsinki Convention* has been in force since January 17, 2000, and it succeeded the 1974 Helsinki Convention. It was adopted by Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. Perhaps because of the sensitivity of shallow, enclosed seas such as the Baltic to pollution and the generally progressive nature of Scandinavian countries, the Helsinki Convention is relatively stringent. For example, the 1974 convention already banned the dumping of waste at sea [16].
- Ramsar (1971), *Convention on Wetlands of International Importance Especially as Waterfowl Habitat*, international cooperation for the conservation and wise use of wetlands, which is defined as marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water up to 6 m deep at low tide [19].
- Espoo (1991), *Convention on Environmental Impact Assessment in a Transboundary Context*: Obligates parties to assess the environmental impact of certain activities at an early stage of planning and lays down the obligations to notify and consult each other on all major projects likely to have a significant adverse environmental impact across boundaries. It was adopted in 1991 and entered into force on September 10, 1997 [15]. The convention was later supplemented by the Kiev Protocol on Strategic Environmental Assessment¸ which was adopted in May 2003 by an extraordinary meeting of the parties to the Espoo Convention. [17].
- Bonn Agreement (1983): *Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances* [14].

Denmark

The main environmental regulations governing offshore wind in Denmark are described in the section on key applicable laws and conventions in Chapter 4.

In contrast to many other countries, defense issues do not usually present a planning obstacle in Denmark, since the work on planning for the future offshore wind farms [41] has taken defense interests into account. As presented in Table 27, defense interests can be both priority A or B, and until now there have been no significant conflicts.

The fishermen are a group for which compensation must be negotiated. There are no standard rules, but usually the calculated loss based on documentation for landed fish is used as a basis for negotiation. Problems have been observed in the North Sea, where international groups of fishermen have been causing problems (for example, removing buoys and blocking transport to site) as a way to protest not having received any compensation. The official lines of negotiation with the fishermen are through the national organization.

Testing and monitoring programs for specific environmental issues can be imposed by law, as described in the section on licensing and consenting in Denmark in Chapter 4.

Germany

The *Seeanlagenverordnung* regulates the development, construction, and operation of offshore wind projects. The *Standards for Environmental Impact Assessments of Offshore Wind Turbines in the Marine Environment* [77] describe the environmental studies to be performed in the planning stage and the measures during the construction, and reference [78] describes the turbine requirements.

Based on this, the BSH will issue a permit that may include restrictions on operation of the wind farm.

The Netherlands

Under the Wbr, an Environmental Impact Statement (EIS) must be submitted, together with the request for a building permit. The procedure starts when the applicant submits an inception memorandum (notification of intent or starting note; *startnotie*) for the EIS to the Directorate of Water Management North Sea (DNZ). If successful, the process ends with the Ministry of Transport, Public Works and Water Management awarding exclusivity and a Public Works Act (PWA) permit.

Spain

An Environment Statement (to document the results of the Environmental Impact Assessment) must be submitted together with the licensing applications. The EIA should be carried out according to Royal Decree 1302/1986, which was developed according to the European Directive 85/377/CEE. The EIA will include the following information:

- Brief description of the project on the use of the ground and other natural sources.Estimation of the quantity and sort of resulting wastes and emissions
- Evaluation of predictable direct and indirect impacts on population, flora, fauna, air, water, ground, climate factors, landscape, and historic-artistic and archaeological heritage
- Considered measures to reduce, eliminate, and make up for significant environmental harm
- Summary of the study and conclusions
- Environmental vigilance program.

The United Kingdom

Sites of Special Scientific Interest

Sites of Special Scientific Interest (SSSIs) are required to be conserved and enhanced under the Wildlife and Countryside Act 1981 (as amended) [131]. These areas typically only extend to the mean low water level at the shoreline, but potentially an adjacent or nearby offshore wind project could be considered to have an impact on the SSSI. In this instance, the relevant consenting authority is required to consult statutory environmental conservation bodies (Natural England or the Countryside Council for Wales) and to take their views into account.

Other Protected Areas

In addition to SSSIs, there are several other national designations for areas in the United Kingdom that afford protection that might jeopardize the development of an offshore wind farm:

- Marine nature reserves
- National nature reserves
- Heritage coasts
- Areas of outstanding natural beauty
- National parks.
- Landscape and seascape

In the United Kingdom, the potential visual impact of offshore wind farms is a sensitive issue, and developers have been careful to address this in conjunction with statutory consultees. The Countryside Council for Wales has produced useful guidelines on this issue [120].

COWRIE

In order to address scientific uncertainties over the potential impact of offshore wind farms on the environment, the UK government set up a company, Collaborative Offshore Wind Research into the Environment (COWRIE), to undertake and fund the necessary fundamental research required to fill such gaps in understanding. The intention was that this would aid the consenting process in the United Kingdom by providing generic findings on environmental impacts and how best to assess them during the EIA process. The Board of COWRIE is drawn from the DTI, Crown Estate, and the British Wind Energy Association (BWEA).

5

Drivers, Barriers, and Experiences

This chapter contains an overview of the different countries' experiences with offshore wind and an analysis with respect to factors driving offshore wind development and regulatory barriers that exist.

Denmark

Drivers

The main driver for offshore wind in Denmark is the positive stance of the government, as illustrated by the recent announcements on the siting of future offshore wind farms [42] within the framework of a national strategic energy plan. The very large expenses connected with grid reinforcement will almost make it prohibitive to start a project independent of tender announcements from the DEA. Therefore, independent development of nonsanctioned sites is considered unlikely.

This level of political support has been achieved partly through strong industry associations that have successfully lobbied the government. The Danish Turbine Owners Association (Dansk Vindmølleforening) is one of the two main lobbying groups with more than 80 percent of the turbine operators, including all large power plant operators, as members. The other group lobbying the political system is the Danish Wind Industry Association.

In addition to industry lobbying and coordination, public acceptance of wind turbines is at a very high level in Denmark (more than 80 percent positive during many years of polls). Local resistance can sometimes appear to a specific scheme, and therefore cooperation between developers and local people has a long tradition, also in offshore wind. Community participation is also commonplace through part ownership of some turbines. This has been achieved for offshore projects at Middelgrunden and Samsø.

The development of a new offshore wind project off the county of Hvidovre is following the same route with a strong local participation in the planning and the ownership. One-third of the total project is expected to be owned by private people; citizens of Hvidovre are expected to have a preferential option to buy shares during the first half year.

It is difficult to imagine that any single developer can "press" the timetable for development of the projects in the national Action Plan, since this is the subject of political debate. This can best be illustrated by the ongoing discussion between the government parties and the situation in the Parliament where the opposition is blaming the government for not fulfilling the targets in the old Action Plan.

The strong wind turbine manufacturing industry in Denmark can also be seen as something of a driver for the development of a viable offshore wind market. Although the vast majority of revenue is derived from exports, it can be argued that there is an incentive for the Danish administration to be taking the lead in an international sense to push forward the commercialization of offshore wind technology by continuing to foster a successful domestic market.

Barriers

Perhaps the most important barrier to the fast development of the offshore wind market in Denmark is that associated with political uncertainty. The influential industrial group Dansk Industri represents energy-intensive industries (such as sugar and cement) and has been lobbying the government to take a more reluctant attitude toward wind energy, which it sees as an expensive option. The main argument from the organization is that the members are not able to compete internationally if more RE is introduced. Ironically, wind energy represents one of the largest single export industries today, generating approximately US$5 billion annually in export revenues.

The government is also conflicted by the attitude of its minority coalition partner, which takes a strongly anti-wind stance. This conflict is in contrast to the broad political consensus on energy policy that Denmark has enjoyed historically. Another factor that will limit both the pace and ultimate extent of offshore wind employment in Denmark is the size of the electricity supply market. Denmark has a population of just 5.5 million and is already a net exporter of electricity. With a long-term target of 4 GW of offshore wind by 2030, an average build rate of 200 MW per year can be expected, which while significant perhaps does not match the ultimate potential of larger European national markets.

A Simple, Mature Framework?

The one-stop-shop procedure with the DEA as a central coordinating body has shown good results and is functioning well. The detailed upfront work delivered in the national Action Plans has addressed the long-term strategic planning required for a sustainable market.

The Danish market has a strategic plan in place for offshore wind and has had largely positive regulatory experiences from the projects deployed to date. In this sense, the national market can perhaps be seen as the most mature regulatory regime for offshore wind in Europe and by virtue of the lack of activity elsewhere in the world.

Political Risks

The cancellation of four planned offshore wind projects in 2002 following a change of administration demonstrates that even Denmark is subject to market instability because of political factors. However, that was precipitated by a change of government from a liberal pro-wind to a center-right administration. Any future change in the opposite direction would be likely just to strengthen the restabilized national plans for offshore wind.

Lesson Learned

Denmark pioneered offshore wind energy in the 1990s and has the most mature regulatory regime for this technology in the world. A major setback in 2002 because of a change in government has since been rectified, and plans are now in place for delivery of a continued pipeline of projects. In summary, the following lessons can be learned from this experience:

- Strategic planning
  The planning work carried out by the Danish authorities in the 1990s can be described as the forerunner of the Strategic Environmental Assessment, which is now enshrined in EU law. This long-term coordinated planning approach has continued with the release of planned future sites for exploitation over the next 20 years.
- A coordinated approach and the one-stop-shop
  The single most important lesson from offshore wind experience in Denmark is the value of a coordinated approach to the regulatory regime, which should work in unison with a well-organized industry and a (generally) supportive and involved local population [51]. The relative simplicity and transparency of the consenting system and its administration by a single governmental agency (which also has broader responsibilities for the development of offshore wind) has allowed Denmark to pioneer offshore wind and continue deployment with a viable, if limited, pipeline of future projects.
- Does one size fit all?
  It should be noted that the Danish approach to offshore wind is perhaps not transferrable to all markets, given country specifics. The generating utilities and electrical network operator have had and continue to have strong Danish regional or national identities. Hence, they have cooperated well to meet national objectives. It could be argued that countries with more competitive national electricity markets may require somewhat more complex systems to serve the needs of government, business, and consumers.

Germany

Drivers

The key drivers propelling offshore wind energy forward are two concerns shared universally, first, climate change, and, second, scarcity and security of energy supply. Currently, it is impossible to imagine a realistic future scenario where these concerns do not remain important. Hence, offshore wind energy would seem to be based on a sound foundation in Germany. Onshore wind energy has already reduced the country's CO_2 emissions and, with the scope for significant further expansion on land severely limited, alternatives need to be found. In spite of offshore wind's high costs, it appears to be the cheapest available and viable option for generating low-carbon electricity, the alternatives being inappropriate for the following reasons:

- Nuclear power has not recovered from the negative impact on public opinion caused by the Chernobyl disaster and, although the early closure of existing nuclear plants may well be postponed, new construction appears to be out of the question because of public opinion, uncertainty of cost, issues of disposal, and risk of terrorism.
- PV does have a high profile and high installation rates in Germany, as well as significant political and public support. However, costs remain high and hence, the capacity that can be realistically implemented in the medium term is limited.
- Biomass requires exclusive use of large areas of land. Competition for the feedstock usually accompanies it: for food in some cases, and for heating of individual homes, as well as larger buildings, in others. Many feedstocks have a greater value if converted into liquid fuel for transport, and biomass electricity generation is unlikely to be able to expand to the point where all other technologies are pushed out.
- As in most countries, the best sites for hydropower have already been developed, and major future expansion would involve environmental impacts that are no longer acceptable.

This leaves offshore wind, with technology proven to be viable and competitive onshore and strong German industrial capability, ensuring that the benefits of this policy will remain substantially in Germany.

In the medium term, nuclear, PV, and solar thermal could re-emerge as contenders. However, offshore wind should be sufficiently established by then to be able to compete effectively.

German Leadership

Germany is the largest country in Western Europe and is relatively wealthy, which has enabled it to take an active role in the development of international environmental legislation, both at a European as well as a global level. Germany's advanced manufacturing capabilities mean that advanced technological solutions, such as wind energy as opposed to reducing consumption, bring immediate benefits to the country in terms of increased exports.

Onshore wind energy is seen as a success, although important concerns about visual impact must be considered and have been balanced against the benefits of wind energy usage. The wind energy industry has its own momentum today. It is a large and powerful lobby and appears to be successful at ensuring that changes in legislation are proportionate and timely.

Barriers

Clearly, the delays in the takeoff of offshore wind energy in Germany indicate that there have been substantial barriers. Pre-eminent of these is that the existing tariff may not be sufficient to compensate for the considerable costs and risks of developing offshore wind farms. It has been difficult for the German government to estimate accurately the financial support needed, especially when at the same time there is the opposing desire to reduce the cost of wind energy. The approach chosen has been to gradually increase the support mechanisms until construction starts in earnest, although it is not yet clear whether the most recent improvements mean that that point has been reached, and the EEG tariffs may need to be modified yet again.

A second important barrier is the lack of suitably large proven offshore wind turbines. The deep waters in the German offshore sector mean that wind farms and also wind turbines need to be larger than off Denmark, the United Kingdom, or The Netherlands, and 5 MW is probably the minimum size necessary. To date, of the German manufacturers, only Siemens (via its Danish subsidiary) has gained substantial offshore wind energy experience, while REpower has installed 5 MW wind turbines in the deepest waters to date, the two machines at the Beatrice project in 45 m seas off Scotland. Enercon installed a single wind turbine close to shore near its base in northern Germany, although it has shown less interest in the market since and has pulled out of the Alpha Ventus test field. This Alpha Ventus project will still allow REpower and MultiBrid to demonstrate their technology at a remote and exposed site, and both companies have announced they will be supplying 5 MW wind turbines to first-phase developments off Belgium and France, respectively. It must be a concern that five of the six largest wind turbine manufacturers in the world[13] [2] will test their wind turbines at Alpha Ventus, that they can offer a 5 MW wind turbine, or that they even have announced the imminent development of one. Given their recent

13. The exception being Suzlon through its ownership of REpower.

renewed enthusiasm for offshore wind farms, it would seem highly likely that Siemens would also supply a 5 MW wind turbine in the medium term, although the technology development and trialing will require several years. The other major manufacturers have not given any indications that they may change their currently disinterested stance.

Experience with the first large offshore wind farms has been challenging, in particular at Horns Rev. Rapid expansion of manufacturing capacity will involve major risks. There have been several high-profile and extremely expensive retrofits to offshore wind farms, resulting in heavy losses for the wind turbine suppliers. Similar experiences in the first German projects to be constructed will delay the expansion of offshore wind in the country by several years.

The way that the German on-land market developed in general meant that there was a lack of large and experienced companies with the financial ability to develop the first-phase offshore wind farm: 80 wind turbines, 400 MW, and an investment of around €1 billion. The site claim and permit application procedures are relatively low cost, and the small German wind developers were able to fund the work through to receiving the permits, although they generally avoided the major costs of geotechnical surveys and met masts by restricting themselves to lower-cost geological surveys and waiting for the government to finance the FINO met masts. The existing developers need to sell at least part of the projects to a financially stronger partner in order to build the wind farms, and DONG, Airtricity, and E.ON indeed ended up buying projects. No doubt there are differences between how the small developers and the potential investors value these projects.

Grid connection to shore has also been a challenge, first because of the cost and second because of the complexity of permitting, when a large number of projects simultaneously need new connections to the sufficiently strong grid points over 50 km inland. The chosen solution has been for the utilities to supply the grid connection through to the offshore substation, although this results in a split of responsibilities and interests. Will the utilities provide connections of sufficient quality and will they do so early enough? It may be wise for project developers to pursue the permitting process themselves and then pass the permits over the utility to construct.

In general, the German regulatory system has encouraged high levels of activity, but with limited progress, and allowed the development of widespread offshore project development capability and knowledge. The lack of transparency earlier and the presence in Germany of large numbers of small developers have resulted in limited foreign involvement. Indeed, there has been very limited foreign involvement in German onshore projects until recently.

Lessons Learned

Two important points shed light on how the German offshore experience could have been and could be improved:

- Development has been slow. Why was this?
- Offshore project sites were allocated in an unstructured manner. Were the sites awarded to developers that were most capable of realizing the projects?

Development has been very slow. If project construction were going to start only the turn of the decade, was it really efficient that sites were allocated at the beginning of the decade? The German offshore seabed is relatively small in comparison with the targets for offshore wind energy. Small developers have been able to make claims for large expanses of seabed at relatively low cost, although the relative risks to the capital base of such small companies could be high. It must be admitted that there are no perfect solutions to this challenge. In other countries where moratoriums have been put in place or large deposits required, developer unhappiness has been equally prevalent.

As in most countries, the size of the potential rewards in Germany caused applicants to request site licenses and construction permits before the regulatory regime was in place. The original regulatory regime was not suitable for potentially high-cost and high-value projects, such as wind farms, and the majority of permits were lodged before the regulatory regime could be adapted. In addition, an unstructured permitting process allowed small, agile businesses to claim the sites. To some extent, this can be seen as a false early start to the sector deployment.

The involvement of foreign companies may bring in capabilities and experiences missing among the home companies, in addition to the obvious expansion in access to investment capital and competition between developers. This can stimulate progress, with DONG's contribution to the United Kingdom being a good example.

The Netherlands

Drivers

The Netherlands is a trading nation, with Rotterdam in particular playing a prominent role in European and world trade, including that of oil and gas; The Netherlands is one of Europe's three largest producers of natural gas [88]. At the same time, a large part of the country is on land reclaimed from the sea and hence is below sea level. This creates internal conflicts over how to deal with climate change, since the country disproportionately benefits from extracting and trading fossil fuels in the short term while being disproportionately sensitive to the effects of global warming in the longer term.

The Netherlands did not take on a particularly challenging Kyoto target, requiring only a 6 percent reduction in GHG emissions for the 2008–12 period compared with 1990 levels. The primary focus to achieve this has been energy efficiency, and much has been done to reduce energy consumption in buildings. CHP, district heating, and building-integrated PV are well supported, and there are significant installed capacities of these technologies. Meanwhile, The Netherlands has limited expanses of undeveloped land, which consequently are probably more highly valued than elsewhere, which creates challenges for the development of onshore wind.

Consequently, offshore wind presents the best large-scale RE development potential for The Netherlands. This is further reinforced by the maritime history of the country and its large and active oil and gas industry bringing relevant expertise.

Barriers

The grid capacity will pose a barrier to offshore wind if more than 3,500 MW are to be connected. Plans are in place to reinforce the grid, but not at a pace that could encourage large-scale rapid development.

The MEP tariff for offshore wind is not particularly generous. This appears to be a deliberate policy to attract only those schemes that can be made commercially viable in the shorter term rather than subsidize the industry for its own sake. It is notable that only nearshore projects that can be expected to have lower capital expenditures and O&M are currently moving forward. There have also been and continue to be numerous changes to the MEP and related government policy, at times of a significant nature, which has unsettled investors and developers.

Does This Work for The Netherlands?

Historically, the support system for renewable electricity in The Netherlands has been a confusing mix of different schemes that have changed frequently. Hence, investors cannot be sure at the inception of a project what type of support mechanism will be available, if any, once permits have been obtained and the project can be constructed. The previous REB scheme, an ecotax applied to nonrenewable energy sources, stimulated significant demand for renewables, but unfortunately not an expansion of indigenous supply. For example, by 2002, 1 million Dutch households were buying green electricity, the majority of which was being produced cheaply in neighboring countries and then imported.

Since the introduction of the MEP scheme in 2003, RE generated within The Netherlands has increased. Together with improvements to the planning regulations, a rapid expansion in offshore wind project activity has resulted, with submissions for 20–25 GW of offshore projects delivered to the ministries. However, it should be noted that to date only two major offshore wind farms have been approved. They are under construction, and both received consent via alternative routes. Hence, the current procedures have not been demonstrated to be effective.

The strengths of the Dutch system can be quantified as follows:

- A mixture of tax reduction and a guaranteed premium for wind power should encourage both indigenous demand and supply.
- The majority of the subsidies are based on production; hence, only successful projects are rewarded fully.
- The MEP system consists of the relatively simple feed-in tariff as opposed to the complications of previous schemes in The Netherlands and elsewhere.
- The Wbr appears to provide a single set of procedures to be followed to gain all the necessary permits to build.

The key concerns relate to the following:

- Whether a 10-year premium will be sufficient, since projects may have to be amortized over this relatively short period; 15 to 20 years may be more appropriate.
- Adjustment of the MEP tariffs on an annual basis, breeding uncertainty; the government also has a

recent history of summarily suspending the support mechanism, as happened in both mid-2005 and mid-2006.

- Lack of transparency in how competition between applications will be resolved; this causes further uncertainty and could have been resolved through bidding rounds.
- The need for grid reinforcement for a total offshore wind capacity over 3,500 MW.

Lessons Learned

The first key message is that regulatory uncertainty will stifle development, and the number of changes in the past years of the subsidy schemes and permitting policies means that offshore wind power has not been as successful in The Netherlands as it could have been. Any government support scheme needs to follow the principles of being clear, free from unnecessary change, and sufficiently long term to attract investors. In The Netherlands, although the first offshore wind farms are under construction, regulatory uncertainty continues to exist, discouraging private parties from investing in offshore wind.

The second key message relates to having a more defined spatial planning process up front to ensure that permit applications do not overlap. This causes uncertainty for the developers, generates duplicate work for the permitting authorities, and delays the approval processes.

Finally, the inclusion of timely and appropriate grid studies and transparency in the timing and allocation of financial and permitting responsibilities is also important, as are the development and publication of grid codes and standards applicable to offshore wind.

Spain

Drivers

The fact that specific legislation for the permitting of offshore wind energy and for stipulating a specific feed-in tariff has been published creates an initial level of confidence in the future of the industry. This is likely to be a highly effective driver for encouraging exploitation of offshore wind energy in Spain, as recent announcements have demonstrated. Spanish government policy on RE, at both national and regional levels, has tended to be highly encouraging and stable, and the expectation is that this will also be the case for offshore wind.

The government goals for sourcing increasing proportions of total energy from renewables in order to combat climate change can also be considered a driver. Other new renewable technologies (if hydropower is not classed as a new RE), with the important exception of onshore wind, make only a limited contribution to electricity generation currently. Offshore wind energy has the opportunity to expand rapidly once suitable technologies and a manufacturing capability have been developed.

The strength and ambitions of the major Spanish RE developers can also be seen as drivers. They are showing preliminary interest in wind energy and offshore wind outside Spain and can be expected to push offshore wind projects forward within Spain as soon as attractive opportunities present themselves.

The tariff established by the government on initial inspection appears to be sufficiently high to encourage development. However, there is a competitive element that should ensure that financial support is spent effectively and efficiently, although it carries the risk that successful bidders will have underbid and will be unable to complete the projects. The requirement to pay a guarantee in two stages means that high-risk strategies will carry a significant cost to the bidder.

Barriers

The current lack of experience and infrastructure is a significant barrier. The purpose of the extended timescale through the permitting process and to construction may have been to allow this to be rectified.

The number of suitable sites for bottom-mounted offshore wind turbines is very limited off the Spanish coast because of Spain's position at the edge of the continental shelf. Significant potential exists for floating offshore wind once a reliable and economically feasible technology has been demonstrated.

There has been considerable resistance to the offshore wind farms proposed to date, in particular from the fishing industry, tourism, and environmental interest groups. With tourism being extremely important and prevalent in Spain, it is perhaps not surprising that many suitable sites are also popular tourist destinations. In addition, the rapid descent of the seabed close to shore means that projects need to be sited extremely close to the coast, exacerbating this situation.

Experience

Not surprisingly, Spanish companies have had very little experience with offshore wind to date, although this can be expected to change, in part because of Iberdrola's purchase of Scottish Power, together with its portfolio of offshore wind farms.

In addition, if Spanish turbine manufacturers develop offshore wind turbines, a demonstration offshore wind project would allow validation and an opportunity to gain experience in operating offshore.

The United Kingdom

Government Policy

The most important drivers for the development of offshore wind in the United Kingdom are political, which have led to strong governmental support. Principally they are associated with climate change and security of supply. It is these issues that have stimulated the UK government to pursue a policy of support for the substantial deployment of renewable energies. This support has been enacted in the Renewables Obligation—the mechanism that is designed to meet national targets on RE through a market-based approach. Security of supply as an issue has come to the fore, with much of the UK nuclear capacity coming offline by 2015 and reliance on gas imports increasing.

New nuclear generation remains an option for the UK government as a means to fulfill national and international commitments on carbon emissions and energy security. The 2007 Energy White Paper indicates a willingness to pursue this to some degree. However, major obstacles relating to public acceptance and economics or financing remain. In addition, any new build nuclear program in the coming decade is only likely to offset reduced generation through the decommissioning of existing nuclear plants that are coming to the end of their design life. Recently (June 2008), very positive statements were made by senior figures, including the prime minister, about the future of nuclear in the United Kingdom, and the development of new nuclear power plants now seems to be a certainty.

RE technologies, other than wind energy and existing hydropower installations, are unlikely to make a substantial contribution toward the national target of 15.4 percent renewable electricity supply by 2015, because of their immaturity or lack of economic viability, or both. Significant support has been provided to wave and tidal energy technologies with the intention of commercialization for significant deployment beyond 2015. Little scope exists for the significant expansion of hydropower in the United Kingdom and the lack of socially, environmentally, and economically acceptable sites for onshore wind will ultimately limit deployment—especially in the 2010–15 timeframe. These factors in combination suggest that the only means of achieving the 2015 national target is through the large-scale deployment of offshore wind energy. The slow initial progress on this front in the United Kingdom primarily because of poor economics has been addressed through the proposed revision to the RO with increased support for offshore wind. Latterly, the announcement of plans for 25 GW of further offshore wind site awards in a new concessionary round has clarified the level of ambition of the current government with respect to offshore wind.

Early-Mover Advantage

A subsidiary driver for offshore wind in the United Kingdom is the skills and knowledge advantages that companies may obtain through the experience gained in the development, construction, and operation of early projects. This is particularly important if there is a clear indication that there will be a substantial, viable market in the medium to long term. This factor was perhaps crucial in the construction of the first two Round 1 projects—North Hoyle and Scroby Sands. More significant is the pre-eminence of the Danish utility DONG as a developer in the UK offshore market, having gained substantial early offshore wind experience in Denmark. In general, it could be argued that, in the context of offshore wind, UK utilities are to a varying degree "behind the learning curve." Strong evidence now suggests that this issue is being addressed, with an acceleration of utility-led deployment expected for the period 2007–10.

Grid Access and Costs

Connection to the grid has been a major barrier to the development of the offshore industry in the United Kingdom in two ways. First, as described in the section on grid access in the United Kingdom in Chapter 4, access to the grid has necessitated negotiations with system operators who have no obligation to provide priority access to renewables and who have imposed the payment of large securities as a condition of any offer to cover the cost of upgrading works in the event that the project is not built. Second, in contrast to Denmark and Germany, the high cost of connecting the wind farm to the grid is currently borne by the project company. This significant additional capital cost has contributed to poor economics for many projects.

These grid-related issues are currently being addressed to some degree by the UK government and the electricity industry regulator, Ofgem. The most important outcome of this is likely to be the licensing of third parties to own and operate offshore electricity transmission assets—charging projects on a use-of-system basis. From the developer's perspective, this will effectively convert a capital expenditure into an operational expenditure, thereby providing the potential for some improvement in project economics.

Consenting Success

Perhaps the most successful aspect of the regulatory regime in the United Kingdom has been the success rate for consent applications and the associated resolution of stakeholder conflicts during this process. This success has come in many ways in spite of the laws regulating the construction of offshore wind that are relatively complex and in some cases outdated. Although this is being addressed by the Marine Bill, which is likely to result in a more streamlined legal framework, the interim solution of creating a coordinating body for applications (ORCU) appears to have been successful. As well as a good success rate, the vast majority of offshore wind consent applications reached determination within 18 months of submission.

Technology Blind Support—The Problem with the RO

The principal framework for encouraging offshore wind in the United Kingdom is what is used for all RE technologies—the Renewables Obligation (RO). (More details on this are provided in the section on the United Kingdom in Chapter 3.) In its current form, the RO provides undifferentiated support for all renewables in the form of a tradable certificate system with an increasing annual target. The strength of this system is that the level of incentive is directly proportional to the target deficit ; therefore, the effective level of support is continually adjusted depending on the target in each year and the generation level. This system will inherently favor the cheapest RE to produce—currently onshore wind.

In some ways, this undifferentiated support can be seen as an advantage, since it is most efficient to deploy the cheapest technology. However, for the system to be successful, the deployment rate of the cheapest technology should always be sufficient to achieve the majority of the increasing RE target set by the RO. The barriers faced by developers of onshore projects in the United Kingdom are increasing because of a lack of site and grid connection availability (in the windiest regions). Although this is likely to mean that incentives will increase as the gap between the annual obligation and the achieved level widens, they are unlikely to increase *enough* to offset the cost differential between energy generated from onshore and offshore wind farms. This will lead to high returns for onshore wind farm owners and limited growth of the offshore wind sector in the United Kingdom.

The UK government is attempting to address this issue through amendment of the RO to provide technology-differentiated support, from 2009 at the earliest. This will mean that the RO will provide an additional 50 percent of support for energy generated at offshore wind farms compared with the energy generated onshore. Some commentators have suggested that the success or failure of the RO on a technology-differentiated basis will be highly sensitive to the exact value of the arbitrary multiples applied.

In general terms, the RO has also been criticized for transferring risk to the private sector through the perceived political risk associated with time-variable levels of support. It can be argued that this has affected the value of PPA contracts, as well as the lending profile financiers ascribe to RE projects in the United Kingdom.

The lessons learned from regulatory experience in the United Kingdom can be summarized as follows:

- Streamline consenting.
  The creation of a single government body for dealing with consents for all offshore RE projects in the United Kingdom has contributed to both the relatively high success rates and short evaluation periods achieved to date. Further streamlining of the consenting process, including the consideration of strategic national issues, through the forthcoming Marine Bill, is likely to simplify the process further. Where existing legislation is inappropriate to facilitate renewables deployment in line with government policy, industry should lobby to amend such legislation and, where possible, simplify consenting procedures.
- Align grid regulation with strategic energy policy.
  The regulation of electrical grid infrastructure and energy transfer in the United Kingdom is controlled by the independent body, Ofgem. Disputes between offshore wind project developers and network

operators are arbitrated by this body whose primary objective is to protect the rights of consumers and not to help the government achieve strategic energy targets. It is argued that this incongruity is not for the long-term good of anyone and has helped to stall offshore wind deployment in the United Kingdom. Alignment of grid regulation and government energy objectives would help to accelerate the deployment of offshore wind.

- **Deal with differences in cost *and deployment potential* when incentivizing renewables.**
  As described above, the incentive system in the United Kingdom (the Renewables Obligation) is to some degree flawed, since the targets will substantially exceed the deployment capacity of the cheapest RE technology while not adapting quickly or severely enough to stimulate growth in the next cheapest technology. This is now being addressed through reform of the RO, although the results of this reform will not be seen for many years. Whether a feed-in tariff approach (as favored in all four other countries considered in this study) or a tradable certificate scheme is favored, the incentive system must account for differences in the cost of supported technologies and their potential to meet government targets, given deployment constraints.

Other Countries

Some brief notes are provided on three further European countries not considered in detail for this study, but where recent regulatory reform is likely to have a major impact on the development of offshore wind projects. Outside Europe, there is considerable interest in the United States, and more recently in Canada; Japan, where two turbines have been built in shallow waters at Setana [139]; China, where a wind turbine was installed offshore during 2007; Korea, where plans for a demonstrator at Jeju are well advanced; and Taiwan (China), which recently announced a competitive tender for six sites for offshore wind farms [138].

Belgium

Belgium is an informative case and hence useful to study in greater detail, even if the market is likely to remain limited in size. Initially, Belgium suffered from a divergence between the excellent enthusiasm of the project developers and the poorer commitment and capability of the regulatory regime and authorities. This is exemplified in the extreme case of a Belgian developer that believed it had all the necessary permits and proceeded tp place a purchase order with the turbine suppliers only to discover that the authorities had made an error and hence the permission was invalid.

When the first projects were developed in 1999, there was no legal framework; hence, applications for concessions, construction permits, and tariffs were made ad hoc. This changed in 2004, when a 270 km^2 zone for offshore wind projects was designated adjacent to the Dutch border [159], within which three projects are currently under development [160].

Offshore wind energy is regulated at the national level (unlike on-land wind energy), with only the province of Flanders having a coast. Table 32 summarizes Belgian legislation governing offshore wind development.

In reality, the developer has a choice of funding mechanisms, with the federal offshore feed-in tariff (FIT) being the most generous [5]. Concession applications are made whenever the developer wishes. However, to ensure competition, a public announcement is made and contenders have 30 days to inform the authorities that they

TABLE 32: BELGIAN OFFSHORE WIND LEGISLATION

Subject	Level	Legislation
Domain concession	Federal	Royal Decrees of December 20, 2000, and May 17, 2004
Wind farm building permit and exploitation permit	Federal	Protection of the Marine Environment 1999
Offshore cable building permit and exploitation permit	Federal	Royal Decree; March 20, 2002
Onshore cable permit	Flanders	Royal Decree; May 18, 1999
Feed-in tariff[a]	Federal	Royal Decree; July 10, 2002

a. 90 €/MWh FIT for the first 10 years of operation.
Source: [5].

wish to challenge for the site. The minister will need to evaluate the competing proposals and decide which proposal merits success. The submission should define the scope of the EIA, which, unusually, is not undertaken by the developer, but instead by a government department MUMM (*Management Unit of the North Sea Mathematical Models*)[162].

Details of the Flanders grid code are given in [163]. Wallonia does not have a coastline.

Ireland

Ireland (Eire) has a single offshore wind farm consisting of seven 3.6 MW wind turbines lying on Arklow Bank of the east Irish coast. It was developed by Airtricity in partnership with the wind turbine suppliers, GE. At that time, no special offshore framework had been created. Hence, this can be considered a demonstration project for Ireland, as well as for both parties involved, since it was the first offshore wind farm to be built by either party. Plans for the subsequent phases of this project have been delayed pending creation of a suitable framework with sufficient financial support to make offshore wind viable.

In February 2008, the Irish government announced that an incentive scheme for offshore wind would be created and provided a feed-in tariff of €140/MWh.

This followed an announcement in the most recent white paper, which reconfirmed the commitment to a target of 15 percent of electricity consumption to be met by RE by 2010 and also introduced a new target of 33 percent by 2020 [164]. This compares favorably with EU Renewables Directive target for Ireland of 13.2 percent of electricity consumption in 2010 [35]. In fact, the 2020 target was raised from 30 percent and converted from an aspiration into a commitment compared with the preparatory green paper.[14]

The permitting process for offshore wind farms in Ireland consists of two main steps:

1. A foreshore *license*, which assigns exclusive rights to the developer to perform an in-depth site assessment within four years and allows the developer *legitimate expectations* that it will have priority
2. A foreshore *lease*, which assigns exclusive site development rights.

Prior to construction, three further permits are required:

1. Authorization to construct a generating station
2. A license to generate electricity
3. A license to supply electricity [162].

To date, although a dozen projects have had a license, only one has been constructed, primarily because of the low feed-in tariff payable, of €c5.7/kWh over 15 years, identical to onshore premiums and lower than the offshore wind cap set at €c8.4/kWh under the final round of the previous competitive tendering under the Alternative Energy Requirement (AER) Programme [165].

Further changes to the Irish electricity market include the introduction of a single electricity market on November 1, 2007, with participation mandatory for generators of 10 MW and above. The recent rapid expansion of the Irish economy has been accompanied by a similarly rapid expansion in electricity demand and plans for a reinforcement of the electrical network, including two new interconnectors—northward to Northern Ireland and eastward to Wales. The early years of this decade (the 2000s) saw a moratorium for new wind farm connections, and recently only three substations, all located on the east coast, were capable of connecting significant offshore wind energy capacity.

A key challenge for the expansion of RE in Ireland is the relatively small size of the grid, which delivers electricity to only around 5–6 million people, and the paucity of alternatives. Hydropower potential is limited, sunshine is less abundant than elsewhere in Europe, and marine energy is insufficiently mature to provide a credible amount of electricity at such a close date. Hence, new grid connections will be needed, either in the form of a new interconnector, potentially between Ireland and Wales, or in the longer term in the form of a more substantial network, such as that envisaged by Airtricity in the Offshore SuperGrid. On a final positive note, the offshore wind resources appear to be excellent [166].

France

The national target for RE set by the 2001 EU directive is 21 percent by 2010, which requires an increase of 6 percent over the 1997 figure [35].

14. Editor's note: *White paper* generally refers to documents that contain proposals and statements of government policy. *Green papers* generally put forward ideas and opinions for consideration, public discussion, and consultation.

To achieve this, onshore and offshore wind are being expanded, with the feed-in tariff having been established in 2000, including for onshore wind farms of up to 12 MW [140]. In 2004, in parallel with the onshore feed-in tariff, a series of competitive tenders for RE PPAs was offered by the CRE (Commission de Régulation de l'Energie) [141], including for larger onshore wind farms and up to 500 MW in total for offshore projects. The conditions for the offshore tender included the following [142]:

- Maximum project size of 150 MW
- Expected production of at least 2,200 equivalent full-load hours
- Fixed structures (no floating wind turbines permitted)
- Siting within the 12-mile territorial zone of mainland France.
- Evaluation criteria: price, 60 percent; technical and financial capabilities, 15 percent; environmental impact and decommissioning, 15 percent; and conflict with other users, 10 percent.

After more than one year of evaluation, the CRE recommended offering PPAs to two projects only, with the minister going against this advice and awarding a PPA to a single project, at Côte d'Albâtre [143]. The other 12 projects were rejected for various reasons, including visual impact and excessively high bids. According to the conditions of the tender, the wind farm should have started operating by the end of 2006. However, the delays in the decision process, together with this being a totally unrealistic requirement in the first place, means that this condition has been relaxed.

This competitive tender awarded a PPA at the requested price, as well as a concession, but did not award a construction permit, which had to be applied for in a separate process to the *préfet* (prefect) of the local department [144].

In 2006, the government announced a new feed-in tariff, which included offshore wind at €c13/kWh for the first 10 years followed by a sliding scale between €c13/kWh and €c3/kWh for the next 10 years, depending on the productivity of the project in the first period. The tariff is indexed to inflation once the wind farm is in operation. However, it reduces by 2 percent per year for commissioning dates after 2007. During the second 10 years of operation, a sliding-scale tariff between €c13/kWh (2,800 full-load hours), €c9/kWh (3,200 full-load hours), and €c3/kWh (3,900 full-load hours) is available, depending on the productivity of the project in the first period [145].

In addition, as of 2005, the 12 MW size limit was withdrawn (it was being circumvented anyway by the construction of multiple 12 MW wind farms adjacent to each other) and a new requirement was instituted that wind farms need to be located within a ZDE, *zone de développement de l'éolien* [146].

Since 2002 [147], French renewable policy has been guided by the *Programmation pluriannuelle des investissements* (Multiyear Investment Program, PPI), with the 2006 revision specifically identifying a target of 1 GW by 2010 and 4 GW by 2015 of offshore wind capacity [148].

Lessons that can be learned from the French experience are as follows:

- Maximum wind farm size tends to be circumvented by construction of multiple wind farms adjacent to each other.
- Feed-in tariffs that depend on equivalent hours output may encourage poor utilization of the grid capacity, since the wind farm operator is encouraged to use wind turbines with relatively low capacity factors.
- The first offshore tender of 2004 was not well designed and hence has not delivered significant capacity. In the very limited time available, the majority of the bidders could not resolve the conflicting requirements of bidding a low price and hence requesting a cheap site to develop, on the one hand, versus the need to protect the environment while taking account of local interests and other users of the seas, on the other.

Sweden

Svante 1—A World First

Sweden led the world with the first deployment of an offshore wind turbine at Norgersund, Blekinge, in 1990/91. The single turbine was a 225 kW Wind World unit, which was decommissioned in 2006, and which in itself was another world first.

Since then, four more wind farms have been constructed, as summarized in Table 33.

Table 34 presents information on Swedish offshore wind farms under development. A number of further projects have been under development, in some cases for almost a decade. The main reason for the failure of these projects to progress further has been weak project economics because of the current incentive scheme.

TABLE 33: SWEDISH OFFSHORE WIND FARMS IN OPERATION

Project	Bockstigen	Utgrunden I	Yttre Stengrund	Lillgrund
Location	Southwest of Gotland	Kalmar Sund, Kalmar Län	Kalmar Sund, Blekinge Län	Öresund, south of the bridge
Status	In operation	In operation	In operation	In construction
Installed capacity	2.5 MW	10 MW	10 MW	110 MW
Number of turbines	5	7	5	48
Turbine size	0.5 MW	1.425 MW	2 MW	2.3 MW
Distance to shore	3 km	8–12 km	5 km	10 km
Sea depth	6 m	7–10 m	8 m	9 m
Foundation	Monopile	Monopile	Monopile	Gravity base
Commissioned	1998	2000	2001	2007
Turbine manufacturer	Wind World	Enron Wind (GE Wind)	NEG-Micon (Vestas)	Siemens Wind Power

Source: Garrad Hassan and Partners Limited compilation.

Overall National Renewable Energy Target

The Swedish production of power based on wind energy is about 1 TWh/year out of a total electricity demand of about 135 TWH/year (2006). As of the end of 2006, 571 MW of wind capacity had been installed in the country, and net production that year was 0.99 TWh.

The parliament has set the target for 2015 of 10 TWh/year corresponding to approximately 4 GW of installed wind capacity. This is characterized as a relatively modest target, since the potential for deployment in Sweden is thought to be considerably larger than this. Even to attain the 10 TWh/year target, however, will require a considerable acceleration of deployment, with a 10-fold increase in current RE production. The Swedish government assumes that 60 percent of this 2015 target will come from offshore wind projects outside territorial waters, with the remaining capacity coming from onshore wind and offshore projects within territorial waters [153]. In addition, the 10 TWh per year target actually only relates to the spatial planning system that should allow for the development of renewable capacity to meet this value.

TABLE 34: SWEDISH OFFSHORE WIND FARMS IN PLANNING

Site	Developer	Status	MW
Klasården	Vestas	Planned	44
Utgrunden II	E.ON	Consented	90
Kriegers Flak	WPD/Vattenfall	Planned	500–640

Source: Garrad Hassan and Partners Limited compilation.

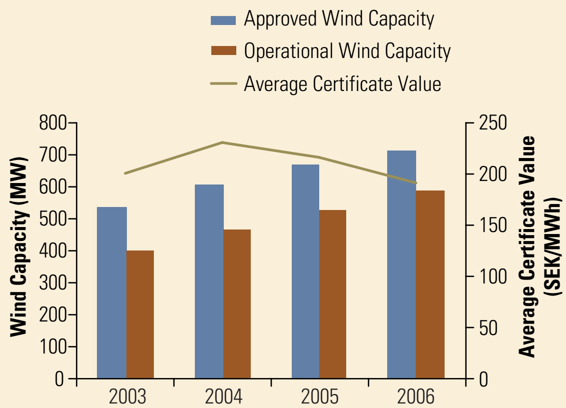
Renewable Electricity Certificates

The Elcertifikatsystemet was introduced in May 2003 for all RE-based electricity, and it replaced other incentive systems. The system is based on a market mechanism to create competition between RE systems and is comparable with the ROC system used in the United Kingdom. There is no provision for technology-differentiated support under this mechanism, so the system encourages deployment of the cheapest available RE technology.

The producer of electricity receives a certificate for each unit of RE generated. Electricity suppliers are obliged to buy (or generate) certificates equivalent to an annually increasing proportion of the company's supply [154]. The RE targets under this scheme are 10.4 percent of supply by 2005 and 16.9 percent by 2010.

Significant industry concerns over post-2010 subsidy levels led to the extension of the Renewable Energy Certificate scheme in 2006 out to 2030. Renewable generating plant is eligible for support under the scheme for a period of 15 years. The quota beyond 2016 will be reduced significantly to allow for generating plants that have been in the system for 15 years, to leave it and a more modest level of support for new plant beyond that time.

FIGURE 24: AVERAGE VALUE OF SWEDISH RENEWABLE ENERGY CERTIFICATES



Source: Garrad Hassan and Partners Limited.

In 2005, the average price of the certificate was about SEK 225 per MWh. The variation of this price since the system came into force is presented in Figure 24. The penalty for not buying certificates is a tax of 150 percent of the price of the certificates based on the average price in the previous 12 months.

Environmental Bonus (Miljöbonus)

For wind power–based electricity, a supplementing support system has been in force. This system will end by 2010. Offshore wind has received higher bonuses than onshore wind, as seen in the Table 35.

The typical revenue rates to the producer of offshore wind generated electricity in 2007 in Sweden are provided below by way of example:

- Market electricity price: ~ SEK 0.30 per kWh
- Renewable Energy Certificate: ~ SEK 0.20 per kWh
- Miljöbonus (2007): ~ SEK 0.15 per kWh

TABLE 35: VALUE OF SUBSIDY (MILJÖBONUS) FOR ONSHORE WIND AND OFFSHORE WIND

Year	Onshore [SEK/kWh]	Offshore [SEK/kWh]
2007	0.04	0.14
2008	0.02	0.13
2009	0.00	0.12
2010	0.00	0.00

Source: Garrad Hassan and Partners Limited.

- Total: ~ SEK 0.65 per kWh (~ €0.07 per kWh)

It should be noted that the market electricity price was subject to significant volatility in 2006 in Sweden because of erratic rainfall and the consequent shortfall in hydroelectric production.

Future Changes

The Swedish government recently commissioned an investigation into the connection of RE to the grid [155]. The scope of this work is to assess the suitability of the existing legislative regime for the large-scale deployment of RE. The commission was due to report before the end of 2007, but little has been published. A guide to developing wind farms, with a brief mention of offshore, was published by the Swedish Energy Agency in 2008 [156].

Comparative Summary

Table 36 provides a brief comparative summary of the identified drivers, barriers, and experiences for offshore wind in the five countries considered.

TABLE 36: COMPARATIVE SUMMARY—DRIVERS, BARRIERS, AND EXPERIENCES

Country	Drivers	Barriers	Experience
Denmark	• Positive government stance • Indigenous wind turbine industry • Strong industry lobbying • High levels of public support	• Future political uncertainty	Strong early government support and industrial innovation. Regulatory framework has matured and benefited from simplification and centrals administration by the DEA.
Germany	• Positive government stance • Public support for wind • Limited further onshore potential	• Lack of suitable turbines • High costs because of difficult sites • Financially weak developers • Timing of grid consent and construction	No significant offshore deployment to date because of very weak economics. Increased incentive will be required to address this. Entrance of larger players signals the start of a new phase of development.
Netherlands	• International commitments • Developer activity	• Unstable support mechanism • Unsuitable and unstable regulation • High costs of grid upgrades	Successive changes to both the support mechanism and regulatory framework have hindered development. Despite this, a large volume of applications has been made, but the system for dealing with these effectively is unsuitable.
Spain	• Positive government stance • Public support for wind • Strong developers • Indigenous wind turbine industry	• Limited offshore potential using currently demonstrated technology • Significant onshore potential remains	Regulatory framework for offshore wind has recently been created. There was an apparent attempt to learn from the experience of onshore wind in Spain and offshore wind in other countries.
United Kingdom	• International commitments • National commitments • Positive government stance • Limited further onshore potential	• Grid regulation and costs • Undifferentiated incentives	Reform of regulation and incentives for offshore wind in the United Kingdom has been implemented and has stimulated growth. The alignment of grid regulation to government policy has not yet been achieved, which is a major barrier for future developments.

Source: Garrad Hassan and Partners Limited.

6

Conclusions

Based on documentary evidence presented in Chapters 2 (Market Development), 3 (Targets and Incentives), and 4 (Regulatory Framework) of this report and the inferences discussed in Chapter 5 (Drivers, Barriers, and Experiences), several themes have been identified with respect to best practice for the regulation of offshore wind energy. Clearly, this suggested practice should be adapted appropriately for use in China, but some matters are clearly beneficial whereas others are clearly detrimental.

Avoiding Past Failures

The following findings are based on poor experiences to date in one or more of the national markets considered in this study. The root cause is described, along with potential measures that may allow the failure to be avoided.

Inappropriate Legislative Frameworks

Given the relative novelty of offshore wind technology, certain areas of the regulatory regime for most of the national markets examined are considered inappropriate. This theme is of particular importance in the area of consenting, where,in many cases existing legislation has had to be utilized that was designed to regulate other activities, such as oil and gas exploitation. This can lead to a complex and uncertain consenting route that can add to project costs, delays, and potential failures. Where existing legislation is a significant barrier to offshore wind deployment, legal reform is necessary.

Coordinated industry lobbying of government is the most effective way to achieve the required regulatory reform, although in the absence of genuine political support for offshore wind, this is unlikely to be enough to bring about the necessary changes.

Ineffective Industry Coordination

Offshore wind development can be stifled in the absence of effective industry coordination. In The Netherlands, the wind lobby has been unable to incentivize the government effectively to make the changes necessary to accelerate offshore wind deployment. This has been partly a result of the lack of strong and influential industry associations that should be the primary lobbying vehicle for industry. This can be contrasted with experience in Denmark, where a united and coordinated industry body has effectively lobbied the government to bring about the development programs and regulatory reforms necessary for a successful offshore wind industry.

The development of a strong, united, and influential industry association provides the coordination necessary to have a significant impact on government policy on and regulation of offshore wind deployment.

Grid Access Difficulties

The review presented in this report identified grid access to be a significant barrier to deployment in all the national markets considered. Although the detailed reasons for this differ, a general conclusion is that where the regulation of grid infrastructure is not aligned to national policy objectives with respect to RE, delays in offshore wind deployment are likely. A good of example of this can be found in the United Kingdom, where the grid regulator prioritizes protection of consumer rights and is tasked with minimizing cost over the delivery of RE.

Access to the grid is a significant barrier to offshore wind energy, unless its regulation is aligned to RE policy objectives, and responsibility for costs and construction is clearly delineated at an early stage.

Political and Regulatory Instability

Changes to government policy and the regulatory regime for offshore wind can cause a loss of financial confidence, delaying investment decisions and, consequently, deployment. Experience in Denmark following the cancellation of four planned offshore wind farms in 2002 can be said to have damaged the confidence of developers in that market to proceed quickly with sanctioned sites. Instability in the incentive framework in The Netherlands has been identified as a major issue in that national market. Proposed reforms to the incentive regime in the United Kingdom can be considered unsettling for RE in general, but for offshore wind, the additional revenue support it will create has to be viewed as positive for that technology.

Repeated reform of regulations can be avoided if they are well drafted in the first instance. New markets for offshore wind should draw heavily on experience in other countries. A stable regulatory regime engenders higher investor confidence.

Inappropriate Site Awards

The award of concessionary rights for the development of an offshore wind project site can lead to slow build rates if the award is either made to an inappropriate party or the site itself is unviable economically or environmentally. Early experience in the United Kingdom has led to the delay of some projects, or even their abandonment, because of unforeseen technoeconomic or environmental "showstoppers," post–site award. This can be avoided through early strategic planning to identify appropriate development regions. In Germany, the vast majority of development work implemented to date has been led by small independent companies. Since these organizations do not have the financial strength to construct the projects and may not have invested sufficiently during the development phase to mitigate key technical risks, these projects are likely to be sold to larger players, delaying project deployment. It should be noted, however, that the authors consider a mix of small, "nimble" companies and major public utilities to be healthy for any particular national market, and the regulatory regime should allow for such a mix.

Technoeconomic and environmental feasibility for offshore wind should be assessed at a national strategic level prior to the award of any sites for development. The system for such award would benefit from allowing for a mix of large companies and small entrepreneurial developers to stimulate growth.

Requirements for Success

The following findings are based on positive experiences to date in one or more of the national markets considered in this study. The causes of this success are described, along with potential measures that may allow for replication elsewhere.

Strong Political Will

A prerequisite for a successful offshore wind market is a good level of support from the government. Unfortunately, this is to a large degree beyond the control of any particular industry, since the attitude of an administration will be shaped by broader policy and strategic objectives. Although effective industrial coordination and lobbying can play an important role on specific regulatory issues (as described in finding 2), in the absence of genuine political ambition to deploy RE and specifically offshore wind, little progress can be made. In the context of the current study, the situation in The Netherlands best exemplifies negative experience in this regard, whereas political support in the United Kingdom, Denmark, and Germany for offshore wind is considered strong.

Simplify and Centralize

Simplification of the regulatory regime for offshore wind provides more transparency for project developers and confidence for potential investors. The channeling of responsibility for the administration of offshore wind through a central agency offers the opportunity for a more efficient system through the reduction of conflict and alignment of strategic policy objectives. Of the national markets reviewed in this study, only Denmark has achieved this system. It has done so, perhaps, at the expense of industrial control over deployment rates and the location of future sites. In Denmark, the "one-stop-shop" approach has been taken to the extreme, with a single government agency in control of virtually all aspects of offshore wind regulation. More modest success has been achieved in the United Kingdom, where a central coordinating body deals with the majority of the required consents.

Simplification of regulation provides the necessary transparency and confidence on the part of industry to move forward with development of offshore wind. Significant efficiency gains can also be made through the administration of the regulatory regime by a single government agency through the mitigation of user conflicts and alignment of government strategic objectives.

Strategic Spatial Planning

Long-term planning for the future use of the marine environment at the national level can play an important role in avoiding conflicts with various user groups while meeting policy objectives on energy. This route has been adopted to the fullest extent in Denmark and to a lesser degree in the United Kingdom and Germany. Such an approach is also a mechanism for avoiding conflicts between various sites and allows for economic grid integration of significant wind capacity. To some degree, the European Union Directive on Strategic Environmental Assessment will enforce this approach (for EU states).

Long-term strategic planning for the future use of offshore regions can improve the prospects for offshore wind deployment through the avoidance of potential stakeholder conflicts and improvement in grid connection efficiency.

Capital Support and Grid Ownership

Capital support for offshore wind projects to date has been provided through two avenues. Grants for R&D and demonstration projects have been essential for early deployment, and evidence for such provision, to a greater or lesser degree, has been found for all national markets considered. In addition, Denmark, Germany, and, to some degree, the United Kingdom have opted to provide ongoing capital support to projects through the transfer of grid connection costs, including export cables and offshore substations to the relevant network operator. The former approach has allowed valuable technical experience to be accrued during the early years of offshore wind, whereas the latter has provided ongoing alleviation of the marginal project economics faced by developers, thus increasing the incentive for deployment.

Capital support for the first offshore wind projects in any national market is important in order to achieve early momentum. Transfer of grid connection costs to network operators is an important support mechanism in markets where such costs are prohibitively high.

Incentives: Fixed Tariff Versus Certificate Trading

In broad terms, two systems of revenue support for offshore wind energy have been deployed to date, each with the stated aim of encouraging deployment of generating capacity in an efficient and effective manner.

The fixed tariff approach can be implemented in two ways: in terms of (1) conventional universally applicable RE feed-in tariffs' (REFITs) potential, with some adjustment that depends on project characteristics (for example, prolonged eligibility for the higher tariff for projects in deep water or far from the coast) or (2) through competitive tendering. The first approach has been adopted in Germany and The Netherlands, while the second is currently used in Denmark, has been proposed for Spain, and was trialed with limited success in the United Kingdom (NFFO or Non-Fossil Fuel Obligation, although no offshore sector was included in any of the five rounds) and France. In particular, the first approach has virtues of simplicity and predictability—mitigating risks associated with revenue security from the perspective of the developer. Disadvantages include the sensitivity of deployment rates to the exact level of the tariff, the absence of a mechanism for achieving government targets, and the potential for increasing costs to the consumer through an unexpectedly wide take-up of the tariff.

A system of tradable RE certificates with an annually increasing quota, as adopted in the United Kingdom, has the advantage of a link to government targets and, in theory, the deployment of the most economic projects. A further advantage is that the cost to the consumer is fixed irrespective of how much RE is deployed. However, the converse is also true in that the cost to the consumer is fixed irrespective of how little renewable power is delivered.

The principal disadvantages of such a system are its complexity and exposure of projects to fluctuating revenue streams in more than one market (that is, power, RE certificates, and possibly carbon credits in the future)—in other words, multidimensional volatility and risk. In addition, as has been experienced in the United Kingdom, nondifferentiated support can lead to the stalling of a more expensive technology, such as offshore wind and unreasonably high returns for cheaper renewables, for example, onshore wind, where a restriction on the deployment volume of the latter exists. This can be dealt with to some degree through differentiating the value of certificates depending on the technology, although it is suggested that this devalues the market virtues of the system outlined above.

To summarize:

- REFIT can be claimed to be efficient and effective because it is simple. However, the government needs to be able to judge at what level to set the tariff to ensure that it encourages sufficient development without delivering windfall profits to developers.
- Competitive tender can be claimed to be efficient and effective because the lowest-cost bidder is awarded the site. However, there are risks that parties will submit optimistic bids in the hope that full project risks will not be realized, and then abandon the project if these risks are realized. The likelihood of abandonment can be reduced through the requirements for substantial guarantees from the bidders, although this reduces the field of potential applicants and adds a risk premium to the submitted prices.
- Certificate trading can be claimed to be efficient and effective because it is a sophisticated market-based system, which can be designed and tuned to allocate each risk to the parties that can manage it most efficiently. However, the system is complex, which means that it can fail, for example, because of gaming by participants, changes in market circumstances, or gross errors in how the mechanism is designed. Simply put, complexity creates risks for all parties and hence costs, in terms of the regulation burden, as well as market inefficiencies.

Experience has shown that both systems can work, although on balance, a feed-in tariff is considered a more guaranteed instrument for encouraging deployment because of the simplicity and long-term certainty of the system.

Encourage Technical Innovation

The principal barrier facing the offshore wind industry currently is high cost. Although the main reasons for this are not inherent to the technology, but rather are commercially driven, experience has shown that there is significant potential for cost reduction through technical innovation. Although ongoing R&D and demonstration projects, such as Beatrice in the United Kingdom and Alpha Ventus in Germany, will play an important role in this regard, a continued effort is required within the offshore wind industry to bring capital and operational costs down. Arguably, the most important future technical development for offshore wind will be the inception of truly offshore-specific wind turbine designs. Funding and project sites will be required for this, and the markets that provide them are likely to benefit more from the derived lessons.

Technical innovation should be encouraged in order to bring down the costs of offshore wind energy in the medium and long term. This can be facilitated through continued funding of R&D and demonstration projects with a focus on offshore-specific technological solutions.

Allow Foreign Involvement

Offshore wind is an international business, albeit with the vast majority of important players located in Europe. However, specific capabilities in project development, management, and construction are not evenly distributed through the active markets reviewed in this study. Significant benefits can be accrued through the opening of national markets to foreign companies with the specific skills required to deliver offshore wind projects. The prominence of the Danish utility, DONG, in the UK market is an example of how such openness can accelerate deployment.

Access to national markets for foreign companies should be provided where skills and experience are lacking domestically. The benefits of this approach in terms of deployment volume and knock-on learnings are of significant value.

International Competition

Given the expanding number of national markets with an active offshore wind industry, it is anticipated that demand for the deployment of new projects will exceed the supply chain capacity to deliver in the coming years. In addition, as European utilities consolidate further and national markets become (generally) more liberalized, there will be an increasing tendency toward deployment of offshore wind in the most attractive national markets. Both of these factors mean that the instigation of a new national market for offshore wind will only be successful if the incentives for developers are sufficiently attractive to be competitive with other parallel markets.

Any entrance of a new national market for offshore wind requires a regulatory framework and market incentives that are sufficiently attractive to international developers and contractors to be competitive with existing markets.

References

General

[1] BTM Consult ApS. "World Market Update 2004: Forecast 2005–2009." March 2005.

[2] BTM Consult. "World Market Update 2006, Forecast 2007-2011." March 2007.

[3] Butler, L., and K. Neuhoff. "Comparison of Feed in Tariff, Quota and Auction Mechanisms to Support Wind Power Development." Cambridge Working Papers in Economics, Department of Applied Economics, University of Cambridge. December 2004. www.econ.cam.ac.uk/electricity/publications/wp/ep70.pdf.

[4] Energy Transition Task Force. "Interim Report." December 2006. http://www.senternovem.nl/mmfiles/Energy%20Transition%20Task%20Force%20Interim%20Report%20December%202006_tcm24-217782.pdf.

[5] EWEA (European Wind Energy Association) and RE-Xpansion. "Support Schemes for Renewable Energy—A Comparative Analysis of Payment Mechanisms in the EU." June 2005. http://www.ewea.org/fileadmin/ewea_documents/documents/projects/rexpansion/050620_ewea_report.pdf.

[6] Global Wind Energy Council (GWEC). "Global Wind 2006 Report." May 2007. http://www.gwec.net/uploads/media/gwec-2006_final.pdf.

[7] Global Wind Energy Council (GWEC). "Global Wind 2007 Report." 2008.

[8] IEA. "Wind Energy Annual Report 2006." July 2007. http://www.ieawind.org/AnnualReports_PDF/2006%20AR%20IEA%20Wind/2006%20IEAWind%20AR.indd.pdf.

[9] IEA. "Wind Energy Annual Report 2001." May 2002. http://www.ieawind.org/iea_wind_pdf/2001%20annual.pdf.

[10] IEA. "Wind Energy Annual Report 2004." April 2005. http://www.ieawind.org/iea_wind_pdf/PDF_2004_IEA_Annual_Report%20PDF/IEA%20Wind%20AR%201-264%20/2004%20IEAWind%20AR.pdf.

[11] OptRES. "Recommendations for Implementing Effective and Efficient Renewable Electricity Policies." Report of the IEE project OPTRES (Assessment and Optimisation of Renewable Energy Support Schemes in the European Electricity Market). February 2007. http://www.optres.fhg.de/OPTRES%20-%20recommendations%20report.pdf.

[12] Shaw, S., M. J. Cremers, and G. Palmers. "Sea Legal. Enabling Offshore Wind Developments." 2002. http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/offshore_-_EWEA_version_.pdf.

[13] Woyte, A., P. Gardner, and H. Snodin. "Concerted Action for Offshore Wind Energy Deployment (COD), Work Package 8: Grid Issues." October 4, 2005. http://www.offshorewindenergy.org/cod/CODReport_Grid.pdf.

International Conventions

[14] Bonn Agreement. http://www.bonnagreement.org.

[15] Espoo Convention. "Convention on Environmental Impact Assessment in a Transboundary Context." 1991. http://www.unece.org/env/eia/documents/conventiontextenglish.pdf.

[16] Helsinki. "Convention on the Protection of the Marine Environment of the Baltic Sea Area; the Helsinki Convention." 1992. http://www.helcom.fi/home/en_GB/welcome/.

[17] Kiev. "Protocol on Strategic Environmental Assessment." 2003. http://www.unece.org/env/eia/documents/protocolenglish.pdf.

[18] OSPAR Convention. "Convention for the Protection of the Marine Environment of the North-East Atlantic." 1992. http://www.ospar.org/eng/html/convention/welcome.html.

[19] Ramsar Convention. "Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, Iran, 2.2.1971, as Amended by the Protocol of 3.12.1982 and the Amendments of 28.5.1987." July 13, 1994. http://www.ramsar.org/key_conv_e.htm.

[20] United Nations. "Kyoto Protocol to the United Nations Framework Convention on Climate Change." 1998. http://unfccc.int/resource/docs/convkp/kpeng.pdf.

[21] United Nations Convention. "Law of the Sea." December 10, 1982. http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm.

European Union

[22] Commission of the European Communities. "Communication from the Commission: The Support of Electricity from Renewable Energy Sources." COM (2005) 627 final, SEC (2005) 1571. December 2005. http://ec.europa.eu/energy/res/biomass_action_plan/doc/2005_12_07_comm_biomass_electricity_en.pdf.

[23] Commission of the European Communities. "Report from the Commission: Progress towards Achieving the Kyoto Objectives." COM (2006) 658 final, SEC (2006) 1412. October 27, 2006. http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0658en01.pdf.

[24] Commission of the European Communities. "Country Profiles, Greenhouse Gas Emission Trends and Projections Germany in 2006." http://ec.europa.eu/environment/climat/pdf/countries/2006/germany.pdf.

[25] Commission of the European Communities. "A European Strategy for Sustainable, Competitive and Secure Energy." Green Paper 2006.

[26] Commission of the European Communities. "An Energy Policy for Europe." Communication from the Commission to the European Council and the European Parliament COM (2007) 1 final, SEC (2007) 12. January 2007. http://ec.europa.eu/energy/energy_policy/doc/01_energy_policy_for_europe_en.pdf.

[27] Commission of the European Communities. "Renewable Energy Road Map: Renewable Energies in the 21st Century: Building a More Sustainable Future." Communication from the Commission to the European Council and the European Parliament, COM (2006) 848 final, SEC (2006) 1719 / SEC (2006) 1720 / SEC (2007) 12. January 2007. http://ec.europa.eu/energy/energy_policy/doc/03_renewable_energy_roadmap_en.pdf.

[28] Commission of the European Communities, Directorate-General for Research—Sustainable Energy Systems. "Energy Corridors—European Union and Neighbouring Countries." EUR 22581. 2007. http://ec.europa.eu/research/energy/pdf/energy_corridors_en.pdf.

[29] Commission of the European Communities. "Proposal for a Decision of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources." 2008/0016 (COD), Brussels. January 23, 2008.

[30] Commission of the European Communities. "Proposal for a Directive of the European Parliament and of the Council on the Effort of Member States to Reduce Their Greenhouse Gas Emissions to Meet the Community's Greenhouse Gas Emissions Reduction Commitments up to 2020." 2008/0014 (COD), Brussels. January 23, 2008.

[31] European Union Directive 79/409/EEC. "Directive on the Conservation of Wild Birds." http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/birds_directive/index_en.htm.

[32] European Union Directive 85/337/EEC. "Council Directive of 27 June 1985 on the Assessment of the Effects of Certain Public and Private Projects on the Environment." http://ec.europa.eu/environment/eia/full-legal-text/85337.htm.

[33] European Union Directive 92/43/EEC. "Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora." http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/habitats_directive/index_en.htm.

[34] European Union Directive 2001/42/EU. "Directive on the Assessment of Certain Plans and Programmes on the Environment." http://europa.eu/scadplus/leg/en/lvb/l28036.htm.

[35] "European Union Directive 2001/77/EC of the European Parliament and of the Council, on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market." September 27, 2001. http://eur-lex.europa.eu/pri/en/oj/dat/2001/l_283/l_28320011027en00330040.pdf.

[36] Official Journal of the European Communities. "COUNCIL—Council Decision of 25 April 2002 Concerning the Approval, on Behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the Joint Fulfilment of Commitments Thereunder (2002/358/CE)." May 2002. http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_130/l_13020020515en00010020.pdf.

[37] European Commission, Directorate-General for Research. "SmartGrids, European Technology Platform, Vision and Strategy for Europe's Electricity Networks of the Future." EUR 22040. 2005.

[38] TradeWind R&D Project, website. http://www.trade-wind.eu/.

[39] UpWind R&D Project, website. http://www.upwind.eu.

Country Specific

Denmark

[40] Danish Energy Authority. "Offshore Wind Farms and the Environment Danish Experiences from Horns Rev and Nysted." November 2006.

[41] Danish Energy Authority. "Action Plan Havmølleplan." 1997.

[42] Danish Energy Authority. "Future Offshore Wind Power Sites—2025." Committee for Future Offshore Wind Turbine Locations. English summary: 11 pp., August 2007. Danish report: April 2007, 105 pp. ISBN: 978-87-7844-643-5. http://ens.netboghandel.dk/english/PUBL.asp?page=publ&objno=16304090; http://193.88.185.141/Graphics/Publikationer/Havvindmoeller/Future_Offshore_Wind_Power_Sites_2025/index.htm.

[43] Danish Government Policy. "Energy 2000." Introduced in 1990.

[44] Danish Government. "Law 256: Act of Energy Supply." April 2005, 53 pp. (English edition) (Lovbekendtgørelse nr. 115 af 08/11/2006).

[45] Danish Ministry of Energy. "Energy Policy Statement 2007." May 2007. http://ens.netboghandel.dk/english/PUBL.asp?page=publ&objno=16301455.

[46] Danish Ministry of Energy. "A Visionary Danish Energy Policy 2025." June 2007. http://ens.netboghandel.dk/english/PUBL.asp?page=publ&objno=16299888.

[47] Danish Energy Authority. "Copenhagen Strategy for Offshore Wind." 2005. http://ens.netboghandel.dk/english/PUBL.asp?page=publ&objno=16267261.

[48] Danish Energy Authority. Danish Carbon Newsletter JI and CDM, No. 2. October 2008. http://www.co$_2$info.dk/Portals/0/Ny%20mappe/October%20Danish%20Carbon%20newsletter,%20JI%20and%20CDM.pdf.

[49] Danish Energy Authority. Danish Carbon Newsletter JI and CDM, No. 6. February 2009. http://www.co2info.dk/Portals/0/Ny%20mappe/February_Danish_Carbon_Newsletter_JI_and_CDM.pdf.

[50] Personal conclusions of author following discussions with industry figures. August 2007.

[51] Sørensen, H. C., and others. "Middelgrunden Offshore Experience." Copenhagen Offshore Wind Conference. October 2005. http://www.middelgrunden.dk/artikler/Copenhagen%20Offshore%207%20Middelgrund.pdf.

[52] Danish Ministry of Energy. "Energipolitisk aftale." February 21, 2008. http://www.ens.dk/graphics/Energipolitik/dansk_energipolitik/politiske_aftaler/Energiaftale%2021.feb08/Pr%E6sentation%20af%20energiaftale_210208.pdf.

[53] Danish Ministry of Environment and Ministry of Foreign Affairs. "CO_2 Info, Strategy for JI and CDM Initiatives of the Danish State Joint Implementation (JI) and Clean Development Mechanism (CDM)." June 2007. http://www.danishcarbon.dk/Documents/The_Carbon_Market/Materials/CDMHaeftestrategiengelskFINAL2.pdf.

[54] Danish Energy Authority. Danish Carbon Newsletter JI and CDM, No. 2. October 2008. http://www.co2info.dk/Portals/0/Ny%20mappe/October%20Danish%20Carbon%20newsletter,%20JI%20and%20CDM.pdf.

[55] Danish Energy Authority. Danish Carbon Newsletter JI and CDM, No. 6. February 2009. http://www.co2info.dk/Portals/0/Ny%20mappe/February_Danish_Carbon_Newsletter_JI_and_CDM.pdf.

[56] Energinet.dk general communication. March 2008. www.energinet.dk.

[57] Hvidovre Vindmøllelaug. http://www.hvidovrevindmollelaug.dk.

Germany

[58] Breitling (Rostock) Offshore Wind Farm, Wind Projekt. http://www.wind-projekt.de/deutsch/offshore2.htm.

[59] Bundesanzeiger. "Gesetz für den Vorrang Erneuerbarer Energien." March 29, 2000. http://bundesrecht.juris.de/bundesrecht/eeg/gesamt.pdf.

[60] Bundesanzeiger. "Gesetz zur Neuregelung des Rechts der erneuerbaren Energien im Strombereich (EEG)." Bundesgesetzblatt Jahrgang 2004 Teil I Nr. 40, ausgegeben zu Bonn am 31, July 2004, p. 1918. http://217.160.60.235/BGBL/bgbl1f/bgbl104s1918.pdf. http://bundesrecht.juris.de/bundesrecht/eeg_2004/gesamt.pdf.

[61] Bundesanzeiger Infrastrukturplanungsbeschleunigungsgesetz (InPBeschlG). "Gesetz zur Beschleunigung von Planungsverfahren für Infrastrukturvorhaben." German Infrastructure Investment Acceleration Law. December 9, 2006. http://217.160.60.235/BGBL/bgbl1f/bgbl106s2833.pdf.

[62] Bundesanzeiger, Seeanlagenverordnung (SeeAnlV). "Verordnung über Anlagen seewärts der Begrenzung des deutschen Küstenmeeres." BGBl. I S. 57. Marine Facilities Ordinance. January 23, 1997. http://www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/SeeAnlV.pdf.

[63] Bundesanzeiger, Seeaufgabengesetz (SeeAufgG). "Gesetz über die Aufgaben des Bundes auf dem Gebiet der Seeschifffahrt." May 1965; revised October 2006. http://bundesrecht.juris.de/bundesrecht/bseeschg/gesamt.pdf.

[64] Bundesanzeiger. "Raumordnungsverordnung (ROV)." 13 December 1990. http://www.gesetze-im-internet.de/bundesrecht/rov/gesamt.pdf.

[65] Bundesanzeiger, Bundesimmissionsschutzgesetz (BImSchG). "Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche,

Erschütterungen und ähnliche Vorgänge." March 15, 1974. http://www.gesetze-im-internet.de/bundesrecht/bimschg/gesamt.pdf.

[66] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU) und Stiftung Offshore Windenergie. "Entwicklung der Offshore-Windenergienutzung in Deutschland (Offshore Wind power Deployment in Germany)." February 2007. http://www.wind-energie.de/fileadmin/dokumente/Themen_A-Z/Offshore/bmu_offshore_wind_deployment_de_en.pdf.

[67] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU). "Nationales Klimaschutzprogramm—Beschluss der Bundesregierung vom 18. Oktober 2000 (Fünfter Bericht der Interministeriellen Arbeitsgruppe—CO_2-Reduktion)." http://www.bmu.de/files/pdfs/allgemein/application/pdf/klimaschutzprogramm2000.pdf.

[68] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU). "The National Climate Protection Programme 2005." Summary in English at http://www.bmu.de/files/english/climate/downloads/application/pdf/klimaschutzprogramm_2005_en.pdf.

[69] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU). "Erneuerbare Energien in Zahlen—nationale und internationale Entwicklung." June 2007. http://www.bmu.de/files/erneuerbare_energien/downloads/application/pdf/broschuere_ee_zahlen.pdf.

[70] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU). "Erfahrungsbericht 2007 zum Erneuerbaren-Energien-Gesetz (EEG), Kurzfassung." July 2007. www.bmu.de/files/pdfs/allgemein/application/pdf/erfahrungsbericht_eeg.pdf.

[71] Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU), Erneuerbare-Energien-Gesetz (EEG), draft. "Entwurf eines Gesetzes zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich und zur Änderung damit zusammenhängender Vorschriften." http://www.bmu.de/files/pdfs/allgemein/application/pdf/entwurf_ee_recht.pdf.

[72] Bundesamt für Seeschifffahrt und Hydrographie (BSH), website. http://www.bsh.de/en/Marineuses/Industry/Windfarms/index.jsp.

[73] Bundesampt für Seeschifffahrt und Hydrographie (BSH). "Festlegungsdokument Eignungsgebiet Nördlich Borkum." December 19, 2005. http://www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/EG%20Noerdlich%20Borkum.pdf.

[74] Bundesampt für Seeschifffahrt und Hydrographie (BSH). Festlegungsdokument Eignungsgebiet Kriegers Flak." December 19, 2005. http://www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/Festlegung%20EG%20Kriegers%20Flak.pdf.

[75] Bundesampt für Seeschifffahrt und Hydrographie (BSH), "Festlegungsdokument Eignungsgebiet Westlich Adlergrund." December 19, 2005. http://www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/Festlegung%20EG%20Westl%20Adlergrund.pdf.

[76] Bundesampt für Seeschifffahrt und Hydrographie (BSH). "Standard Baugrunderkundig, Mindesanforderungen für Grundungen von Offshore-Windenergieanlagen." August 2003. www.bsh.de/de/Produkte/Buecher/Sonstige%20Publikationen/Standardbaugrunderkundung/Baugrunderkundung-eng.pdf. Also in English as "Standard for Geotechnical Site and Route Surveys Minimum Requirements for the Foundation of Offshore Wind Turbines and Power Cable Route Burial Assessments," 2003. www.bsh.de/de/Produkte/Buecher/Sonstige%20Publikationen/Standardbaugrunderkundung/Baugrunderkundung.pdf.

[77] Bundesampt für Seeschifffahrt und Hydrographie (BSH). "Standard—Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (stUK 3)." February 2007. www.bsh.de/de/Produkte/Buecher/Sonstige%20Publikationen/Standarduntersuchungskonzept/Untersuchungskonzept.pdf. Previous revision also in English as "Standards for Environmental Impact Assessments of Offshore Wind Turbines in the Marine Environment," February 25 2003. www.bsh.de/en/Marine%20uses/Industry/Wind%20farms/standard_environmental.pdf.

[78] Bundesampt für Seeschifffahrt und Hydrographie (BSH). "Standard—Konstructive Ausführung von Offshore-Windenergieanlagen." June 2007. www.bsh.de/de/Produkte/Buecher/Sonstige%20Publikationen/Standard/Standard.pdf.

[79] Ems Emden Offshore Wind Farm, ENOVA. http://www.enova.de/ccms/index.php3?hid=037143; http://www.ofw-online.de/pages/projekte/projekte_nordergruende.html.

[80] dena, Deutsche Energie Agentur, Offshore Wind website. http://www.offshore-wind.de.

[81] Deutscher Bundestag, Drucksache 16/9476. "Beschlussempfehlung und Bericht des Ausschusses für Umwelt, Naturschutz und Reaktorsicherheit zu dem Gesetzentwurf der Bunderegierung—Drucksachen 16/8148, 16/8393." Berlin, June 4, 2008.

[82] Deutschen Energie-Agentur (dena). "Electricity from Renewable Energies—Part Two of the dena Grid Study Commences: Renewable Energy up to 30 Percent by 2020/25." Press release. March 26, 2007.

[83] Deutschen Energie-Agentur (dena). "Strategie der Bundesregierung zur Windenergienutzung auf See im Rahmen der Nachhaltigkeitsstrategie der Bundesregierung." January 2002. www.offshore-wind.de/page/fileadmin/offshore/documents/Strategie_der_Bundesregierung_zur_Windenergienutzung_auf_See.pdf. In English as "Strategy of the German Government on the Use of Offshore Wind Energy in the Context of Its National Sustainability Strategy." www.offshore-wind.de/page/fileadmin/offshore/documents/offshore_strategy_of_federal_Government.pdf.

[84] Energiewirtschaftliches Institut an der Universität zu Köln (EWI), Deutsches Windenergie-Institut (DEWI), E.ON Netz, RWE Transportnetz Strom, and Vattenfall Europe Transmission; commissioned by Deutsche Energie-Agentur (dena). "Energiewirtschaftliche Planung für die Netzintegration von Windenergie in Deutschland an Land und Offshore bis zum Jahr 2020." February 2005. German: http://www.offshore-wind.de/page/fileadmin/offshore/documents/dena_Netzstudie/dena-Netzstudie__Haupttext.pdf. Summary (English). http://www.offshore-wind.de/page/fileadmin/offshore/documents/dena_Netzstudie/dena_Grid_Study_Summary_2005-03-23.pdf.

[85] Nitsch, J., F. Staiß, B. Wenzel, and M. Fischedickfor for Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU). "Ausbau Erneuerbarer Energien im Stromsektor bis zum Jahr 2020—Vergütungszahlungen und Differenzkosten durch das Erneuerbare-Energien-Gesetz." December 2005. http://www.bmu.de/files/pdfs/allgemein/application/pdf/ausbau_ee.pdf.

[86] Nitsch, J., and DLR for Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit. "Ausbaustrategie Erneuerbare Energien Aktualisierung und Neubewertung bis zu den Jahren 2020 und 2030 mit Ausblick bis 2050." Leitstudie 2007. February 2007. http://www.bmu.de/files/pdfs/allgemein/application/pdf/leitstudie2007.pdf.

[87] Verband der Netzbetreiber (VDN). "Transmission code." August 2003. http://www.vdn-berlin.de/global/downloads/publikationen/Anhang_D2_SRL.pdf.

The Netherlands

[88] Barry, M., I. Elema, and P. Van der Molen. "Ocean Governance in The Netherlands North Sea." The International Federation of Surveyors (FIG) 26th General Assembly and Working Week, Paris, April 2003. http://www.fig.net/pub/fig_2003/TS_20/TS20_2_Barry_et_al.pdf

[89] ECN. "Netherlands Offshore Wind Atlas, ECN-CX-04-136." 2004. http://www.ecn.nl/en/wind/additional/special-projects/offshore-wind-atlas/.

[90] EnerQ. "Tarieven wind op zee." Accessed August 2007. http://www.enerq.nl/informatie/Tarieven/Tarieven_wind_op_zee.asp.

[91] EnerQ. "Tarieven." Accessed August 2007. http://www.enerq.nl/informatie/Tarieven/.

[92] Grontmij Advises. "GIS Based Analysis of Potential Wind Farm Area in the Dutch NCP Report." In Dutch, November 1998. English summary from http://www.offshorewind-energy.org/txt2html.php?textfile=home/dutch_corner.txt.

[93] KEMA T&D for Ministerie van Economische Zaken. "40510025-TDC 05-48500 Connect 6000 MW-II: Elektrische infrastructuur op zee." September 6, 2005. http://www.senternovem.nl/mmfiles/KEMA%20eindrapport%207%20sept_tcm24-172671.pdf.

[94] Kolhoff, A., G. Draaijers, and M. Bremmer. "Offshore Wind Farms in the North Sea, IAIA Conference 2006, Stavanger." June 23, 2006. http://www.eia.nl/ncea/pdfs/trnng/offshorewindgenerationiaia2006.pdf.

[95] Ministerie van Economische Zaken. "Connect 6.000 MW—Eindrapportage." July 2004. http://www.senternovem.nl/mmfiles/Eindrapport%20Connect%206000%20MW_tcm24-124656.pdf.

[96] Ministrie van Verkeer en Waterstaat. "Q7 Windparks, Permits." http://www.noordzeeloket.nl/Images/Besluiten%20E-connection%20(Q7-WP)%20(18-2-2002)_tcm14-2339.pdf.

[97] Ministrie van Verkeer en Waterstaat. "NSW Permits." http://www.noordzeeloket.nl/Images/Besluiten%20Noordzeewind%20(Near%20Shore%20Windpark)%20(9-3-2004)_tcm14-2342.pdf. http://www.senternovem.nl/mmfiles/Definitieve_vergunning_NSW_Wbr_en_Wm_VW_tcm24-124606.zip.

[98] Near Shore Wind Farm website. http://www.noordzeewind.nl/.

[99] NoordZee Loket, offshore wind park project status: http://www.noordzeeloket.nl/activiteiten/windenergie/algemeen/.

[100] Noordoostpolder Wind Farm website: http://www.windkoepelnop.nl/.

[101] Phijffer, H. "Key Aspects of the Financing of Offshore Wind Park Q7, We@Sea Workshop Financieringsmodellen Offshore Windprojecten." February 6, 2007. http://www.we-at-sea.org/docs/Q7tailormadefinancingstructure.pdf.

[102] Q7 Wind Farm Web site. http://www.q7wind.nl/.

[103] Rijkswaterstaat RWS Noordzee. "Meetnet Noordzee, Measuring Network North Sea." http://www.actuelewaterdata.nl.

[104] Senter Novem. "Offshore Wind Energy." http://www.senternovem.nl/Offshore_Wind_Energy/index.asp.

[105] SenterNovem. "Licence System—Offshore Wind Park Project Status." http://www.senternovem.nl/Offshore_Wind_Energy/locations_and_licences/licence_system.asp.

[106] Senter Novem. "EIA: Investeren in energiebesparing en duurzame energie." http://www.senternovem.nl/eia/.

[107] Staatscourant. "Besluit tot van het van toepassing verklaren van de rijksprojectenprocedure op een categorie van windenergieprojecten in de Noord-Oostpolder." May 12, 2006. http://www.senternovem.nl/mmfiles/00201_008%20toegangsbesluit%20Wind parken%20NOP%2012mei2006_tcm24-192224.pdf

[108] Tilburg, X. Van, E. A. Pfeiffer, H. Cleijne, G. J. Stienstra, and S. M. Lensink. "Technisch-economische parameters van duurzame elektriciteitsopties in 2008." Conceptadvies onrendabele topberekeningen." ECN-E--06-025. February 26, 2007. http://www.ecn.nl/docs/library/report/2006/e06025.pdf

[109] Wet beheer rijkswaterstaatswerken (Wbr). "Wet van 14 november 1996 houdende vaststelling van bepalingen betreffende waterstaatswerken in beheer bij het rijk." http://www.wetten.nl/wet%20beheer%20rijkswater staatswerken

[110] Wind Service Holland. http://home.planet.nl/~windsh/

Spain

[111] Ministerio de Medio Ambiente (*Ministry for the Environment*). "Estudio estratégico ambiental para determinar las zonas del litoral aptas para la instalación de parques eólicos marinos" (*Environmental Strategic Study for Determining Suitable Coastal Zones for Installation of Offshore Wind Farms*). December 2007. http://www.mma.es/secciones/evaluacion_ambiental/planes_programas/planes_ea/pdf/EEA_parques_marinos_26_09_07.pdf

[112] Ministerio de Industria, Turismo y Comercio (*Ministry for Industry, Tourism and Trade*). "Estrategia española de cambio climático y energía limpia (*Spanish strategy for climate change and clean energy*). November 2007. http://www.mma.es/portal/secciones/cambio_climatico/documentacion_cc/estrategia_cc/pdf/est_cc_energ_limp.pdf.

[113] European Environment Agency. "Greenhouse Gas Emission Trends and Prospects in Europe 2007, Spain." http://reports.eea.europa.eu/eea_report_2007_5/en/Spain.pdf.

[114] Ministerio de Industria, Turismo y Comercio (*Ministry for Industry, Tourism and Trade*). "Plan de Energías Renovables 2005–2010 (*Renewable Energy Generation Plan for 2010*). July 2005. http://www.mityc.es/NR/rdonlyres/C1594B7B-DED3-4105-96BC-9704420F5E9F/0/ResumenPlanEnergiasRenov.pdf.

[115] Ministerio de Industria, Turismo y Comercio (*Ministry for Industry, Tourism and Trade*). "Medidas urgentes de la estrategia española de cambio climático y energía limpia" (*Urgent Measures for the Spanish Strategy on Climate Change and Clean Energy*). July 2005. http://www.mma.es/portal/secciones/cambio_climatico/documentacion_cc/estrategia_cc/pdf/plan_med_urg.pdf.

[116] Real Decreto 661/2007, de 25 de mayo, por el que se regula la actividad de producción de energía eléctrica en régimen especial (*regulation of electricity production under the special regime*). Ministerio de Industria, Turismo y Comercio. Boletín de Estado (BOE) n. 126 de 26/5/2007. http://www.boe.es/boe/dias/2007/05/26/pdfs/A22846-22886.pdf.

[117] Real Decreto 1028/2007, de 20 de julio, por el que se establece el procedimiento administrativo para la tramitación de las solicitudes de autorización de instalaciones de generación eléctrica en el mar territorial (*regulation of electricity production under the special regime*). Ministerio de Industria, Turismo y Comercio. Boletín de Estado (BOE) n. 183 de 1/8/2007. http://www.boe.es/boe/dias/2007/08/01/pdfs/A33171-33179.pdf.

The United Kingdom

[118] British Wind Energy Association. "Guidelines for Health and Safety in the Wind Energy Industry." April 2005. http://www.bwea.com/pdf/HSGuidelines.pdf.

[119] British Wind Energy Association. "Best Practice Guidelines: Consultation for Offshore Wind Energy Developments." 2002. http://britishwindenergy.co.uk/pdf/bwea-bpg-offshore.pdf.

[120] Countryside Council for Wales. "Guide to Best Practise in Seascape Assessment." Maritime Ireland/Wales INTERREG Report No. 5. March 2001.

[121] Crown Estate. "Tender Procedures and Criteria for Round 2 UK Offshore Wind Developments." July 2003. http://www.thecrownestate.co.uk/87_round_2_tender_procedures_criteria_04_02_08.pdf.

[122] Figueira, D. "Future Offshore Renewables Development: Beyond Round 2." DTI presentation at BWEA Offshore Wind 2007. June 2007.

[123] HM Government. "Energy White Paper: Meeting the Energy Challenge." URN No. 07/1006. May 23. 2007.

http://www.berr.gov.uk/energy/whitepaper/page39534.html.

[124] HM Government. "Energy Act 2004." HM Stationery Office. http://www.uk-legislation.hmso.gov.uk/acts/acts 2004/20040020.htm.

[125] HM Government. "Electricity Act 1989." HM Stationery Office. http://www.opsi.gov.uk/ACTS/acts1989/Ukpga_19890029_en_1.htm.

[126] HM Government. "The Food and Environment Protection Act (Part II) 1985." HM Stationery Office. http://www.mceu.gov.uk/MCEU_LOCAL/fepa/FEPA-ACT.HTM.

[127] HM Government. "Transport and Works Act 1992 (TWA)." HM Stationery Office. http://www.opsi.gov.uk/ACTS/acts1992/ukpga_19920042_en_1.

[128] HM Government. "Coastal Protection Act 1949." HM Stationery Office.

[129] HM Government. "Water Resource Act 1991—Section 109." HM Stationery Office. http://www.opsi.gov.uk/acts/acts1991/ukpga_19910057_en_1.

[130] HM Government. "Town and Country Planning Act 1990—Section 90 or Section 57." HM Stationery Office. http://www.opsi.gov.uk/ACTS/acts1990/Ukpga_19900008_en_1.htm.

[131] HM Government. "Wildlife and Countryside Act 1981." http://www.opsi.gov.uk/acts/acts1991/Ukpga_19910039_en_1.htm.

[132] UK Department of Trade and Industry (DTI). "Monitoring and Evaluation of Blyth Offshore Wind Farm." URN Numbers: 02/866, 01/686, 02/787, 01/1524 and 04/881.

[133] UK Department of Trade and Industry (DTI). "Future Offshore: A Strategic Framework for the Offshore Wind Industry." November 2002. http://www.berr.gov.uk/files/file22791.pdf.

[134] UK Department of Trade and Industry (DTI). "Renewables Obligation Order 2002." April 2002. http://www.berr.gov.uk/files/file22100.pdf.

[135] UK Department of Trade and Industry (DTI). "Renewable Energy: Reform of the Renewables Obligation." May 23, 2007. http://www.berr.gov.uk/files/file39497.pdf.

[136] UK Health and Safety Executive. "CDM 2007: Managing Health and Safety in construction." March 2007.

[137] UK Department for Environment, Food and Rural Affairs. "A Sea Change: A Marine Bill White Paper." March 2007. http://www.defra.gov.uk/corporate/consult/marine bill-whitepaper07/marinebill-whitepaper.pdf.

Other Countries

[138] Taipei Times (Bloomberg). "Bureau to Take Offshore Wind Farm Bids." August 28, 2007. http://www.taipeitimes.com/News/biz/archives/2007/08/28/2003376213.

[139] Kawasaki Heavy Industries. "Japan's First Offshore Wind Power System Delivered to Hokkaido. Press Release, February 2004. http://www.khi.co.jp/ba/2004data/ba040209-1.html.

[140] Loi n°2000-108. "Loi relative à la modernisation et au développement du service public de l'électricité (*modernisation and development of electricity supply*). February 10, 2000. http://www.legifrance.gouv.fr/texteconsolide/RIEAY.htm.

[141] Décret n° 2002-1434, relatif à la procédure d'appel d'offres pour les installations de production d'électricité (*procedures for invitation to tender for electricity power stations*), December 4, 2002. http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=INDI0200715D.

[142] Cahier des charges de l'appel d'offres "centrales éoliennes en mer." http://www.cre.fr/fr/content/download/2560/42564/file/2.pdf.

[143] Arrêté du 13 octobre 2005 autorisant la SAS CECA à exploiter une installation de production d'électricité. http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=INDI0505832A.

[144] Décret n° 2004-308, relatif aux concessions d'utilisation du domaine public maritime en dehors des ports (*concessions for use of the public domain in the sea, outside ports*). March 29, 2004. http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=EQUK0301508D.

[145] Journal Officiel de la République Française. "Avis sur le projet d'arrêté fixant les conditions d'achat de l'électricité produite par les installations utilisant l'énergie mécanique du vent telles que visées par l'article 2 (2o) du décret no 2000-1196 du 6 décembre 2000." July 27, 2006. http://www.legifrance.gouv.fr/imagesJOE/2006/0727/joe_20060727_0172_0116.pdf.

[146] Loi n° 2005-781 du programme fixant les orientations de la politique énergétique. July 13, 2005. http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=ECOX0400059L.

[147] Programmation pluriannuelle des investissements de production électrique (PPI). "Rapport au Parlement." January 29, 2002. http://www.industrie.gouv.fr/energie/electric/pdf/ppi_2002.pdf.

[148] Rapport au Parlement. "Programmation pluriannuelle des investissements de production électrique—Période 2005–2015 (PPI). June 9, 2006. http://www.industrie.gouv.fr/energie/electric/pdf/ppi2006.pdf.

[149] Energy Policy Act. EPA 2005. http://www.mms.gov/offshore/PDFs/hr6_textconfrept.pdf.

[150] OCS Alternative Energy and Alternate Use Programmatic EIS, website. http://ocsenergy.anl.gov/.

[151] Vann, A. S. "Wind Energy: Offshore Permitting." Congress Research Service, RL32658. March 7, 2007. https://www.ncseonline.org/NLE/CRSreports/07Apr/RL32658.pdf.

[152] REPP Renewable Energy Policy Project. "Offshore Wind Farm Approval Process, North Carolina." May 30, 2003. www.crest.org/articles/static/1/binaries/REPP_Offshore_Wind_Approval.pdf.

[153] Energimyndigheten (Sweden). "Energi som miljömål, 2007." 52 pp. ID-nr ET 2007:2, ISSN 1403-1892.

[154] Energimyndigheten (Sweden). "Elcertificeringsystemet, 2007." 36 pp. ID-nr ET2007:26.

[155] Energimyndigheten (Sweden). "Nyhedsbrev (Newsletter)." April 2007.

[156] Energimyndigheten (Sweden). "Wind Power-Developer." 2057/ET2008:12, 2008. http://213.115.22.116/System/TemplateView.aspx?p=Energimyndigheten&view=default&cat=/Broschyrer&id=bbb87cfbfc934afb96313e310c9f2d8c.

[157] Swedish National Grid (Svenska Kraftnat SvK). "Guide for the Connection of Wind Power to Grid (Swedish). March 2009. http://www.svk.se/global/06_energimarknaden/pdf/vindkraft/090326_vagledning_vindkraft.pdf

[158] Swedish National Grid (Svenska Kraftnat SvK). "Wind Power Report" (Vindkraftsrapport). June 2007. http://www.svk.se/global/06_energimarknaden/pdf/vindkraft/vindrapport070531_webb.pdf

[159] Belgisch Staatsblad/Moniteur Belge, Federale Overheidsdienst Economie, K.M.O., Middenstand En Energie [C–2004/11206] N. 2004–2446, p52775, 29.06.2004.

[160] Dewilde, L., Offshore Wind in Flanders Region. POWER Workshop, Bremerhaven, June 15, 2007.

[161] MUMM, Beheerseenheid van het Mathematisch Model van de Noordzee. Website www.mumm.ac.be. Accessed August 2007.

[162] Van der Palen, L. "Work Package 3: Legal and Administrative Issues Concerted Action for Offshore Wind Energy Deployment (COD)." 2005.

[163] VREG (Vlaamse Reguleringsinstantie voor de Elektriciteits en Gasmarkt). "Technisch Reglement Distributie Elektriciteit Vlaams Gewest." Versie 30.11.2004.

[164] Department of Communications, Marine and Natural Resources. "Delivering a Sustainable Energy Future for Ireland; The Energy Policy Framework 2007–2020." Government White Paper. March 12, 2007.

[165] de Vries, H. J., and others. "Renewable Electricity Policies in Europe." ECN Report C-03-071, 2003.

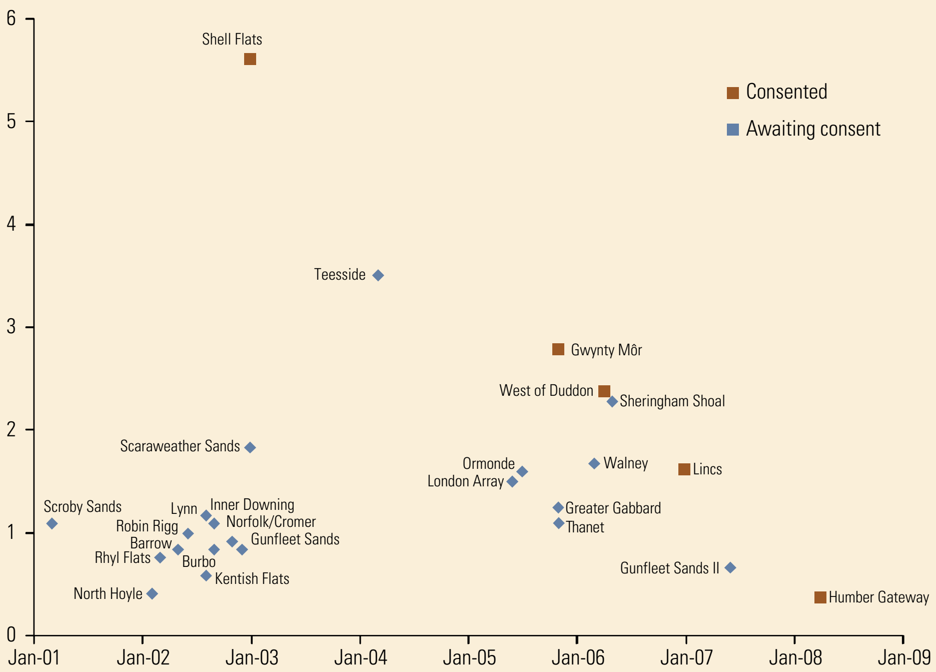
[166] Sustainable Energy Ireland. "Irish Wind Energy Atlas." Website. http://esb2.net.weblink.ie/SEI/MapPage.asp.

APPENDIX A

Consents Timing, the United Kingdom

For applications awaiting consent, time is through to August 2008.

FIGURE A–1: CONSENTS TIMING SUMMARY, UNITED KINGDOM



Source: Garrad Hassan and Partners Limited.

TABLE A–1: CONSENTS TIMING SUMMARY, UNITED KINGDOM

Project	Type	Application	Award	First power generation
Scroby Sands	EA S36	March 2001	April 2002	July 2004
North Hoyle	EA S36	February 2002	July 2002	November 2003
Rhyl Flats	EA S36	March 2002	December 2002	Under construction
Barrow	EA S36	May 2002	March 2003	March 2006
Kentish Flats	EA S36	August 2002	March 2003	July 2005
Robin Rigg		June 2002	June 2003	Under construction
Lynn	TWA	August 2002	October 2003	Under construction
Inner Downing	TWA	September 2002	October 2003	
Burbo	EA S36	September 2002	July 2003	July 2007
Norfolk/Cromer	TWA	November 2002	October 2003	abandoned
Gunfleet Sands	TWA	December 2002	October 2003	Under construction
Scarweather Sands	TWA	January 2003	November 2004	Possibly abandoned
Shell Flats	TWA	January 2003		
Teesside	EA S36	March 2004	September 2007	
London Array	EA S36	June 2005	December 2006	
Ormonde	EA S36	July 2005	February 2007	Close to award of contract
Greater Gabbard	EA S36	November 2005	February 2007	Contracts awarded
Thanet	EA S36	November 2005	December 2006	
Gwynt y Môr	EA S36	November 2005		
Walney	EA S36	March 2006	November 2007	
West of Duddon	EA S36	April 2006		
Sheringham Shoal	EA S36	May 2006	August 2008	
Lincs	EA S36	January 2007		
Gunfleet Sands II	EA S36	June 2007	February 2008	Under construction
Humber Gateway	EA S36	April 2008		

Sources: London Gazette, BERR/DTI, ROC database, Crown Estate.

APPENDIX B

Consents Experience, Germany

Tables B–1 through B–4 summarize the experiences of three wind farms: Borkum West in the North Sea EEZ (Table B–1 and Table B–2), Borkum Riffgatt in the North Sea 12-mile territorial zone (Table B–3), and Kriegers Flak in the Baltic Sea EEZ (Table B–4).

TABLE B–1: PERMITTING PROGRESS FOR BORKUM WEST OFFSHORE WIND FARM

Date	Event	Result
1998	Project initiated	
1999	Planning preparation started	
September 1999	Application submitted	
May 16, 2000	First application hearing at the BSH (Federal Maritime and Hydrographic Agency)	EIA investigation program defined
August–September 2000	EIA investigation program started	
February 20, 2001	Application hearing for the sea cable route through the EEZ by Bezirksregierung Weser-Ems & BSH	
April and October 2001	Ship safety risk analysis (Germanischer Lloyd) submitted to BSH	
July 2001	BSH approval for wind farm construction	Partially granted
November 9, 2001	BSH approval for wind farm construction	Full approval
April 30, 2002	12-mile territorial zone sea cable, for 12-turbine first phase only	Approved by Bezirksregierung Weser-Ems
May 2003	EIA investigation program completed	
December 15, 2004	Sea cable through the EEZ, for 12-turbine first phase only	Approved by BSH

Source: Garrad Hassan and Partners Limited compilation.

TABLE B–2: LIST OF BORKUM WEST OFFSHORE TRANSMISSION CABLE PERMITS

Approval	Authority
Building permission for the pilot phase	BSH
Permission for laying and operating the cable in the seabed by the authorizing agency for river- and navigation-specific police approval	Wasser und Schiffahrtsverwaltung des Bundes (Federal Water and Shipping Authority)
Lease contract to use the 12-mile territorial zone for laying a sea cable	Wasser und Schiffahrtsverwaltung des Bundes (Federal Water and Shipping Authority)
Water and dike permission, approval to cross dikes and waters	Bezirksregierung Weser-Ems (Regional Administrative Board)
Exemption from the prohibitions of the National Park	Bezirksregierung Weser-Ems (Regional Administrative Board)
Permission for laying the sea cable in the EEZ	BSH
Consent for grid connection	E.On Netz (network operator)

Source: Garrad Hassan and Partners Limited compilation.

TABLE B–3: PERMITTING PROGRESS FOR BORKUM RIFFGAT

Date	Event
1999	Project initiated
July 13, 2000	Application submitted for Raumordnungsverfahren (ROV) to Bezirksregierung Weser-Ems (regional authority)
2001	Agreement of Wasser- und Schifffahrtsdirektion Nordwest (WSD NW)
2002	EIA investigation program started
March 12, 2003	Application Meeting determines scope of application
2004	EIA studies completed and submitted to Bezirksregierung Weser-Ems
2005	Local government reorganization delays application
March 9, 2006	Wind farm details fixed
August 2006	Cable route selected
	Permit has not yet been awarded.

Source: Garrad Hassan and Partners Limited compilation.

TABLE B–4: PERMITTING PROGRESS KRIEGERS FLAK

Date	Event
May 2001	Submission of initial application First application hearing
November 2001	Submission of revised application
December 2001	Consultation with federal and regional authorities and parties and with general public Consultation with Denmark and Sweden (Espoo Convention [15])
February 2002	EIA Scoping Conference
March 2002	EIA monitoring starts
November 2003	Submission of EIA and Navigation Study
January 2004	Consultation with federal and regional authorities and parties and with general public Consultation with Denmark and Sweden (Espoo Convention [15])
May 2004	Application hearing
August 2004	Submission of revised Navigation Study
September 2004	Application hearing for revised submission Consent from Wasser- und Schifffahrtsdirektion regarding navigation
March 2005	Cable within territorial waters: Spatial Planning Decision (Landesplanerische Beurteilung)
April 2005	Wind farm approved by BSH

Source: Garrad Hassan and Partners Limited compilation.

APPENDIX C

Consents Experience, The Netherlands

TABLE C–1: LIST OF PERMITS FOR EGMOND OFFSHORE WIND FARM

Permit	English	Law	Date
Beschikking Wet milieubeheer	*Environmental permit*	Wm	September 3, 2004
Beschikking Wet beheer rijkswaterstaatwerken	*Construction permit*	Wbr	September 3, 2004
Besluit Meetmast	*Met mast permit*	Wbr	August 27, 2003
Melding wijziging vermogen windpark	*Change in wind farm layout*	Wm	January 31, 2005
		Wbr	February 2, 2005
Melding wijziging type wind turbine	*Change in wind turbine type*	Wm	May 26, 2005
		Wbr	May 30, 2005

Source: [97].

TABLE C–2: LIST OF PERMITS FOR Q7 OFFSHORE WIND FARM

Permit	English	Law	Date
Beschikking Wet beheer rijkswaterstaatwerken	*Construction permit*	Wbr	February 18, 2002
Melding wijziging type wind turbine	*Change in turbine type*		October 28, 2002
Melding wijziging ashoogte	*Change in turbine height*		May 10, 2004
Besluit wijziging verlichting	*Change in lighting*		May 10, 2004
Besluit verzoek tot verlenging Wbr vergunning	*Attempt to extend permit*		October 21, 2004

Source: [96].

TABLE C–3: PROGRAM FOR EGMOND OFFSHORE WIND FARM

Date	Stage	Comment
1997	Project originated	
February 2000	Location EIA completed	Compared six potential locations and identified Egmond as most suitable
April 2002	Key planning decision made	Decision for Egmond site
July 2002	Consents tender	Shell/Nuon consortium selected
March 2003	Key planning decision confirmed	Appeals rejected
	Project EIA undertaken	Take account of specific details of project
	Permit for Public Works Act (PWA) and the Environmental Management Act (EMA)	
January 2005	PWA and EWA confirmed	Appeals rejected; regarding estimates of bird losses
January 2005	Financial support mechanism confirmed	
May 2005	Developers' decision to proceed	By Shell/Nuon
End 2005	Onshore construction commenced	
2006	Offshore construction	

Source: Garrad Hassan and Partners Limited compilation

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