Dutch Presidency Leads Offshore Policy Debate

A number of policy decisions by European Union governments to ensure a positive future for offshore wind energy are the expected outcome of an important conference taking place this month in the Netherlands.

Attended by key policy makers from all 25 EU member states, as well as representatives from national grid system operators, EWEA, the IEA and prominent NGOs, the two day policy workshop (September 30 - October 1) will focus on how to move offshore forward to a point where it makes a substantial contribution to Europe's electricity supply. The event has been promoted by the incoming Dutch Presidency as part of its aim to encourage achievement of the EU's target for 12% of energy to come from renewable sources by 2010.

Organised by the Dutch Ministry of Economic Affairs, the detailed programme has been handled by Senter-Novem, the national energy agency closely involved in plans for the country's first sea-based turbines. Considerable support has been given by the European Commission. The sessions will be held symbolically at Egmond aan Zee, the nearest seaside town to one of the Netherlands' proposed offshore wind farms.

Nysted wind farm, Denmark: 72 Bonus 2.3 MW turbines

Photo: Gunnar Britse

The aim of the workshop is not to be a "public relations exercise for offshore wind", stresses Michel Verhagen from the Economics Ministry and lead conference organiser. Instead, the central focus will be on two issues which could potentially hold back offshore development, and over which member states and the EU could have a direct and positive influence – integration of large quantities of offshore wind output into the grid and the environmental effects of large scale developments in the sea. Narrow technical issues will take second place to public policy questions.

Focused outcome

Attendance at the workshop has been deliberately limited to help ensure a focused outcome. A maximum of four delegates have been invited from the relevant energy ministry or agency in each member state, and total numbers kept to about 100.

Even countries without coastlines have been invited to send representatives on the basis that the European offshore wind potential is seen as a resource from which every EU member state can benefit, especially if the trans-national grid network is upgraded and interconnection improved - a precondition for a well-functioning internal market in electricity. "Whether you have a coastline is not important," says Ruud de Bruijne of Senter-Novem. "We are talking about deploying one of the major internal energy resources in the EU." In fact, only a handful of the enlarged 25 member states do not have any access to the sea.

At the end of the two days, a declaration including a list of recommendations will be forwarded to the EU's Energy Council, which is expected to consider them at its November meeting. "These will be measures which the member states should undertake in order to deploy the offshore wind energy potential in Europe," says Ruud de Bruijne, "and the fact that they will be considered by the Energy Ministers gives the workshop an important status."

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INTERVIEW

Laurens Brinkhorst,

Minister of Economic Affairs, The Netherlands

Wind Directions: *Why has the Dutch Presidency of the EU decided to make wind power a priority issue, and in particular offshore wind?*

Laurens Brinkhorst: There are a number of reasons for this. First of all, it is generally acknowledged that renewable energy sources play an important role in the overall EU ambitions on sustainable development. The increase of energy consumption in the EU, but also elsewhere in the world, will contribute to the increase in greenhouse gas emissions, and of carbon dioxide in particular. It is clear from the present outlook on our future energy mix that for the next few decades we will still be largely dependant on fossil fuel sources. The commitments made in the Kyoto protocol have only been a first step in the long term battle in combating climate change.

Apart from these environmental concerns, there is also a need to decrease our import dependency. At present, a substantial part of EU oil and gas imports are from the Middle East and Russia. It may not be expected that this will change dramatically before the year 2030. Given the state of current technology, there is enormous potential for the utilisation of renewable energy sources like wind energy, notably offshore wind energy. The point is, however, that there are still some challenges to meet. The most important one is in the necessity for further cost price reductions of offshore wind energy compared to fossil fuels. Other challenges refer to specific technical issues related to balancing infrequent additions of large amounts of offshore wind energy to the electricity grid and limited interconnection capacity and market access procedures between EU countries. There is also still a knowledge gap as to the specific environmental implications of offshore wind energy.

Given that these challenges are the same for every single member country and so far, most of them have only treated them at the national level, we can benefit from international co-operation. Especially if this would incorporate approaches which take the European dimension of the electricity grid into account. Against this background, I have decided to benefit from the Netherlands' presidency of the European Union by organising a Policy Workshop on Offshore Wind Energy in Egmond aan Zee.

Wind Directions: *What are the expected outcomes of this month's policy workshop, in particular in the areas of environmental monitoring and grid integration?*

Laurens Brinkhorst: There will be three separate sessions in the Policy Workshop. These will concentrate on market development, grid integration issues and the environment. Each of these issues have their own importance when it comes to realisation of the policy objectives on the part that renewable energy sources can play in the EU's energy mix. Technological development and cost price reductions will have a decisive impact on market development. These issues may be related to the solutions as to grid integration and environmental effects, but they are very different areas.

By bringing together expertise from within government administrations from all over the EU, Transport System Operators and non-governmental organisations, it should be possible to focus on the urgent challenges. It should also be possible to prioritise certain technical and administrative approaches for solutions. Possibilities for specific international co-operation should certainly also be explored. It would be to the benefit of all if we could obtain improved cost efficiency, a better exchange of information and, eventually, shorter and more effective decision making procedures on specific projects.

Wind Directions: *What actions are expected to result from the workshop, both on the part of individual member states and the European Union?*

Laurens Brinkhorst: The discussions in the workshop should result in a Policy Declaration with specific recommendations as to market development (including offshore wind energy cost price reductions), grid integration issues and possibilities to mitigate adverse environmental implications. These recommendations should also name the parties who will have a specific responsibility for them, whether national governments, the European Commission, industry or the transport system operators. I expect such a declaration to provide focus, prioritisation and possibilities for improved international co-operation within the Union. It is my intention to bring the

recommendations of this Policy Declaration to the EU Council of Energy Ministers in November 2004. In turn they should assist the European Commission, which is due to report on the implementation of its Directive on the share of renewable energy sources at the end of 2005.

Wind Directions: *What progress is being made towards the first (properly) offshore wind farm in the Netherlands?*

Laurens Brinkhorst: At the moment there are two offshore wind energy projects in the planning phase. The first of these is the Near Shore Wind Farm (NSW) near the village of Egmond aan Zee (North Holland), with construction expected to start in 2005/6. This site is located about 12 kilometres from the coast in a water depth of 15 to 20 metres. Its capacity will be 100 MW. The second project is the Offshore Windfarm Q7. This is located 23 km from the coast of IJmuiden (North Holland). There will be 60 wind turbines with a capacity of 2 MW each in a water depth of 20 to 25 metres.

The Netherlands' government is currently developing a licensing system under the Public Works Act for issuing locations for offshore wind farms. It is expected that this system will come into effect in 2005.

Wind Directions: *From the point of view of the Dutch Economics Ministry, what needs to be done to make offshore wind a viable source of electricity with a price competitive with other fuels?*

Laurens Brinkhorst: The contribution of offshore wind energy to our objectives for renewable energy will be significant. There is, in principle, a great potential; there are still some challenges to be met, including the higher cost level compared to fossil fuels, intermittency and balancing problems. In order to arrive at proper cost comparisons between conventional electricity and electricity from offshore wind farms, externalities should be taken into account. The Netherlands' government is stimulating further research on intermittency and grid connection, and the results of the first projects should provide relevant information for the assessment of possibilities for future cost reductions. In summary, cost reductions necessary for offshore wind to become a competitive energy source in the long run will result from a combination of research, innovation and operational experience.

Offshore Policy Debate:

The Central Issues

What can EU governments do to encourage the steady expansion of offshore wind? *Crispin Aubrey* looks at the background to this month's policy workshop in the Netherlands.

There is little argument that the potential for developing wind energy in the seas round Europe is enormous. One estimate is that offshore sites could eventually produce enough power to satisfy all of the enlarged EU 25 member states' electricity demand (1).

An "impressive start" has been made towards establishing offshore wind as a major contributor towards European generation capacity, as the background paper for this month's conference notes. Moving from a negligible amount to the installation of almost 600 MW by the end of 2004 (see table, p. 21) reflects the greater economies of scale to be achieved offshore, it says, as well as "industry's vision for a mainstream electricity supply".

The targets set and licenses issued by a number of European countries also show the expectation for substantial market growth over the next 20-25 years. Among the eight leading nations with specific offshore plans – Denmark, Sweden, Germany, the UK, Ireland, France, the Netherlands and Belgium – the aim is for a total of more than 50 Gigawatts of capacity over the next 25 years (see table, p.21). EWEA's target is for 70 GW to be installed by 2020.

Nonetheless, experience with offshore wind energy is still relatively limited. Only five of the projects already constructed (Horns Rev, Nysted, North Hoyle, Arklow Bank and Scroby Sands) can be seen as representative of future offshore wind farms, the paper points out.

Turbine delivery at offshore site.

Photo: SeaRoc UK

The range of capital costs for completed projects has underlined the fact that offshore is currently more expensive than building on dry land. Embedding foundations in the sea bed and the cost of cabling back to shore are two major items which increase the offshore bill. Capital costs for installing the four largest offshore projects built so far ranged between € 1.7 and € 1.9 million per MW, according to the background paper, compared with well below € 1 million on land. Operation and maintenance costs are estimated at € 105,000 per turbine per year. Against this, however, the stronger and more predictable wind regime out at sea means that output per installed MW can be up to 40% higher than at good shoreline sites.

Costs are also expected to fall as more projects come on line, as has happened on land. The UK government's Innovation Review (2004) has predicted a 5% fall in offshore costs over the next five years. Projections by the German research institute ISET suggest that capital costs could fall by 40% over a 20 year period if major expansion occurs in the offshore market.

Range of issues

Topics to be touched on at this month's conference cover the whole range of issues raised by offshore development, from finance through to zoning of coastal areas, although the main emphasis will be on grid integration and environmental monitoring.

Even before wind farms are constructed there are a considerable number of issues to be resolved over site selection, including legal rights and coastal zoning. Up to the traditional 12 mile (22.2 km) distance from a particular country's shore, approval for and negotiation over offshore development rights rests with the national authorities. Beyond this, although most countries have declared a further area as an EEZ (Economic Exclusion Zone), there remains some uncertainty as to exactly what this jurisdiction covers. There is also a need to avoid developers claiming rights for the exploitation of a particular sea area, but then not progressing a project.

On the technology used to exploit wind energy offshore, there is a need to develop turbines which go beyond the stage of marinised versions of models used on land. A number of larger turbines primarily designed for offshore use, from 3 MW up to 5 MW in capacity, are already in development, but there is still a need for more generic research.

As important as any of these technical issues is finance, in particular how easy it will be to raise the investment sums required for the new larger offshore projects of 100 MW + scheduled to be built over the next decade. Although some EU states, such as Germany, have clear support policies with specific ongoing premium tariffs aimed at offshore schemes, the UK employs a mechanism based on a supply obligation, whilst Denmark has chosen a competitive tender approach, coupled with state subsidy of the grid connection, for its ongoing offshore programme. As the conference background paper puts it, the most important factor for would-be investors is how accurately they can determine the size and nature of any risks.

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Grid integration

The advent of large offshore wind farms sited around the coasts of Europe has raised the issue of grid integration to a new level. Not only will relatively large quantities of wind generated electricity be expecting to enter the network at points not necessarily designed to receive them, but these large inputs will have to be integrated into grid management systems not always geared up to handle intermittent sources like wind.

Increasing experience of the latter, for example in Germany and Denmark, has shown that it is possible for the network to handle large inputs of wind power, especially with the use of more sophisticated forecasting techniques. The conference background paper gives the example of Eltra, which manages the western half of Denmark's power grid, including the Horn's Rev offshore wind farm. 30% of the electricity produced in West Denmark comes from wind power. Increasingly, Eltra is quoted as saying, it views such large offshore projects as "power plants" to be integrated in the same way as conventional power stations.

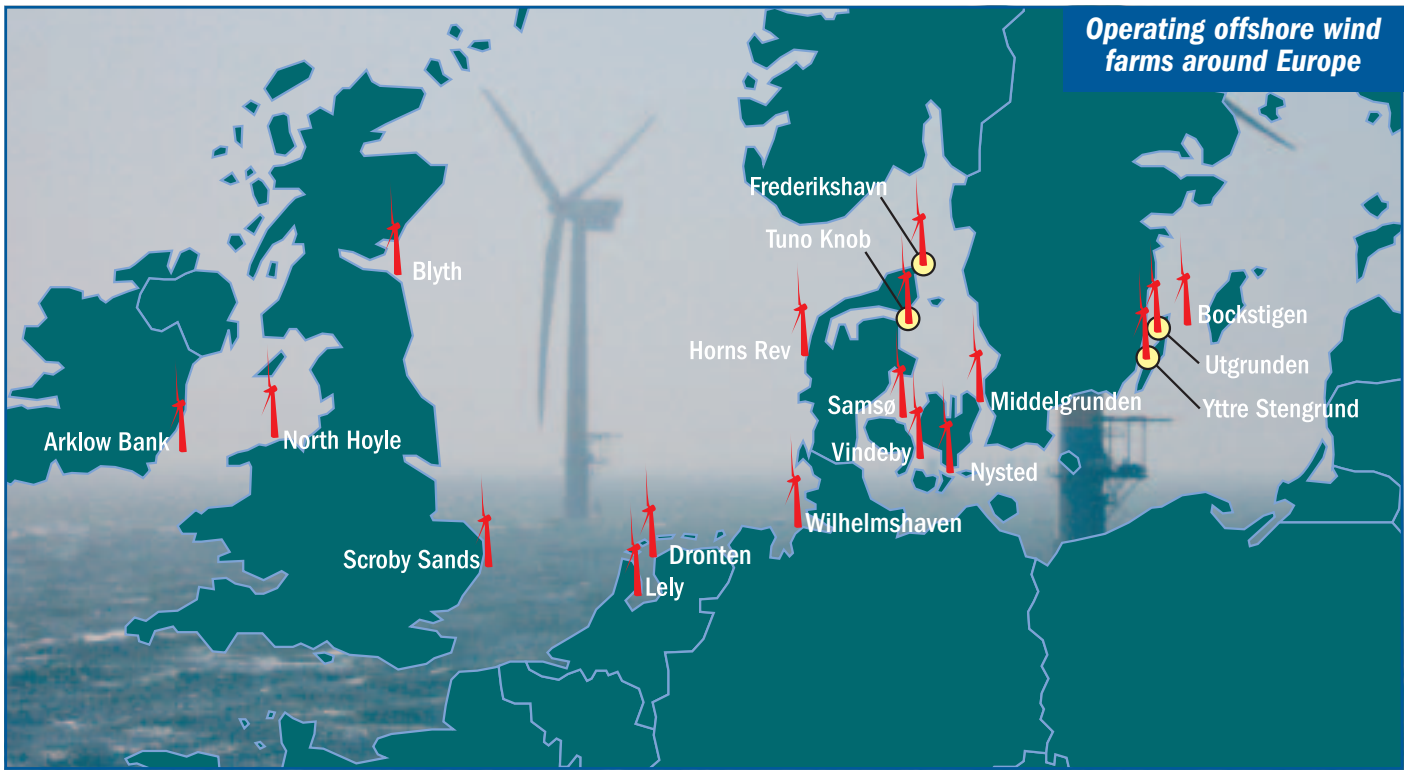
The former issue, however, is certain to require reinforcement of the grid both nationally and across borders, raising the need for infrastructure investment. The need for new power lines to export power from wind energy-rich areas is beginning to emerge across Europe, as the background paper points out. "There is a cost to this, and it may initially prove more expensive, when considered in isolation, than connection of conventional power stations. But this needs to be set against normal grid system replacement costs and extensions that would in any case be required to maintain and develop the system. It should also be set in the context of the need to transport oil and gas from increasingly remote locations, and the rising costs of more and more difficult and remote extraction."

The major question with extending the grid is about who is going to be responsible, as one of the workshop programme planners from the Dutch energy and environment agency Senter-Novem explained. "This is the first time in a liberalised market that we have had a serious discussion about who will pay for the new grid connection needed for these large quantities of offshore wind power. We never raised this question with the existing conventional power plants – the network was just built.

Grid integration is not a technical problem, it's core business for the TSOs (Transmission System Operators). It's just something that has to be done. The question is who is responsible and who will pay for it. Will there be an obligation on the transmission grid operators to pay for the upgrade, should governments get involved, and will there continue to be priority access to the grid for wind energy, as is currently the case in a number of European countries?"

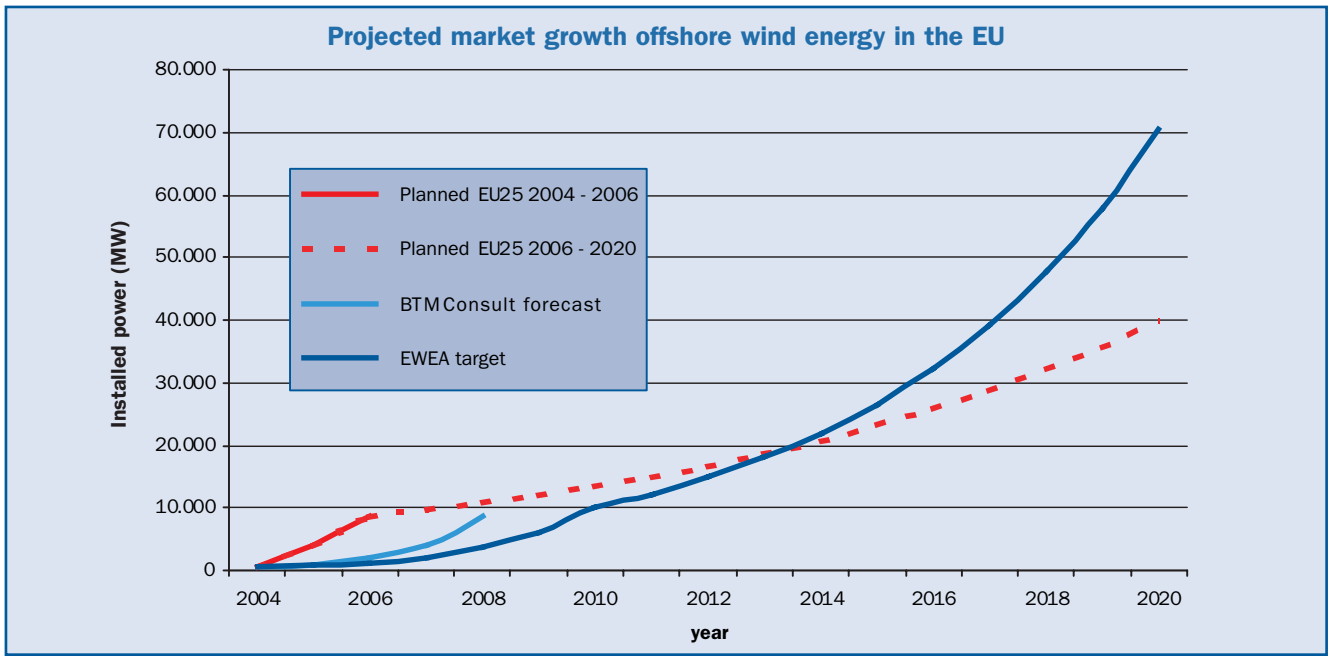
Environmental impacts

The issue of the environmental impact of offshore wind developments is both more diverse but also more straightforward compared to grid integration. Most of the offshore parks built so far have been expected to undertake extensive studies about everything from their potential effect on birds to their influence on fish stocks. COD, the EU Concerted Action on the Deployment of Offshore Wind Energy, which links eight member states, now has 161 environmental reports and ongoing research projects registered on its central database.



Operating Offshore Wind Capacity in Europe

Location	Turbines	Capacity	Year	Country
Vindeby	11 x Bonus 450 kW	4.95 MW	1991	Denmark
Tunø Knob	10 x Vestas 500 kW	5.0 MW	1995	Denmark
Middelgrunden	20 x Bonus 2 MW	40.0 MW	2000	Denmark
Horns Rev	80 x Vestas 2 MW	160.0 MW	2002	Denmark
Samsø	10 x Bonus 2.3 MW	23.0 MW	2002	Denmark
Fredrickshavn	2 x Vestas 3 MW, 1 x Bonus 2.3 MW, 1 x Nordex 2.3 MW	10.6 MW	2003	Denmark
Nysted	72 x Bonus 2.3 MW	165.6 MW	2003	Denmark
Wilhelmshaven	1 x Enercon 4.5 MW	4.5 MW	2004	Germany
Arklow Bank	7 x GE Wind 3.6 MW	25.2 MW	2003	Ireland
Lely (IJsselmeer)	4 x NedWind 500 kW	2.0 MW	1994	Netherlands
Dronten I (IJsselmeer)	28 x Nordtank 600 kW	16.8 MW	1996	Netherlands
Bockstigen	5 x Wind World 550 kW	2.75 MW	1997	Sweden
Utgrunden	7 x Enron Wind 1.5 MW	10.5 MW	2000	Sweden
Yttre Stengrund	5 x NEG Micon 2 MW	10.0 MW	2001	Sweden
Blyth	2 x Vestas 2 MW	4.0 MW	2000	United Kingdom
North Hoyle	30 x Vestas 2 MW	60. MW	2003	United Kingdom
Scroby Sands	30 x Vestas 2 MW	60. MW	2004	United Kingdom
Total	**326**	**597.7 MW**		



EU Member States' Offshore Wind Energy Plans and Targets

Country	Plan/Target	Year	Notes
United Kingdom	8.7 GW	—	Capacity expected from exploration licences granted
France	0.5 GW	2007	
Denmark	4-5 GW	2030	1997 target
Germany	25 GW	2030	
Ireland	2 GW	—	Capacity expected from exploration licences granted
Netherlands	6 GW	2020	
Sweden	3.3 GW	2014-2019	
Belgium	2 GW	2012	
Total	**Up to 52 GW**		

Source: Background paper, Offshore Policy Workshop

This month, a separate two day conference was held in Billund, Denmark at which the first results from environmental impact studies at the 160 MW Horns Rev wind farm, as well as preliminary findings from its companion development Nysted, were made public (see interview with Per Hjelmsted of Energi E2, p.32). When complete, these studies are expected to identify the central environmental issues for all future Danish offshore developments.

"Offshore developers face extensive requirements for impact assessments, which are often both costly and time consuming, especially when compared with other offshore activities," the Senter-Novem spokesman pointed out. "There's a feeling that once a number of major programmes being carried out now in Denmark, the Netherlands and the UK have been finished and analysed, we should have a broad idea of the impact of offshore wind energy on the marine environment. For future projects we should therefore be able to move to a situation where developers only have to assess site specific aspects."

Another approach has been the use of Strategic Environmental Impact Assessments to assess the likely environmental effects on sea areas before they are offered up for licensing to specific wind developers. This was the case, for instance, before the UK selected three large sea areas off its east and west coasts for up to 7,200 MW of wind capacity.

Priorities for governments

What can EU member state governments do to resolve some of these issues and help push forward the frontiers of offshore wind? The conference will consider a number of priority actions, in particular in the areas of consents and licensing, innovation, financing, environmental impact and grid integration. Depending on the outcome of the policy workshop, it will then be up to the EU's Energy Ministers, meeting on November 29, to decide whether or not to progress these proposals.

References: 1. "Study of Offshore Wind Energy in the EC", Garrad Hassan and Germanischer Lloyd, 1995.

Photo: SeaRoc UK

Construction work at Arklow Bank, off the east coast of Ireland (7 GE Wind 3.6 MW turbines)

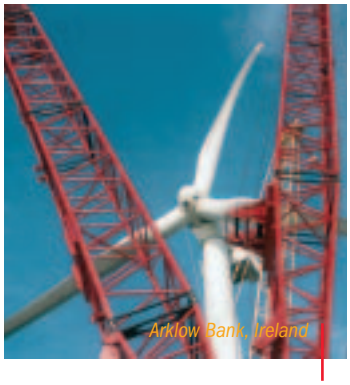

Arklow Bank, Ireland

Photo: SeaRoc UK

Offshore Policy Debate: Priorities for Europe

The European Commission is considering a number of proposals which could support and strengthen the EU's leadership in the growing offshore wind industry.

In its status report on progress towards the EU's 2010 renewable energy targets, published last May, a section on offshore wind policy lists four areas which the Commission considers potential obstacles requiring action by the EU or member states.

The first issue raised is the legal status of projects proposed outside the territorial waters of individual states. Although all member states have clear jurisdiction over their respective sea areas up to 12 nautical miles from the coast, outside that distance their status is based on the concept of an Exclusive Economic Zone (EEZ) – an area of the sea designated by each country for the exploitation of such resources as offshore oil and gas fields. A major proportion of the wind farms proposed off the coast of Germany, for instance, are set well outside territorial waters.

Although offshore wind farms should in theory be able to benefit from the same status as oil or gas platforms, this has yet to be established in practice. There is still uncertainty, for example, about the exact legal position in relation to a potential collision between a ship and a wind turbine, or other external disturbance of its operation. This is an area for action by, and communication between, individual member states.

The second issue is that of grid integration and reinforcement. Here, the critical question is who will pay for the major upgrade work required to bring large quantities of offshore electricity into the system. Should it be project developers, grid operators, government, consumers, or some combination of all four? As importantly, is the requirement for grid reinforcement in a given area entirely driven by offshore developments, or would it be necessary anyway as a result of other demands on the system?

Cross-border connections

One role for the EU is in encouraging the development of cross-border connections which could enable large inputs of offshore power to flow through the European network. This is important not only for offshore (and onshore) wind power but also for creating fair competition and avoiding abuse by dominant players in the EU Internal Electricity Market. The issue is also likely to emerge more strongly when the Commission prepares its first full report on progress under the 2001 Renewables Directive, scheduled to appear before the end of next year. The directive states clearly that member states should "ensure that system operators in their territory guarantee the transmission and distribution of renewable electricity".

One specific though modest way in which the EU is already supporting strategic reinforcement work is through the Trans-European Energy Networks Programme. This is now starting to contribute to investment in grid adaptation and optimisation work which could benefit the integration of offshore projects. A further € 340 million was recently allocated to the co-financing of feasibility studies for new gas pipelines and electricity interconnections. In the longer term the Commission is considering doubling the amount of money allocated under the programme during the 2007-13 budget period.

The third area of concern relates primarily to the procedures offshore developers currently have to go through in order to obtain

Middelgrunden, Copenhagen : 20 Bonus 2 MW turbines

Photo: EWEA

The Bergen Declaration

Extract from the Bergen Declaration (Ministerial Declaration of the Fifth International Conference of the North Sea, Bergen, Norway, 20-21 March 2002) signed by ministers from Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, Switzerland and the UK.

Promotion of Renewable Energy

69. The Ministers **welcome** the development of renewable energy technology, *inter alia*, offshore wind energy, that has the potential to make a significant contribution to tackling the problems of climate change. They **agree** to take action in order to exploit this potential fully and safely, taking into account the global and European commitments linked to the Kyoto protocol. Other technologies, such as wave power, may have a role in the future.
70. The Ministers from the EU Member States **affirm** their commitment to implement Directive 2001/77/EC on renewable energy as part of their commitment in the Kyoto protocol on climate change.
71. In order to ensure a consistent and coherent approach to future developments of offshore wind energy, which, *inter alia*, takes account of environmental, and nature-conservation issues, the Ministers:
    i) **encourage** the competent authorities to develop indicative guidance on areas suitable for offshore wind energy developments, taking account of local wind conditions, ecological importance, shipping, the possibility of connections to national electricity grids and other users of the North Sea;
    ii) **agree** that offshore wind energy parks should be developed taking account of environmental impact data and monitoring information as it emerges and taking account of exchange of information and experience provided through the spatial planning processes;
    iii) **note** that the stage of development of offshore wind energy gives the opportunity to apply the precautionary principle from the outset; and
    iv) **stress** that in particular strategic environmental assessments provide the opportunity to evaluate both the potential for cumulative impacts on the marine environment from offshore wind development and the potential positive benefits of renewable energy in combating global climate change.
72. The Ministers further **invite** OSPAR in cooperation with the European Union:
    i) to develop a comprehensive set of criteria to assist competent authorities when deciding on applications for the development of offshore wind energy installations; and
    i) to develop a description of best available techniques for the location, construction, operation and removal of offshore wind energy parks with a view to facilitating their development and to protect the marine environment.

final consent for their projects. The Commission warns that offshore wind development must not be stifled by "a false assessment of potential problems such as its coexistence with birds, trawling and shipping, the development and application of national planning rules, the source of funds to extend and upgrade the grid, the availability of insurance cover and the provision of legal protection against damage to structures outside states' territorial waters".

Removing obstacles

In response, the Commission says it will "systematically review the obstacles and objections that may block the development of offshore wind, the environmental requirements that need to be met and will develop guidelines for Member States, by offering proposals for legislation if necessary". This could mean, for instance, ensuring that the development of offshore wind (for environmental reasons) does not clash with other European legislation aimed at protecting the environment, for example the Habitats Directive. At a more basic level, there is a need to share and learn from the growing number of studies already made of marine environmental issues.

Finally, the Commission says it will continue to support research and development work on offshore wind, particularly in the areas of designing turbines specifically for offshore use, installation technology and ways in which to improve the stability of the grid for wind energy penetration above a level of 20%.

Grid Integration:

Energy Agency Looks at German Network Issues

A study of how increasingly large capacities of wind power can be integrated into Germany's grid distribution network is being undertaken by the German Energy Agency, Deutsche Energie-Agentur. Its goals have been defined as firstly to "ascertain the concrete effects of an amplified development of wind energy on the German electric power system", then to estimate the costs associated with this, both for the system itself and for the operation of "conventional" power stations.

Although the report is focused primarily on how the German grid system can be adapted successfully to integrate thousands of megawatts of wind power, it will also look at the potential for interchange with neighbouring countries. Germany has the potential for power exchange with Poland, Austria, France, the Netherlands and the Scandinavian network.

The Energy Agency has involved a wide range of stakeholders, including wind developers, government departments, the German Wind Energy Association, the grid operators' association and individual transmission grid operators. The actual work is being carried out by a consortium including the German Wind Energy Institute (DEWI), the Energy-Economy Institute at the University of Cologne and grid operating companies E.ON, RWE and Vattenfall. "The aim of the study is to enable a long-term energy-economy planning process, and with the involvement of as many stakeholders as possible," says Albrecht Tiedemann of DENA.

Series of scenarios

The starting point of the DENA study is a series of scenarios assuming various levels of expansion in Germany's wind power capacity by 2007, 2010 and 2020. The capacity will also be allocated to particular regions, both for on land and offshore connections, so that some picture can be gained of the future pressure on particular parts of the grid.

Based on these scenarios, the "grids" section of the study will look at what expansion and reinforcement measures will be needed to accommodate the future expansion of wind power. In particular it will examine the system design of submarine cables required to bring offshore wind generation to connection points on the North and Baltic Seas.

A separate section of the study will examine the effects of wind power expansion on the rest of the country's generating capacity, including the requirement for regulation and reserve capacity, both in terms of quantity and technical flexibility. It will then look at overall fuel consumption, the effect of increasing the proportion of wind power on CO2 emissions, and the total costs of power generation in the country with a major input from wind.

The results of the DENA study are expected to be published at the end of the year. The Agency says it will form the basis for policy decisions "for the integration of more wind power into the power supply system in Germany".

Photo: Gunnar Britse

Latest and largest: the 165.6 MW Nysted wind farm off the south coast of Denmark

Germany's Offshore Ambitions

Germany has ambitious plans for building wind power plants out at sea. According to the German government's strategy published in 2002, at least 500 MW of offshore capacity is expected to be installed by 2006, with an additional 3,000 MW completed by 2010.

Looking further ahead, the strategy envisages up to 25,000 MW of capacity being installed in both coastal waters and in Germany's Exclusive Economic Zone (EEZ), outside the national 12 mile limit, by 2030. This would generate between 70 and 85 TWh of power, enough for 15% of electricity demand at 1998 levels.

Quite apart from the environmental benefits of this expansion in terms of climate change, there are system reasons for building new generation capacity in Germany. If no new power stations were built, then the country's generation capacity would dwindle to less than 10 GW by 2040. This includes the assumption that the existing policy for a nuclear phase-out by 2022 is carried through.

The imperative to build offshore also comes from the fact that onshore construction of fresh wind farms in Germany is expected to slow down considerably over the next decade, partly because of the lack of suitable locations, with any new developments on land involving the re-powering of existing sites.

In a move intended to simplify the application and zoning process, the federal government has taken responsibility for processing applications in the EEZ, whilst the individual states (länder) are responsible for sea areas off their respective coasts.

A long list of development companies have announced plans for offshore wind farms, most of these in the EEZ, and therefore outside coastal areas protected by wildlife or shipping zoning. Their distance from the shore has meant that most developers are waiting for the larger size of 4 MW+ capacity turbines to become available before starting construction.

Planned development phases of German offshore wind

Phase	Period	Potential capacity	Potential power yield
Preparation	2001 - 3	—	—
Initial construction	2004 - 6	Up to 500 MW	c. 1.5 TWh p.a.
First expansion	2007 - 10	2,000 - 3,000 MW	c. 7 - 10 TWh p.a.
Additional expansion	2011 - 30	20,000 - 25,000 MW	c. 70 - 85 TWh p.a.

Source: German government strategy, January 2002

Installing turbines at Arklow Bank, Ireland

Photo: SeaRoc UK

Offshore Construction: Learning from Experience

With the development of offshore wind farms gathering pace, *Peter Hodgetts says it is vital that we learn from early experiences and ensure that the industry can maximise expertise and resources.**

Construction of offshore wind farms is moving into a significant phase when it is critical for the industry that new developments are able to attract project finance. Thirteen wind farms at a distance of more than 1 kilometre from the shore have successfully started operation around Europe so far (see table below), but in excess of 35 projects are currently in the planning process worldwide (see box, p. 31).

What lessons have been learned from the experience so far? Starting from the top, it is clear that man hours spent on dry land in planning, design and detailed project specific work are an important investment to ensure cost efficient operations offshore. Early engagement with all stakeholders and contractors is equally necessary to maintain a realistic timeline for delivering a project.

Initial investigations

In the initial phase up to obtaining consent from the relevant authorities, the biggest challenge is determining exactly what level of investigation should be undertaken, especially since this involves investment up front. Investigations at this stage typically include both geophysical and geotechnical surveys to analyse the seabed and subsoil conditions, all carried out by vessels at the site itself. Geotechnical surveys in particular, which include taking borehole samples down to 50 metres into the seabed, require major equipment and are consequently expensive.

**Formerly with Garrad Hassan and Partners, Peter Hodgetts is now operations director of marine consultants SeaRoc UK and engineering manager for the proposed Greater Gabbard project off the UK's east coast. He is responsible for the Offshore Renewables Directory (www.marinerenewablesdirectory.com), an interactive online reference guide covering every aspect of the marine renewables industry scheduled to launch on October 8.*

Construction and operation specifications, offshore wind farms over 1 km from shore

Location	Build	Turbines (capacity)	Dist. from shore	Water depth	Hub height	Foundation type	Output kWh/m²/y (kWh /y)
Vindeby, Denmark	1991	11 Bonus (5 MW)	1.5-3 km	2.5-5 m	37.5 m	Concrete caisson	1,130 (11,200,000)
Tunø Knob, Denmark	1995	10 Vestas V39 (5 MW)	6 km	3-5 m	40.5 m	Concrete caisson	1,046 (12,500,000)
Bockstigen, Sweden	1998	5 Wind World 37 (2.8 MW)	4 km	6 m		Drilled monopile	1,544 (8,300,000)
Utgrunden, Sweden	2000	7 Enron Wind 70 (10.5 MW)	12 km	7-10 m		Driven monopile	1,370 (36,900,000)
Blyth, UK	2000	2 Vestas V 66 (4 MW)	1 km	6 m (5 m tide)	58 m	Drilled monopile	1,754 (12,000,000)
Middelgrunden, Denmark	2001	20 Bonus 76 (40 MW)	2–3 km	2-6 m	60 m	Concrete caisson	1,100 (99,000,000)
Yttre Stengrund, Sweden	2001	5 NEG-Micon 72 (10 MW)	5 km	8 m	60 m	Drilled monopile	1,475 (30,000,000)
Horns Rev, Denmark	2002	80 Vestas V 80 (160 MW)	14-20 km	6-14 m	70 m	Drilled monopile	1,493 (600,000,000)
Samso, Denmark	2003	10 Bonus 82 (23 MW)	3.5 km	11-18m	61 m	Monopile	1,480 (78,000,000)
Nysted, Denmark	2003	72 Bonus 82 (165.6 MW)	9 km	6-10 m	70 m	Gravity base	1,600 (595,000,000)
Arklow Bank, Ireland	2003	7 GE 3.6 (25 MW)	7-12 km	5 m	74 m	Monopile	1,600 (95,000,000)
North Hoyle, UK	2003	30 Vestas V80 (60 MW)	7-8 km	12 m (8 m tide)	67 m	Monopile	1,600 (240,000,000)
Scroby Sands, UK	2004	30 Vestas V80 (60 MW)	2.3 km			Monopile	

Source: Wind farm operators

The evidence from experience so far, however, is that well focused geophysical and geotechnical work can provide essential data both to support a comprehensive consent application and to inform the design process, resulting in cost efficient foundation designs.

Foundation design is a key element in all projects, with direct impact on procurement costs, especially given the current high price of steel, as well as on the construction and installation process, a major component in overall project costs. Selection of a foundation design will depend on a range of criteria, but in particular the water depth and soil conditions. As developments move further offshore, and into water depths of more than 20 metres, the monopile design used most often up to now will need to be replaced by other designs, including tripods and larger gravity structures.

Onshore assembly

So far, offshore installation methodology has reflected existing techniques used on land, with some basic adaptations for the construction vessels and equipment available. This could well change, however, with methods being developed now to assemble and commission the turbines onshore, ideally at the nearest port or harbour to the site. Deep water access will be needed at all stages of the tide for the construction vessels, as well as substantial laydown areas for the blades, towers and nacelles, but assembling the turbines onshore, and even carrying out a major part of the commissioning work there, could significantly reduce the offshore construction schedule and have a major impact on project costs.

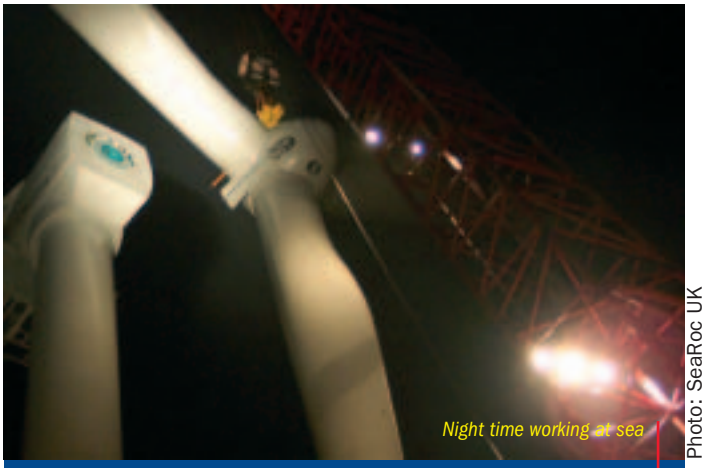
For the electrical connections, new cable technology is being developed to reflect the specific needs of the industry and provide cost efficient solutions for the larger wind farms being sited much further offshore. A decision on cable sourcing needs to be taken at an early stage so that site surveys, layouts and decisions about offshore substations can be made from an informed position. Proper evaluation of cable burial depth should also be carried out, with an appropriate risk assessment informed by the appropriate navigational survey.

During the construction phase, the focus so far has been primarily on the scheduling and cost of major plant, with large construction vessels costing up to € 150,000 per day to hire. Against that, the man hours required for commissioning work, with technicians working on the turbines offshore, has tended to take a lower profile because of the apparently lower cost. These 'forgotten hours' have often had a significant impact, however, by delaying the final commissioning and consequently the schedule to bring the project online and start providing revenue. A strategy to minimise these hours is vital, and with particular attention given to the access requirements.

Service access

Access remains a crucial issue that governs almost everything else in offshore developments. Weather conditions will influence access during initial survey work, whilst water depth, wave and tidal regimes will influence access to the site for both construction and throughout the life of the project. To cope with these demands there have been significant developments in the design of service vessels. From only being able to operate in relatively calm conditions, the latest purpose-built vessels can now handle significant wave heights of up to 'two metres significant'. In practical terms, the most important factor is the safety of technicians making the short but significant step from vessel to turbine ladder.

It is also important that after construction and commissioning is complete, access for operation and maintenance is planned, as this will be critical to the availability of the turbines.



Night time working at sea

Photo: SeaRoc UK

The Future Offshore

An impressive array of offshore projects is being pursued worldwide, with a total of up to 9,000 MW of capacity at various stages of development and planning. Northern Europe is leading the way, with a major commitment in Germany to build both in the deeper water outside the 12 mile zone as well as at several sites closer to the coast, including Borkum and Butendiek.

The Dutch government's aim is to achieve 1,500 MW by 2010, with two near-shore projects - Noordzeewind and Egmond – the first in line. In Belgium, the Zephyr consortium and C-Power are progressing a project near Thornton Bank, 30 kilometres from the coast. In Denmark, an extension to the Horns Rev park is scheduled to provide a further 200 MW in 2006, adding to the 416 MW already installed in eight operational wind farms.

Wave and tidal regimes around the coast of France will provide technical challenges to the commitment of the French government to develop 500 MW in domestic waters. Initial proposals were submitted in a tender process at the end of August, with specific sites scheduled to be allocated by the end of the year.

In UK waters, of the original sites granted leases by the Crown Estate, two have already been completed (North Hoyle and Scroby Sands), with a third (Kentish Flats) under construction. Nine more now have consent to proceed. At the end of 2003 the Crown Estate allocated rights for a total of up to 7,000 MW of capacity from fifteen projects in three strategic sea areas - Liverpool Bay, the Greater Wash and the Thames Estuary.

Arklow Bank has led the way offshore in Ireland, with a pilot 25 MW of capacity already installed and with the expectation to expand up to 500 MW. A further six offshore sites are being investigated around the eastern Irish coast, offering a combined capacity of up to 1,000 MW.

Globally, the United States has two large projects on the horizon - Cape Cod (450 MW) and Long Island (100 MW), whilst a number of other countries are investigating the potential.

INTERVIEW

Per Hjelmsted,
Project Manager, Energi E2

The Nysted wind farm off the southern coast of Denmark is the largest capacity offshore project yet completed. *Crispin Aubrey* talked to project manager and biologist Per Hjelmsted from Danish power company Energi E2 about the experience so far and the company's future plans.

Nysted wind farm was completed ahead of schedule and under its original budget. How did you achieve that?

Per Hjelmsted: One of the main reasons was that we approached this wind farm as a multi-contract project. So we separated out the contracts for the turbines, the foundations, the array cabling and the SCADA system and managed the interface between them ourselves. This was a little bit unusual for offshore wind, which is usually done on a turnkey basis. We did it differently because we felt we had the expertise from other wind projects to manage this, and that it's best for each specialist contractor, whether the turbine manufacturer or foundation installer, to stick to their own area. We also used our experience to prepare detailed tender material for all the equipment, especially the turbines. We weren't just buying turbines off the shelf, we had an extensive specification for what we wanted them to achieve.

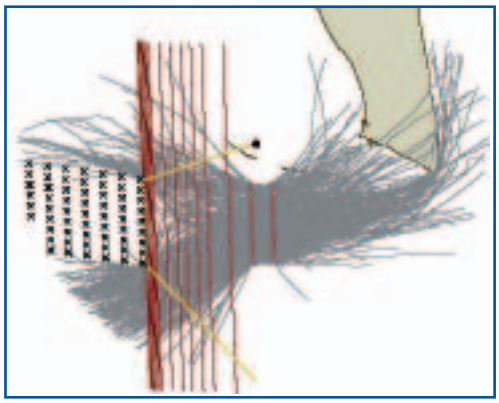
The second reason is that we allocated a lot of skilled engineering manpower into looking in detail at all the contractors' plans – how they would make technical solutions, how they would plan their time. This gave us an extremely good insight into what they were going to do, and also qualified us to manage the interfaces, reducing the number of mistakes. On a number of occasions we suggested changes, but it was still the responsibility of the contractor to carry them out. The end result was a lengthy process but an extremely good and productive dialogue.

How well has the wind farm been operating since it was commissioned at the end of last year?

Per Hjelmsted: We've had an overall availability of about 96%. We feel that's pretty good. Apart from some minor problems with high speed bearings, we have had no serious technical issues.

Were you prepared for the extensive list of environmental studies which you had to carry out?

It was always the intention of the Danish environment agency that both Horns Reef and Nysted wind farms would be demonstration projects where we would have to go into these issues in great depth. This programme was agreed between all the relevant government agencies and the power companies carrying out the work. The



Avoidance tactic: radar tracking shows how migrating sea birds fly either side of the turbines (marked with crosses) at the Nysted wind farm.

Source: Energi E2 enviromental monitoring report

Nysted Fact File

Installed capacity:	165.6 MW
Turbines:	72 x Bonus 2.3 MW
Water depth:	6-9.5 metres
Average wind speed:	12 m/s at 45 m height
Annual output:	595 million kWh, enough power for 110,000 households
Annual CO_2 saving:	500,000 tonnes
Commissioning date:	December 2003
Owners:	Energi E2 (50%), Dong (30%) and Swedish Sydkraft (20%).

results from these two quite different sites could then be compared and experience gained. So in terms of the potential effect on birds, mammals, the sea bed and so on, we have had to carry out five years of monitoring - two years on advance baseline studies, a year during the construction period and then a further two years of operation.

As far as a lot of the environmental questions were concerned, our approach was that we didn't think there would be any impact, but we had to prove that we were right. So at Nysted, for example, we have concentrated a lot of work on migrating birds, because there is a high density of birds in the area and a great variety of species.

What have you discovered so far?

Per Hjelmsted: Basically the studies have shown that whilst we were doing the construction work, most of the bird species kept clear of the area, as you might expect, but then came back quickly again as soon as we were finished. Sea mammals like seals also kept clear, especially when we were doing pile driving – we use underwater acoustic equipment to warn them that something is happening and avoid any damage to their hearing – but they also returned very soon afterwards.

The general conclusion so far is that we are not seeing any major environmental problems, especially bearing in mind that before Nysted went ahead we were told that it would be lethal for sea mammals and lethal for migrating birds. Some people even said that we didn't need to paint the tips of the turbine blades red (to identify them to sea or air traffic) because they would be dyed with the blood of dead birds.

Now we have seen in practice that migrating birds easily recognise the turbines – we can see this from analysis of radar tracking. So they change their direction and either fly between the rows or avoid the wind farm completely. Our preliminary conclusion for migrating sea birds, such as the eider duck, is that there will be just one group of birds each year which could risk having a collision with a turbine because they fly within the turning circle of the blades.

How do you see the results from Nysted and Horns Rev affecting the pattern of environmental studies at future wind farms?

Per Hjelmsted: It's obvious to start with that we have not seen anything even approaching the environmental "disasters" which were predicted in advance. In other areas I think we can now say that it is clear that a wind farm has minor or no effects at all and we should not need to look at them in future. This should hopefully mean that future projects are focused only on those areas where there might be some effect.

What plans does Energi E2 have for involvement in future offshore projects?

Per Hjelmsted: We are involved as partners in three projects – Borkum Riffgrund in the German North Sea, the London Array project outside the estuary of the River Thames, UK, and Scarweather Sands, off the south coast of Wales. The first of these to progress should officially be Scarweather Sands, but this still has to be finally approved by the Welsh parliament.

As far as Denmark is concerned, I'm sure we will be active one way or another if something happens. At the moment it's too early to say because we still do not know the exact conditions of the new tendering system. Meanwhile, we have at least been pre-qualified for the next Horns Rev block, and we're waiting for a further 200 MW to be allocated off the eastern coast.

For further information:
Detailed results from the initial operation and environmental monitoring of the Nysted wind farm will be presented by Per Hjelmsted at the EWEC conference in London this November.