



**EWEA**

THE EUROPEAN WIND ENERGY ASSOCIATION



Photo: Dong Energy

# The European offshore wind industry - key trends and statistics 2009

January 2010

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## Executive summary

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### 2009 offshore wind market and outlook:

- 199 wind turbines installed and grid connected totalling 577 MW during 2009, up 54% from the previous year;
- Turnover in 2009 was approximately €1.5 billion, and is expected to double in 2010 to approximately €3 billion;
- 1,000 MW expected to be installed during 2010, a 75% market growth compared to 2009;
- 17 wind farms under construction, totaling over 3,500 MW and a further 52 wind farms have been fully consented, totaling more than 16,000 MW;
- More than 100 GW of offshore wind farms currently being planned by project developers and utilities.

### Cumulative market:

- 828 wind turbines now installed and grid connected, totaling 2,056 MW in 38 wind farms in nine European countries;
- Average wind turbine size is 2.9 MW;
- 65% of substructures are monopiles, 23% are gravity foundations.

### Trends:

- The average offshore wind farm size in 2009 was 72.1 MW, up from 62.2 MW the previous year;
- Average water depth of offshore wind farms installed during 2009 was 12m, 0.5m deeper than the previous year, but substantially less than the 21.8m for farms currently under construction;
- Average distance to shore of offshore wind farms installed during 2009 was 14.4km, 3.9km further than the previous year, but substantially less than the 30.1km for farms currently under construction.

### Financing highlights and developments:

- Financial crisis constraining the growth of the offshore wind sector, disproportionately affecting independent project developers;
- Move to deeper water further from shore means that government support will remain vital in order for the offshore wind industry to develop;
- Recent and continued involvement of the European Investment Bank crucial given the current financial climate;
- Precedent setting Belwind and Boreas financing deals critical as they should open the door to further financing deals;
- European Commission's Recovery Plan provides a crucial injection of €255 million for six offshore wind farms.

### Industry highlights and developments:

- Turbine supply set to dramatically expand from the two dominant manufacturers with the entry of a number of mostly European newcomers to the market;
- Installation vessel fleet set to expand, but remains a key bottleneck.

## Executive summary

### Offshore supergrid developments:

- Significant steps taken in 2009 on planning and financing specific offshore cables – in particular UK/Norway interconnector, NorGer, Cobra cable, East-West Interconnector, BritNed and Kriegers Flak;
- National governments and the European Commission agreed in 2009 to provide political direction and a strategic plan for an offshore supergrid by the end of 2010.

### International opportunities:

- European companies well placed to take advantage of significant opportunities now emerging in North America and Asia.

## 2009 annual market

### 2009 offshore wind installations

In 2009, 199 wind turbines in eight separate offshore wind farms were installed and grid connected in European waters, totalling 577 MW of new capacity - a 54% increase on 2008 installations. The eight offshore wind farms which were wholly or partially

connected during 2009 range in size from 2.3 MW (Hywind, Norway) to 209 MW (Horns Rev 2, Denmark). The average size of wind turbines installed offshore during 2009 was 2.9 MW.

2009 OFFSHORE INSTALLATIONS: NATIONAL BREAKDOWN

FIGURE 1.0

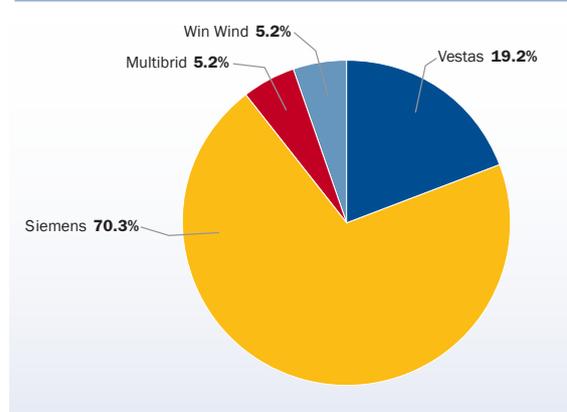
	United Kingdom	Denmark	Sweden	Germany	Norway
Number of turbines	84	98	10	6	1
MW	284.4	230	30	30	2.3
Number of farms	3	2	1	1	1

### 2009 annual market share - manufacturers

Of the 199 wind turbines installed and grid connected during 2009, 146 were Siemens turbines (2.3 MW and 3.6 MW), 37 were Vestas turbines (3 MW), 10 were WinWind turbines (3 MW) and six were Multibrind turbines (5 MW) (see figure 1.1). In addition, six REpower turbines (5 MW) were installed but not grid connected<sup>1</sup> (see figure 1.2).

2009 INSTALLATIONS: WIND TURBINES MANUFACTURERS' OFFSHORE MARKET SHARE IN MW

FIGURE 1.1



<sup>1</sup>The six REpower turbines and their foundations are therefore not included in the analysis undertaken in this document.

### 2009 annual market share – developers/utilities

DONG Energy was the leading developer/utility during 2009 in terms of installations, installing 313 MW of the 577 MW. DONG Energy was followed by E.ON Climate & Renewables and RWE Innogy (see figure 1.2).

### 2009 foundation types

The majority of the substructures installed during 2009 were monopiles – 88% in total. Only two farms installed during 2009 used gravity foundations and one used tripods<sup>2</sup> (see figure 1.3). Importantly, the first full scale turbine was installed using a floating foundation/substructure, in a water depth of 220m.

### Water depth

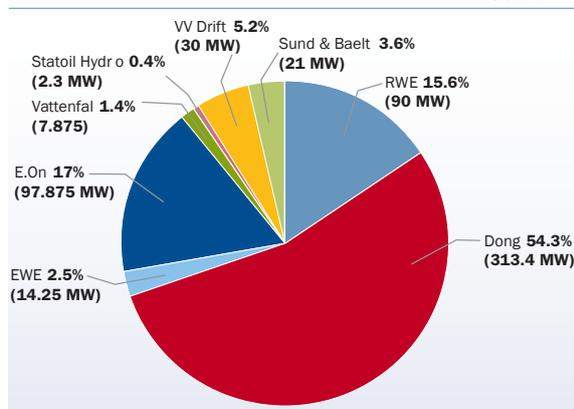
The average water depth of the offshore wind farms installed during 2009 was 12m<sup>3</sup> (see figure 1.4).

### Distance to shore

The average distance to shore of the offshore wind farms installed during 2009 was 14.4km (see figure 1.5).

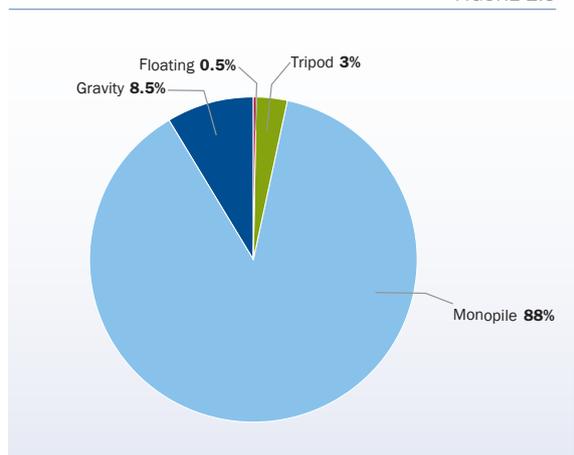
### SHARE OF INSTALLED OFFSHORE CAPACITY DURING 2009

FIGURE 1.2



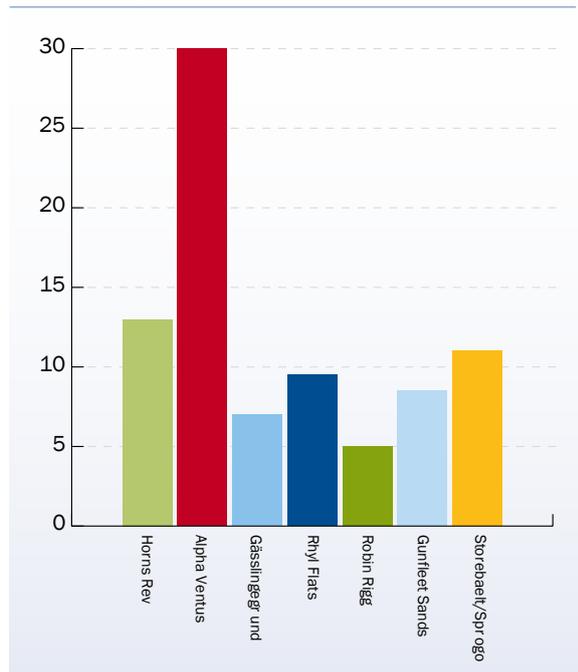
### FOUNDATION TYPE: SHARE OF INSTALLATIONS DURING 2009

FIGURE 1.3



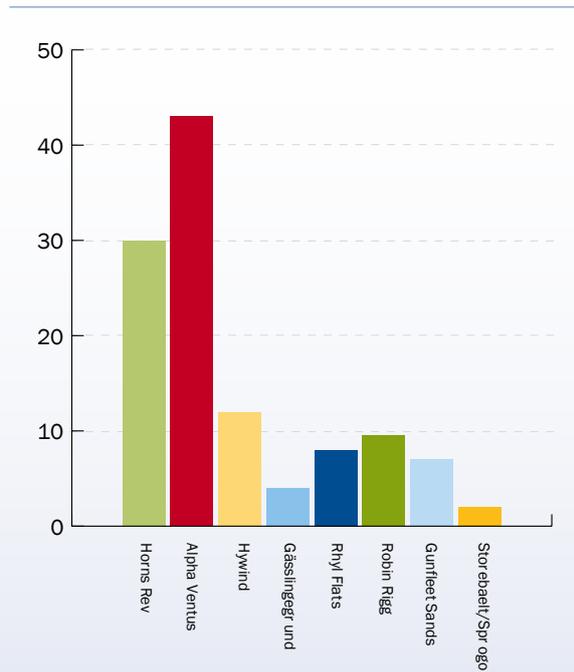
### AVERAGE WATER DEPTH IN M

FIGURE 1.4



### AVERAGE DISTANCE TO SHORE IN KM

FIGURE 1.5



<sup>2</sup> The six REpower turbines at Alpha Ventus using jacket foundations are excluded from this analysis as the turbines were not grid connected by 31 December 2009.

<sup>3</sup> Excluding the floating Hywind turbine, installed in waters 220m deep. If Hywind is included the 2009 average increases to 38m.

## Market outlook: 2010 and beyond

### 2010

2010 will be a defining year for the offshore wind power market in Europe. The economic crisis permitting, 2010 will see around 1,000 MW installed offshore in European waters with more than 10 farms being completed. The installations expected in 2010 should amount to more than a 75% market growth compared to 2009 installations.

Europe's 2010 offshore market could make up approximately 10% of Europe's total annual wind market, making the offshore industry a significant mainstream energy player in its own right.

### Beyond 2010

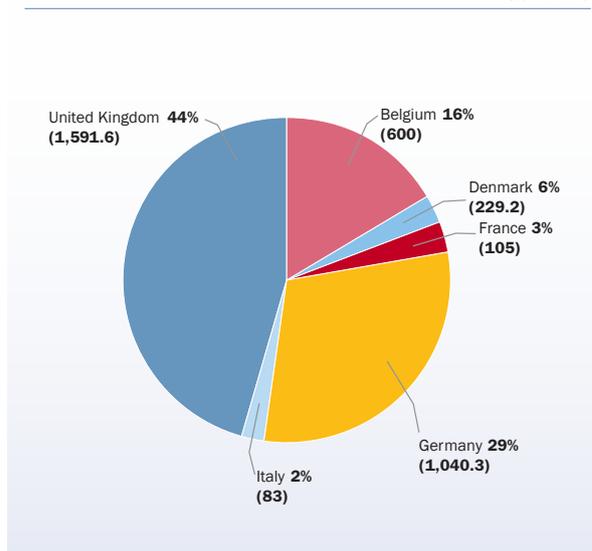
Looking beyond 2010, there is a significant pipeline of offshore projects at varying stages of development.

Currently 17 wind farms are under construction in European waters, totaling more than 3,500 MW (see figure 2.0). In addition, a further 52 offshore wind farms in European waters have been fully consented, totaling more than 16,000 MW (see figure 2.1).

In 2020, EWEA expects between 40 GW and 55 GW of offshore wind farms to be feeding electricity to the grid in the EU, producing between 145 and 198 TWh of electricity<sup>4</sup>. EWEA has identified proposals for over 100 GW of offshore wind projects in European waters – either under construction, consented, in the consenting phase or proposed by project developers or government proposed development zones. This 100 GW of offshore wind projects shows tremendous developer interest and provides a good indication that EWEA's expectation that 150 GW of offshore wind power will be operating by 2030 is feasible.

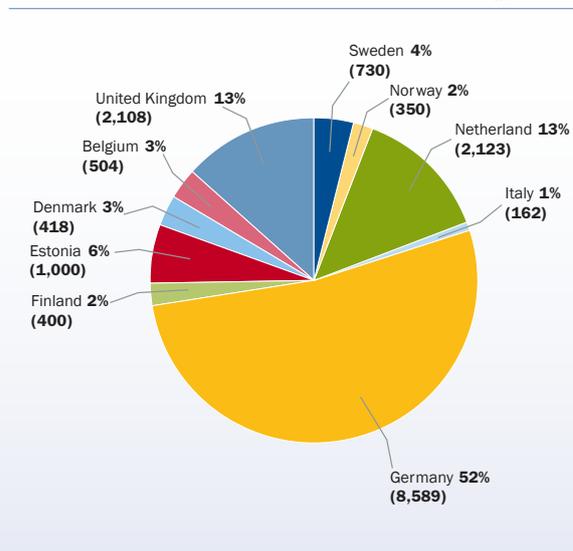
SHARE OF OFFSHORE WIND CAPACITY UNDER CONSTRUCTION

FIGURE 2.0



SHARE OF CONSENTED OFFSHORE WIND CAPACITY PER COUNTRY

FIGURE 2.1



## Cumulative market

A total of 828 wind turbines are now installed and grid connected in European waters, bringing the total installed capacity offshore in Europe to 2,056 MW (see figure 3.0) spread across 38 wind farms in nine European countries (see figures 3.1, 3.2 and 3.3). In

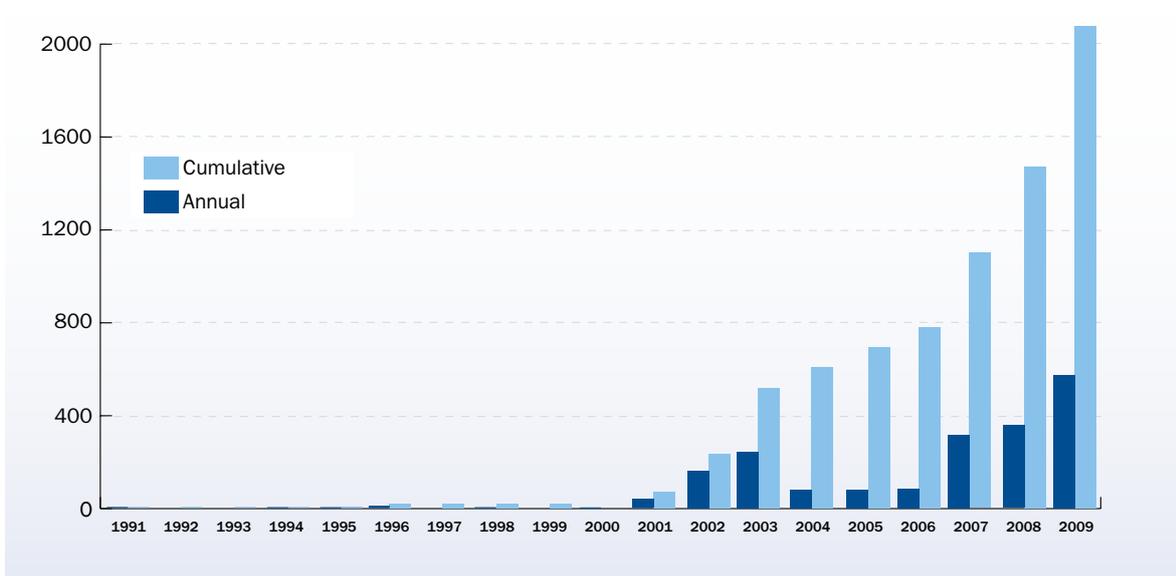
terms of size they range from 2 MW (Lely, Netherlands, built in 1994) to 209 MW (Horns Rev 2, Denmark, built in 2009).

The leading markets remain the UK and Denmark.

<sup>4</sup> Pure Power: Wind energy targets for 2020 and 2030. EWEA. 2009 [http://www.ewea.org/fileadmin/ewea\\_documents/documents/publications/reports/Pure\\_Power\\_Full\\_Report.pdf](http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Pure_Power_Full_Report.pdf).

ANNUAL AND CUMULATIVE INSTALLED CAPACITY IN MW 1991 - 2009

FIGURE 3.0



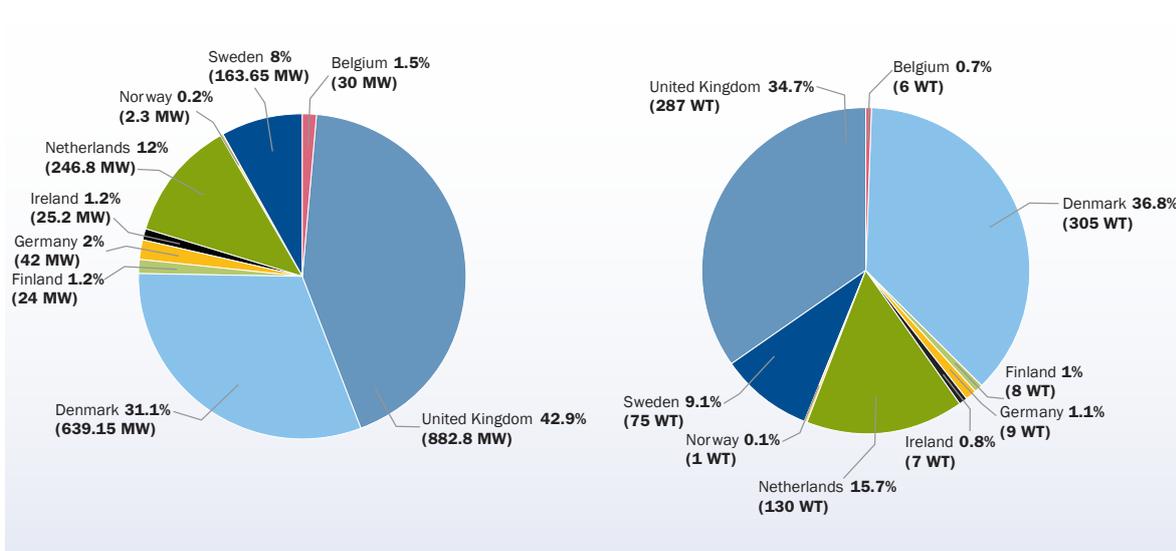
NATIONAL BREAKDOWN OF OFFSHORE WIND INSTALLATIONS END 2009

FIGURE 3.1

Country	UK	Denmark	Sweden	Netherlands	Germany	Belgium	Ireland	Finland	Norway	Total
N° of farms	12	9	5	4	4	1	1	1	1	38
N° of turbines	287	305	75	130	9	6	7	8	1	828
N° of MW	882.8	639.15	163.65	246.8	42	30	25.2	24	2.3	2,056

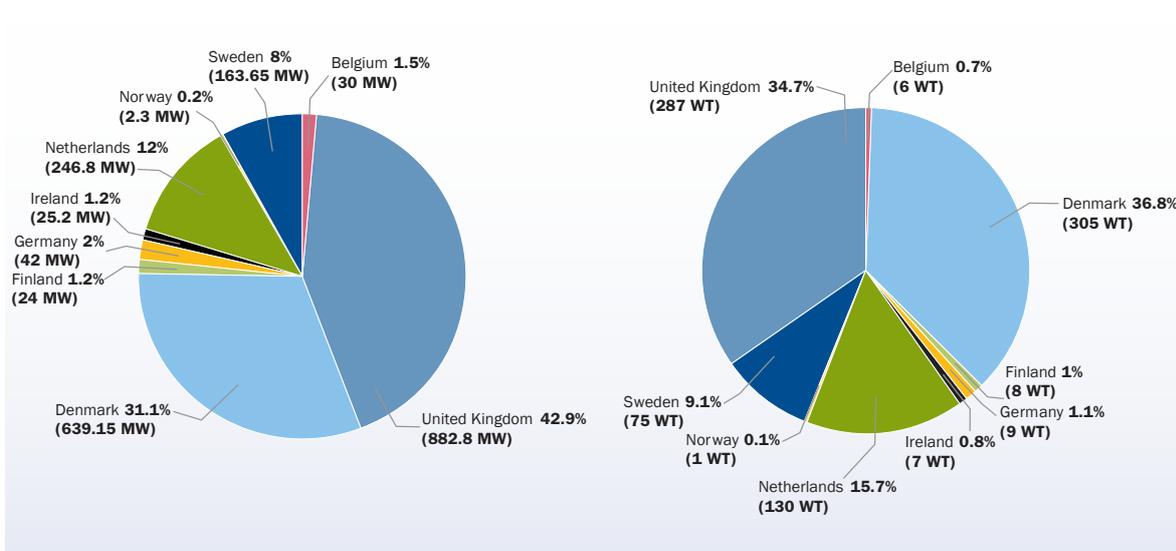
INSTALLED CAPACITY: CUMULATIVE SHARE BY COUNTRY END 2009 IN MW

FIGURE 3.2



INSTALLED CAPACITY: CUMULATIVE SHARE OF INSTALLED TURBINES PER COUNTRY END 2009

FIGURE 3.3



Wind turbine capacity

The average turbine size is now 2.9 MW.

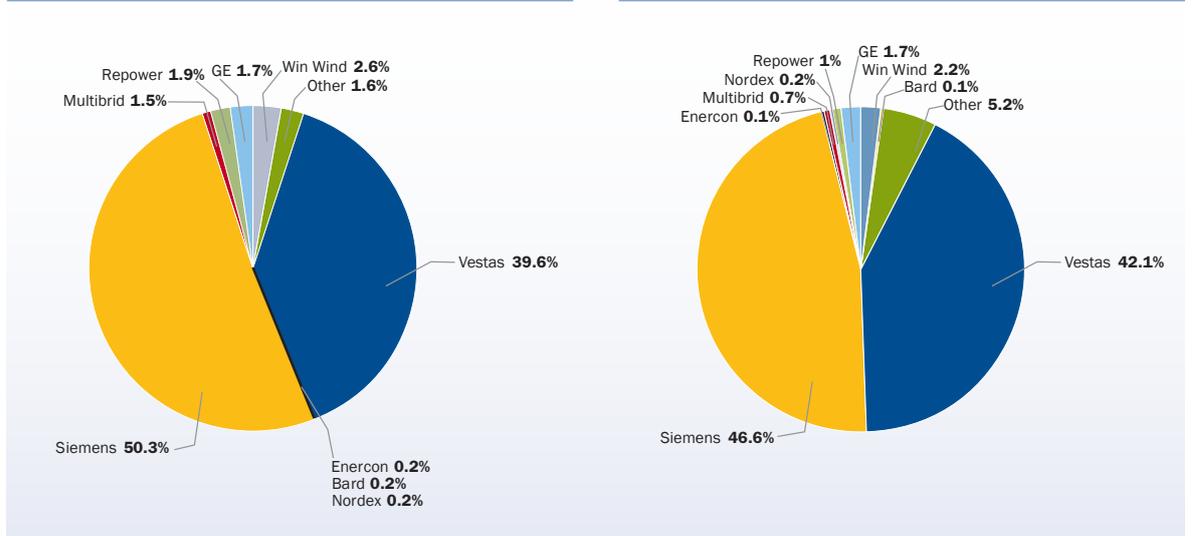
**Cumulative market share**

In terms of cumulative installed units, Siemens (386 WT) and Vestas (349 WT) have been the two largest suppliers.

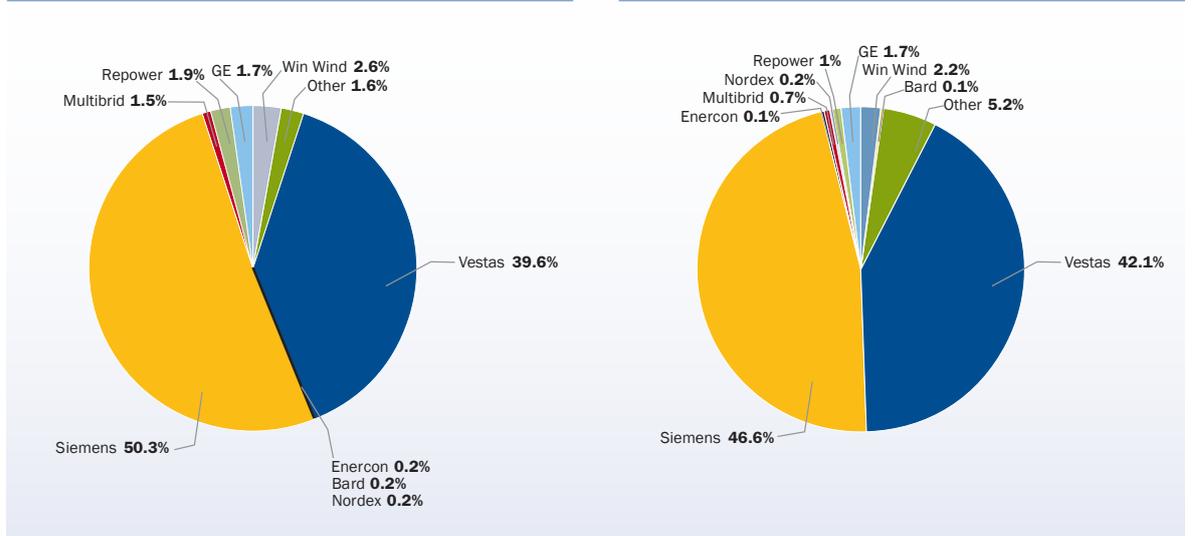
turbines, two Nordex turbines, one BARD turbine, one Enercon turbine and 43 turbines from other manufacturers.

In addition there are 18 WinWind turbines operating, 14 GE turbines, eight REpower turbines, six Multibrid

**WT MANUFACTURERS: CUMULATIVE MARKET SHARE IN MW END 2009** FIGURE 3.4



**WT MANUFACTURERS: CUMULATIVE MARKET SHARE IN N° OF TURBINES END 2009** FIGURE 3.5

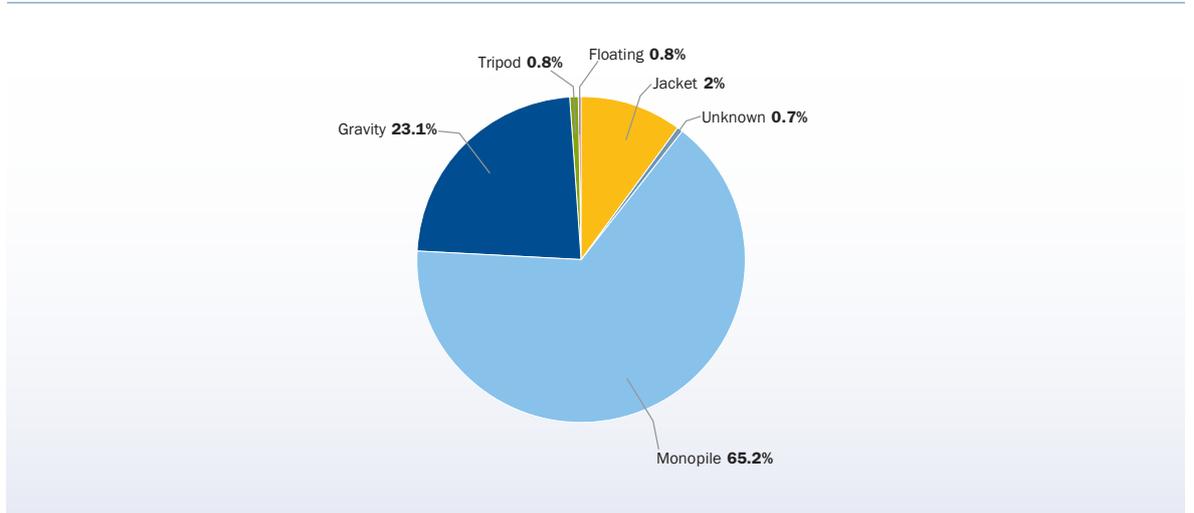


**Foundations**

The main foundation technologies used offshore are gravity and monopile. Other technologies currently used are jacket, tripod and floating. The main foundation manufacturers are MT Højgaard, Smulders, Bilfinger Berger, Per Aarsleff, Bladt, BiFab, Aker and BARD.

Monopiles remain the dominant foundation structure, followed by gravity foundations and jackets.

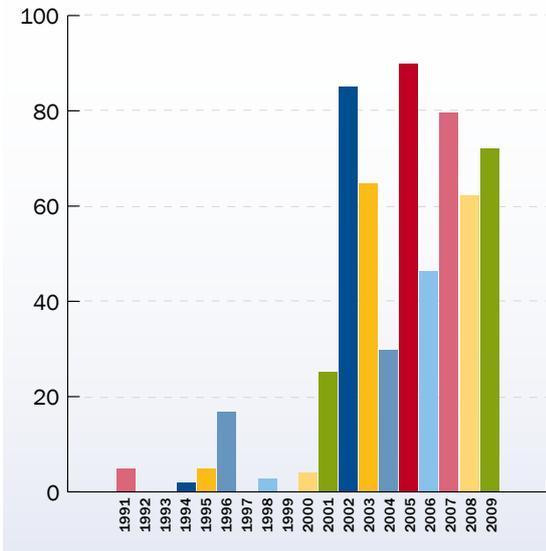
**SHARE OF SUBSTRUCTURE TYPES FOR ONLINE WIND FARMS END 2009** FIGURE 3.6



## Trends: turbines, foundations, water depth and distance to shore

AVERAGE WIND FARM SIZE IN MW

FIGURE 4.0



### Wind farm size

The average wind farm size in 2009 was 72.1 MW. In 2008, the average size was 62.2 MW (see figure 4.0).

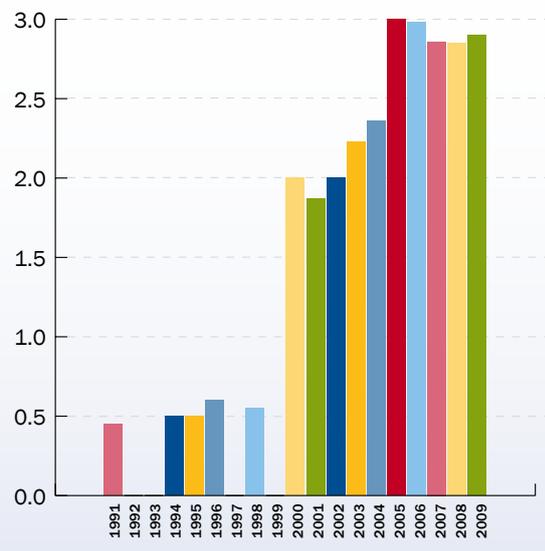
### Wind turbine capacity (see figure 4.1)

Wind turbine capacities have been increasing steadily year on year since 1991. In 2004, 3.6 MW and 4.5 MW turbines were installed. This was the first year that turbines above 2.3 MW were used. In 2005, one offshore wind farm went online using 3 MW turbines.

Since 2005, average turbine size has been slightly below the 3 MW mark, setting a new benchmark for the industry. In the coming years, average wind turbine size is expected to grow, as machines between 3 and 5 MW become standard.

AVERAGE OFFSHORE WIND TURBINE CAPACITY

FIGURE 4.1



### Foundation trends (see figure 4.2)

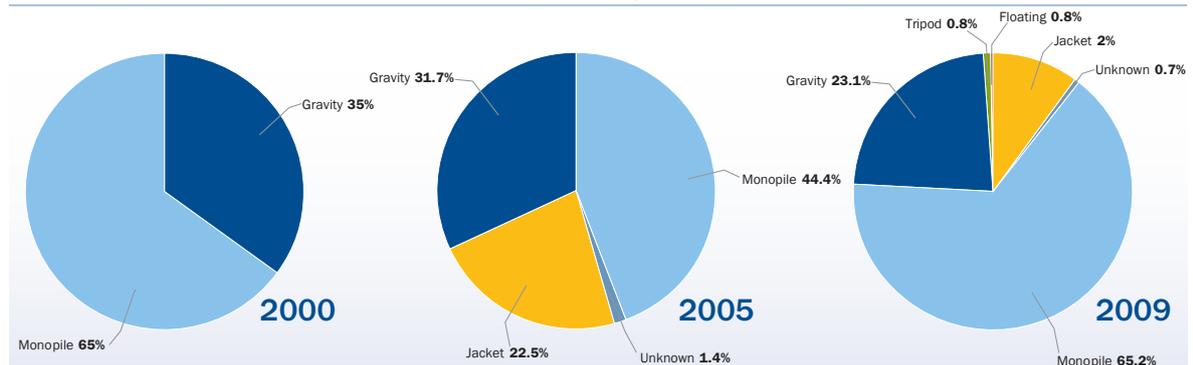
The eight offshore wind farms built in 2009 used four different types of substructure. Since the first offshore wind farm went online in 1991, four main types of substructure have been used.

Monopile is the most common solution adopted for substructures followed by gravity. Jacket and tripod substructures are less common. Jacket structures will be tested at Alpha Ventus when the six REpower wind turbines are grid connected in the beginning of 2010.

If tests on floating substructures are conclusive, this type of substructure could see considerable development in the years ahead.

SHARE OF SUBSTRUCTURE TYPES FOR ONLINE WIND FARMS END 2000, END 2005 AND END 2009

FIGURE 4.2



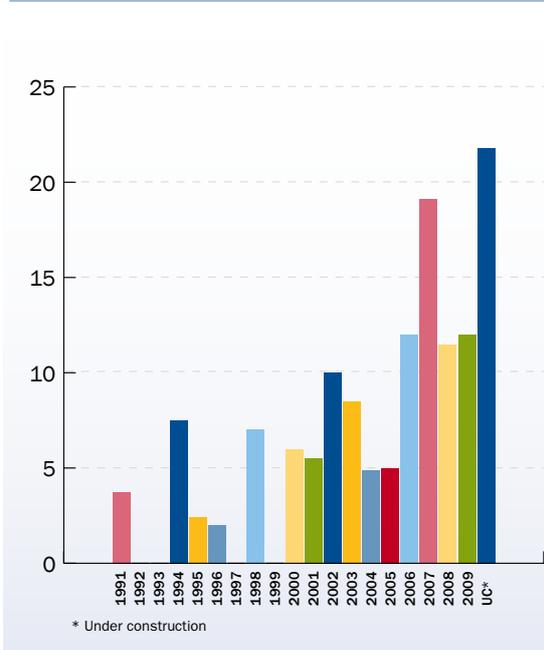
**Water depth<sup>5</sup>** (see figures 4.3 and 4.4)

The average water depth of the offshore wind farms installed during 2009 was 12m, 0.5m deeper than in 2008. Average water depths are increasing but not linearly, with 2009 being exceptional due to the

installation of a floating turbine. The average water depth remains below 20m. However, offshore wind farms under construction have an average water depth of 21.8m.

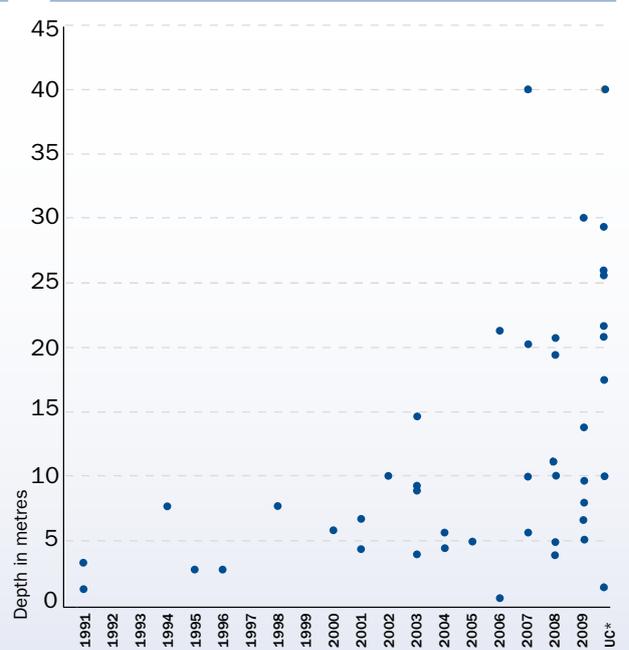
AVERAGE WATER DEPTHS IN M

FIGURE 4.3



WATER DEPTHS OF OFFSHORE WIND FARMS IN M

FIGURE 4.4



**Distance to shore**

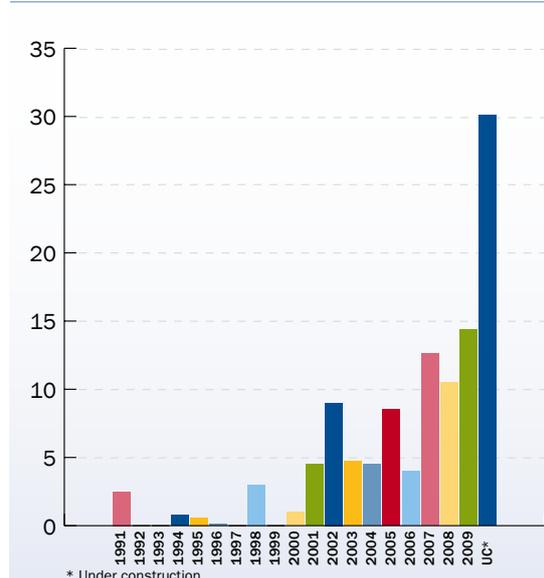
The average distance to shore of the offshore wind farms installed during 2009 was 14.4km, 3.9km further than in 2008 - confirming that distances to shore are increasing. Most projects are still closer

than 20 km, and the vast majority are less than 40 km.

However, a noticeable increase is expected in the coming years, with offshore wind farms under construction averaging a distance to shore of 30.1km.

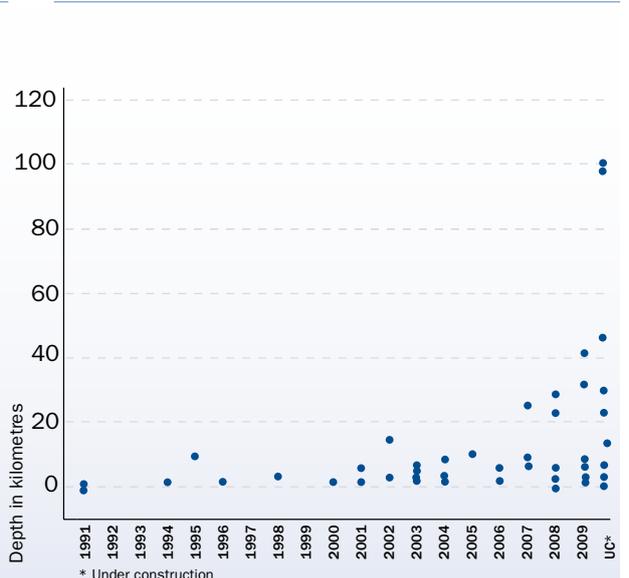
AVERAGE DISTANCE TO SHORE IN KM

FIGURE 4.5



DISTANCE TO SHORE OFFSHORE WINDFARMS IN KM

FIGURE 4.6



<sup>5</sup> Unless otherwise stated this analysis excludes the Hywind floating prototype.

## Financing highlights and developments

In 2009, the turnover of the offshore wind industry was approximately €1.5 billion, and this will double in 2010 to approximately €3 billion.

Given that the offshore wind industry will, over the coming years be moving into deeper water and further from shore, government support will remain vital in order for the industry to develop.

Today, turbines account for 50% to 60% of offshore wind project costs, substructures for 25%, installation for some 15%, and grid connection some 10%.

Financing offshore wind farms on a nonrecourse<sup>6</sup> basis has proved challenging due to the financial crisis. This has had a very different impact on the two sectors active in developing offshore wind farms – utilities and independent project developers. The projects developed by the utilities have been less affected by the financial crisis thanks to their continued ability to fund investments from their balance sheets. Conversely, independent developers have been, and continue to be, severely affected by the financial crisis and the consequent lack of availability of project finance. This is because:

- retrenching banks have taken a more conservative approach to lending. The lack of precedent for the offshore wind industry is curtailing the banks' appetite for the sector; and
- the reluctance of committed banks to undertake syndicated loans leads to difficulty in financing the deals necessary for large offshore wind farms.

The result is that market capacity remains severely constrained by a lack of committed banks and lack of existing deals, even when taking into account development banks.

Positive financial trends were evident in the second half of 2009 with the Belwind and Boreas transactions, which involved different sponsors, technologies, bank groups and authorities. By creating two high-profile precedents for the sector and bringing about the involvement of many new banks, they opened the door to more deals in the future. The presence of the European Investment Bank (EIB) in the Belwind financing is also likely to be a crucial precedent for the multilateral institution as it builds up its investment in the sector.

In addition to closing the Belwind financing, the EIB launched the Marguerite 2020 Fund to provide equity



Photo: SSE

or quasi equity and announced its support for several offshore windfarms, including the London Array (Phase 1: 630 MW), Global Tech I (400 MW), Borkum West II (200 MW of a total 400 MW), Baltic I (48.3 MW), BARD 1 (400 MW) which hope to close their financing during 2010.

In all of the above projects, commercial banks are involved in various advisory or arranging roles, and they are further pursuing other transactions such as the Lincs (270 MW), Nordergrund (105 MW), Meerwind (400 MW), Thornton Bank/C-Power 2 (120 MW) Eldepasco (330 MW) projects or supporting sponsors preparing their bids in the ongoing Dutch offshore wind auction.

Ekspport Kredit Fonden, the Danish Export credit agency has supported transactions and the German government has also offered support in the form of dedicated funding for the sector provided by KfW Bankengruppe. In addition, the US government is considering supporting the nascent US offshore sector through similar funding mechanisms or grants.

The offshore wind industry was also buoyed during 2009 by the European Union's European Economic Recovery Plan which injected €255 million of the €565 million directed towards offshore wind into five separate offshore wind farms, specifically:

<sup>6</sup>A secured loan with no personal liability [www.businessfinance.com/nonrecourse-debt.htm](http://www.businessfinance.com/nonrecourse-debt.htm).

European Economic Recovery Plan - Offshore Windfarm	€ million
BARD 1: Production of innovative tripile foundation system and production and installation of innovative cable in-feed system for a 400 MW offshore wind farm.	53,10
Global Tech I - Gravity foundations: Gravity foundations for deep water wind farms using efficient serial manufacturing and fast installation processes.	58,55
Nordsee Ost: Installation of 6 MW wind turbine generators (jacket foundation structures) in challenging offshore circumstances, including innovative logistics and installation concept.	50,00
Borkum West II: Installation of innovative 5 MW wind turbine generators on tripod foundations.	42,71
Aberdeen Offshore Wind Farm - Wind deployment centre: development of a facility for testing of multi-MW turbines with innovative structures and substructures and optimisation of manufacturing capacities of offshore wind energy production equipment.	40,00
Thornton Bank: optimised logistics for upscaling the far-shore deep-water Thornton Bank wind farm and demonstration of innovative substructures (jacket foundations) for deep water off shore parks.	10,00

This stimulus injection was vital, and it remains crucial that this financing is released as soon as feasible and that the Commission's review in 2010 of the European Economic Recovery Plan, or any further stimulus package, continues to target the offshore wind industry as a strategic European sector.

To ensure that the market growth expected for 2010 is not blown off course the European institutions, particularly the EIB, must continue to increase their involvement in the offshore wind industry.

More generally, banks must be given continued comfort that stable regulatory – and in particular revenue – regimes will be in place over the long term, and that connection to the grid is guaranteed to offshore wind projects.

Given the continued worries in the banking world about long term liquidity availability, European institutions should consider structures to provide dedicated low-cost funding to banks active in the offshore wind sector. Such a mechanism would have the additional advantage of bringing the overall cost of offshore wind down.

## Industry highlights and developments

### Wind turbines

Offshore wind turbine supply is currently dominated by two manufacturers – Siemens and Vestas. Newcomers such as REpower, Areva Multibrid, BARD, WinWind and Nordex are now entering the market. In addition, GE's recent acquisition of Norwegian company ScanWind implies that the company will return to the offshore

market, Acciona has indicated it would participate in the UK's Round 3 with a 3 MW turbine, Gamesa has stated it may produce a 3.5 MW offshore turbine before 2015, and Clipper is developing a 7.5 MW offshore turbine. These newcomers have the potential to increase competition on the supply side and have been attracted by the 5,900 MW of offshore orders announced since the beginning of 2008<sup>7</sup>.

The workhorse offshore turbines are currently 3 MW and 3.6 MW turbines and 2009 saw the announcement from Vestas and Siemens of new models of these turbines. Upscaling is taking place - REpower, Multibrid, and BARD have 5 MW turbines, REpower is testing a 6 MW turbine, Vestas announced its intention to develop a 6 MW turbine and Clipper is developing a 7.5 MW turbine. This trend is motivated by the quest for economies of scale, although the nacelle weight puts constraints on the installation vessels.

There is a clear trend towards a simplification of the gearbox component, with the emergence of one-stage gearboxes, and direct-drive concepts. These concepts are developed with a view to reducing the number of moving parts in the system, potentially increasing reliability.

To secure supply chains, key strategic turbine partnerships emerged during 2009 between DONG Energy and Siemens, and between RWE Innogy and REpower.

### Installation vessel supply chain highlights and developments in 2009 and 2010 outlook<sup>8</sup>

There are currently 10 vessels available for turbine installation globally, some of which are limited due to lifting capacities, water depth operation range and weather conditions.

<sup>7-8</sup>Emerging Energy Research. Global Offshore Wind Energy. Markets and Strategies: 2009–2020. December 2009.

Up to five new jack-up installation vessels are expected to be operational by 2011, increasing the sector's installation capacity by over 50% as these new vessels will have bigger lifting capacities and could operate in deeper waters. Companies which are expanding their fleets include Beluga Hochtief, Master Marine, Seajacks, and MPI. DONG and RWE both sought to secure the availability of installation vessels during 2009: DONG Energy recently bought A2Sea, and BARD and RWE Innogy are building their own customised installation vessels.

## Offshore supergrid developments

### EWEA's 20 year plan

In September, EWEA published its 20 Year Offshore Network Development Master Plan, which provides a step by step approach to planning Europe's offshore grid in the North and Baltic Seas.

### Stockholm Declaration

The Stockholm Declaration was agreed during EWEA's Offshore Wind Conference in September by government representatives from 12 Member States, plus Norway and the European Commission. It contains a series of recommendations to harness the offshore wind resource in the North and Baltic Seas. The declaration stipulates that the European Commission, national governments and other organisations involved in the creation of an offshore grid should establish a work plan to address the relevant technical, financial, regulatory and environmental issues.

### North Sea Grid Initiative

During the Energy Council on 7 December, an inter-governmental agreement called the "North Seas Countries Offshore Grid Initiative" was signed by nine countries. By signing, they agreed to develop "a strategic working plan" on the future offshore supergrid.

### President Barroso

Over the summer President Barroso's 'Political Guidelines for the Next Commission' stated: "One of the next great European projects is to give Europe a new European supergrid for electricity...".

### UK/Norway developments

In October, the countries' system operators signed an agreement to explore the feasibility of building a HVDC interconnector. A previous pre-feasibility study already indicated that the cable would be economically and technically feasible. The capacity of the interconnectors tested in the study ranges between 1-1.2 GW, and "could include connection nodes along the route with spurs taking power from offshore generation".

### NorGer development

A private consortium of three partners plans to build a first transmission line between Germany and Norway with a capacity of 1,400 MW. The consortium is now waiting for commercial authorisation from the Norwegian regulator, which is expected in 2010. After passing this regulatory hurdle, construction time is envisaged to be about four years.

### Kriegers Flak – European Commission funding

The European Commission approved €150 million for Kriegers Flak. The three system operators are currently working on a joint feasibility study for the so-called combined solution. The final investment decision is expected by mid 2010, stepwise commission and start of operation of the wind farms could then commence from 2012 on.

### Cobra Cable

The European economic recovery plan (EERP) has awarded the Cobra Cable, the planned offshore transmission line between the Netherlands and Denmark, a grant of € 85 million.

The grant will facilitate investigations into the possibility of connecting offshore wind farms directly to the cable. The final investment decision is expected by 2012, and the cable should be ready for operation by 2016.

### East-West interconnector

The European Investment Bank (EIB) agreed to lend Irish TSO EirGrid €300million towards construction of the 256 km transmission cable between Ireland and Wales. Construction of the East-West Interconnector is scheduled to commence in 2010. The project is due for completion in 2012.

## BritNed - EIB financing

The European Investment Bank (EIB) agreed to provide €300 million for the construction of the BritNed Interconnector, a new electricity transmission cable between the United Kingdom and the Netherlands. Construction started in the summer of 2008 and in 2011 the interconnector will be operational with a capacity of 1 GW.

## Skagerrak 4

In December the transmission system operators in Denmark and Norway decided to build a further transmission line between their countries. The Skagerrak 4 cable will have a capacity of 700 MW and is expected to be commissioned in 2014.

## Outlook for 2010

The “North Seas Countries Offshore Grid Initiative” will hold a high level meeting during the Belgian Presidency of the EU in the autumn in order to agree “a strategic working plan” on the future offshore supergrid.

The European Commission aims to publish in 2010 proposals for a revised Trans-European Network (Energy) Instrument in the form of a new “EU Energy Security and Infrastructure Instrument” and its Blueprint for a North Sea Offshore Grid.

The first draft European Network of transmission System Operators Ten-Year Network Development Plan will be finalised in the summer.

The envisaged market integration and interconnection projects outlined in the Baltic Energy Market Interconnection Plan (BEMIP) - most prominently the Nordbalt Interconnector between Lithuania and Sweden, to be operational by 2016 - are on track and the next progress report will be presented by mid 2010.

## Contributors

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Jacopo Moccia (Regulatory Affairs Advisor - Member State Liaison, EWEA) – All research and analysis

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Jérôme Guillet (Head of Energy, Dexia Crédit Local) – Financing highlights

Paul Wilczek (Regulatory Affairs Advisor - Grids and Internal Electricity Market, EWEA) - Grid highlights

JANUARY 2010

## International opportunities

### Canada

North America’s largest offshore wind project will be located in British Columbia, and will total 1,750 GW in five phases. The European company Siemens will supply 110 turbines (3.6 MW) for the first phase.

### Taiwan

Taiwan is moving closer to having its first offshore wind farm, the 600 MW Changhua Offshore Windfarm, which will be located in the Taiwan Strait. The companies involved are the Taiwan Generation Corporation and European company SeaEnergy Renewables.

### US

In the US there are 10 offshore projects being driven by four companies, totaling 2,000MW.

### China

China will be the first non-European country with an operating offshore wind farm. The first offshore wind turbine in China was installed in 2007, located in Liaodong Bay in the northeast Bohai Sea. The test turbine has a capacity of 1.5 MW. The wind turbine was built by the China National Offshore Oil Corp (CNOOC), the country’s largest offshore oil producer. Construction of the first offshore wind farm in China started in 2009, close to Shanghai Dongdaqiao. The first three machines were installed in April 2009, and by the end of 2009 there were 15 turbines installed, 3 of them grid connected. The wind farm is expected to be completed in the first half of 2010 to provide electricity to the 2010 Shanghai Expo. The wind farm will consist of 34 Sinovel 3 MW turbines. Three 3MW turbines are expected to be installed in Rudong Offshore Wind Farm in Jiangsu province. Other provinces that have plans for offshore wind farms are Shandong province, Zhejiang province and Fujian province.