THE EUROPEAN WIND ENERGY ASSOCIATION

The European offshore wind industry key trends and statistics 2010

January 2011

A report by the European Wind Energy Association

Contents

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Executive summary

2010 offshore wind power market	• 308 new offshore wind turbines, worth some €2.6 billion, were fully grid connected between 1 January and 31 December 2010, totalling 883 MW – a 51% increase on the previous year; • Eight wind farms were fully completed and grid connected, one wind farm was partially grid connected, and one wind farm was completed but not grid connected; • Offshore work began on a further four projects and preparatory onshore work on four new projects.
Cumulative offshore wind power market	• 1,136 turbines installed and grid connected, totalling 2,946 MW in 45 wind farms in nine European countries. The offshore wind capacity installed by the end of 2010 will in a normal year produce 11.5 TWh of electricity; • Average wind turbine size is now 3.2 MW; • 65% of substructures are monopiles, 25% are gravity and 8% are jacket.
Market outlook: 2011 and beyond	• EWEA forecasts that between 1,000 and 1,500 MW of new offshore wind capacity will be fully grid connected in Europe during 2011; • 10 wind farms, totalling 3,000 MW, are currently under construction. When completed, Europe's installed offshore capacity will increase to 6,200 MW; • 19,000 MW are currently fully consented.
Trends: turbines, foundations, water depth and distance to shore	• The average offshore wind farm size in 2010 was 155.3 MW, up from 72.1 MW the previous year; • Average water depth in 2010 was 17.4m, a 5.2m increase on 2009, with projects under construction in water depth averaging 25.5m; • Average distance to shore increased in 2010 by 12.7 km to 27.1 km, substantially less, however, than the 35.7 km average for projects currently under construction.

Financing highlights and developments

- 2010 saw two major deals come to financial close: Thornton Bank C-Power (325 MW) and Trianel Wind Farm Borkum West II (200 MW). Both projects use turbines of 5 MW or more, signalling that financing institutions are willing to invest in the large turbines likely to dominate the sector in the coming years;
- A positive 2010 trend has been the arrival of new financial investors - pension funds - into the sector, with two notable transactions in the second half of the year;
- 2010 saw a flow of investment announcements from utilities which have continued to increase their balance sheet commitments to the sector;
- National and international finance institutions such as the European Investment Bank (EIB) and export credit agencies have been critical for the development of the sector during a critical juncture. They are likely to remain active in the sector in the near future, providing critical liquidity at a low cost, and will help ensure that a smooth transition can be engineered towards a more mature market when commercial banks are able to do large transactions without them.

Industry highlights and developments

- During 2010, 29 new offshore turbine models were announced by 21 manufacturers: 44 new turbine models have been announced by 33 manufacturers over the last two years;
- European manufacturers are developing 6 and 7 MW prototypes, including dedicated offshore concepts, whilst foreign companies are mainly developing 5 MW turbines.

Offshore grid developments

- The signing of the memorandum of understanding by the North Seas Countries' Offshore Grid Initiative, and the European Commission's Communication "Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network" put a future offshore grid at the centre of EU energy policy;
- Significant steps were taken in 2010 on planning, financing and constructing specific offshore cables – in particular NorGer, CobraCable, East-West interconnector, BritNed, NorNed 2, UK/Norway, Kriegers Flak, and NordBalt.

2010 annual market

Offshore wind installations

During 2010, work was carried out on 18 offshore wind farms. Nine wind farms were completed, eight of which were fully grid connected. One wind farm was partially completed and grid connected. In four other projects, work has begun but no turbines were connected during 2010. Finally, preparatory onshore work was carried out for four other projects.

Wind farm name	Status
Alpha Ventus (DE)	Fully completed and connected in 2010 - partially grid connected in 2009
Baltic 1 (DE)	Wind farm completed but waiting for connection to grid
BARD offshore 1 (DE)	First turbines grid connected in 2010
Belwind (BE)	Fully grid connected in 2010
Greater Gabbard (UK)	Offshore work started in 2010 – no turbines grid connected
Gunfleet Sands 1 & 2 (UK)	Fully completed and connected in 2010 – partially grid connected in 2009
Ormonde (UK)	Offshore work started in 2010 – no turbines grid connected
Pöri 1 (FI)	Fully grid connected in 2010
Poseidon (DK)	Fully grid connected in 2010
Robin Rigg (UK)	Fully completed and connected in 2010 – partially grid connected in 2009
Rødsand 2 (DK)	Fully grid connected in 2010
Sheringham Shoal (UK)	Offshore work started in 2010 – no turbines grid connected
Thanet (UK)	Fully grid connected in 2010
Walney (UK)	Offshore work started in 2010 – no turbines grid connected
Global Tech 1 (DE)	Onshore preparatory work started in 2010
Gwynt y Môr (UK)	Onshore preparatory work started in 2010
London Array (UK)	Onshore preparatory work started in 2010
Nodergründe (DE)	Onshore preparatory work started in 2010

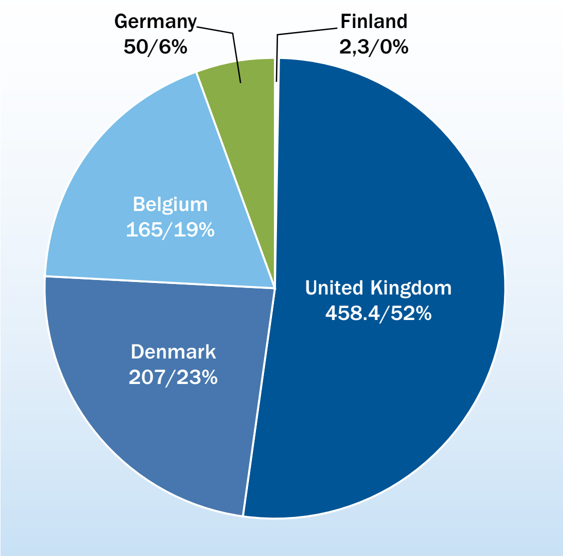


FIG 1: INSTALLED CAPACITY: SHARE OF 2010 INSTALLATIONS (MW)

With 458 MW of new offshore capacity grid connected in British waters, over half of all new offshore capacity in 2010 was added in the United Kingdom. Just under a quarter of new capacity was installed in Denmark (207 MW), followed by Belgium (165 MW), Germany (50 MW) and Finland where one 2.3 MW turbine was installed near shore.

Country	UK	Denmark	Belgium	Germany	Finland	Total
No. of farms where turbines have been installed and connected in 2010	3	2	1	2	1	**9**
No. of wind turbines installed and connected in 2010	149	93	55	10	1	**308**
Capacity installed and connected in 2010 (MW)	458.4	207.03	165	50	2.3	**882.7**

2010 annual market share – wind turbine manufacturers

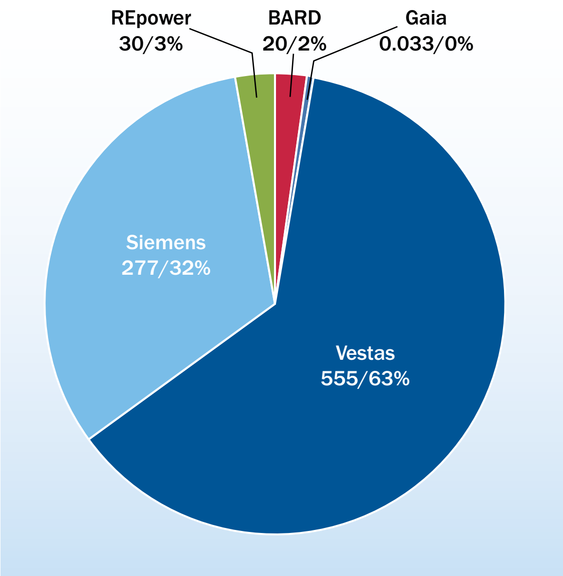


FIG 2: WT MANUFACTURERS: SHARE OF 2010 INSTALLATIONS (MW)

Vestas and Siemens remain the main suppliers of the offshore wind market, as they have been since the first offshore wind farms went online in the early 1990s. In 2010 Vestas and Siemens installed 555 MW and 278 MW respectively, or 63% and 32% of all MW installed in the year. REpower (30 MW) and BARD (20 MW) are the other two turbine manufacturers to have successfully grid connected offshore turbines during 2010. A small floating prototype (0.033 MW) was also installed off the Danish coast using GAIA turbines.

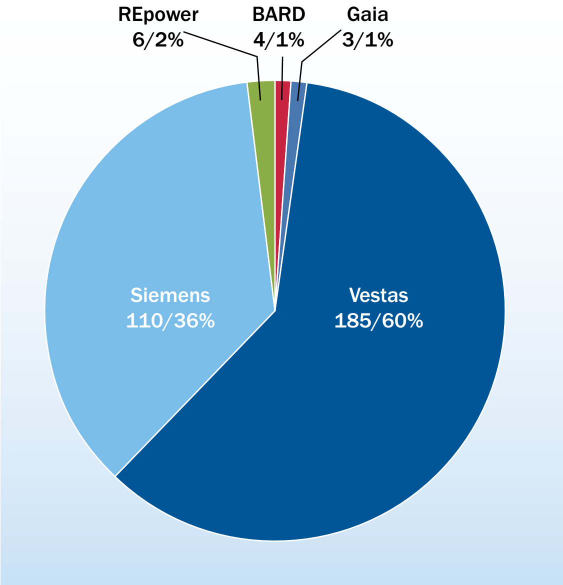


FIG 3: **WT MANUFACTURERS: SHARE OF 2010 GRID CONNECTED TURBINES (UNITS)**

Vestas installed and grid connected 185 turbines in 2010: 60% of all offshore turbines installed during the year. Siemens was in second place with 110 turbines (36%), followed by REpower (six turbines) and BARD (four turbines). Three GAIA turbines were mounted on an experimental floating prototype.

2010 annual market share – developers/utilities

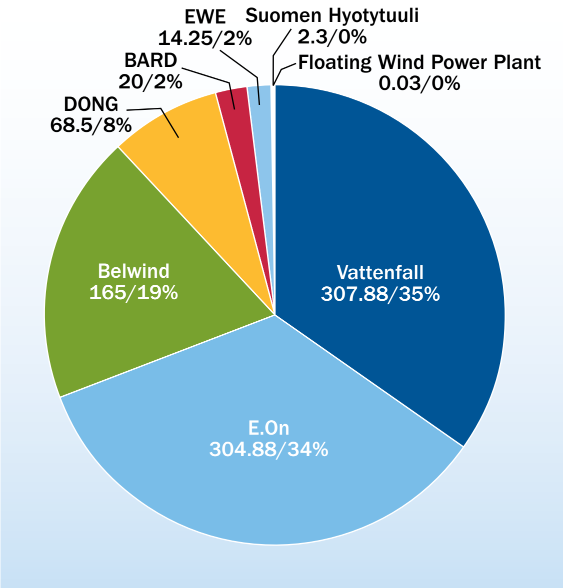


FIG 4: **DEVELOPERS: SHARE OF 2010 OFFSHORE MARKET IN MW**

The utilities Vattenfall and E.ON Climate & Renewables installed the most new offshore capacity during 2010 - 308 MW and 305 MW respectively. However, utilities did not maintain the predominant role they had in 2009, as the Belwind consortium successfully completed its first 165 MW phase. DONG (68 MW), EWE (which owns part of the Alpha Ventus project, representing 14.25 MW in 2010) and BARD (20 MW) follow. Suomen Hyotytuuli installed a 2.3 MW turbine near shore in Finland, and Poseidon installed a 0.033 MW floating prototype.

Foundation type

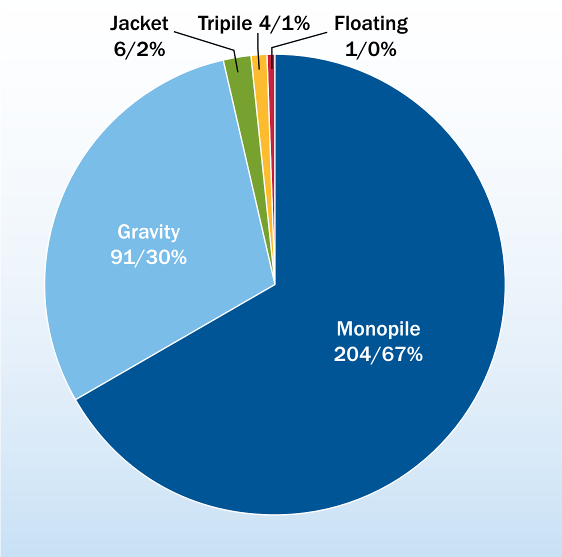


FIG 5: **FOUNDATION TYPE IN 2010 OFFSHORE WIND FARMS**

With 204 units installed in 2010, monopile foundations remained the most common substructure for offshore turbines. However their 67% share of all installed substructures in 2010 was a drop from their 88% share in 2009.

After monopiles, gravity foundations were the most common substructures, having been installed at Rødsand 2 (90 units) and Pöri offshore 1 (one unit). Six jacket substructures were used at Alpha Ventus (2010 grid connection), and the first cluster of four turbines connected at BARD offshore 1 were mounted on tripiles. Finally, an experimental floating prototype is being tested in Denmark.

Water depth

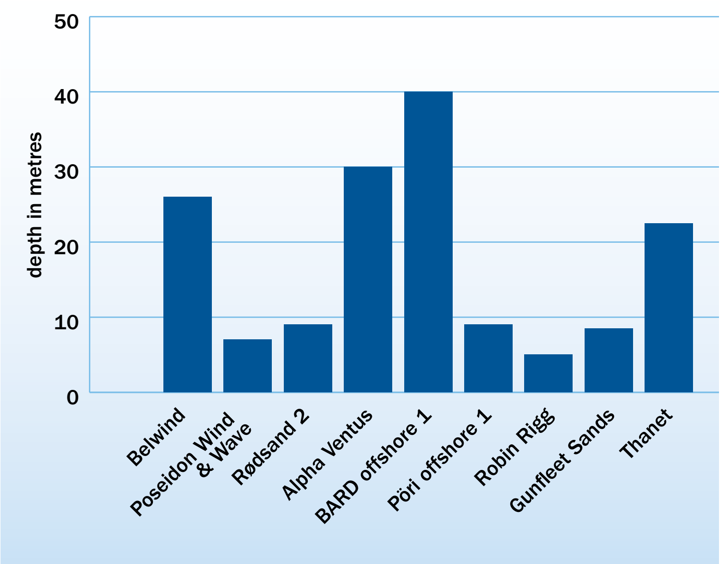


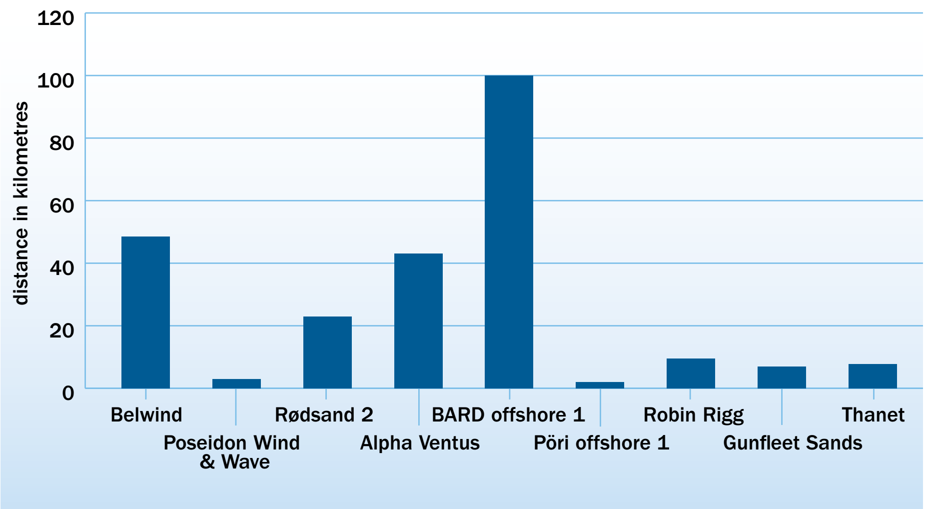
FIG 6: **AVERAGE WATER DEPTHS**

The average water depth of wind farms fully or partially grid connected during 2010 was 17.4m, an increase on 2009 when wind farms were installed in water depths averaging 12 metres. Excluding the experimental site, average water depth increases to 18.8m.

Distance to shore

FIG 7: AVERAGE DISTANCE TO SHORE

In 2010, the average distance to shore of the nine wind farms that were fully or partially grid connected was 27.1 km, significantly up from the 2009 average of 14.4 km. Excluding the experimental site, average distance to shore increases to 30.1 km. In 2009, the furthest offshore wind turbines were the first six turbines installed at Alpha Ventus in Germany at 43 km from shore. In 2010, Belwind installed turbines at an average of 48.3 km from shore, and the first cluster of turbines connected at BARD offshore 1 are on average 100 km from shore.



International market

The only non-European installations have been in China and Japan. China now has an installed capacity of 102 MW and Japan 15.32 MW[1]. Substantial future developments outside of Europe can be expected in China, Japan, the US, Canada, South Korea and Taiwan.

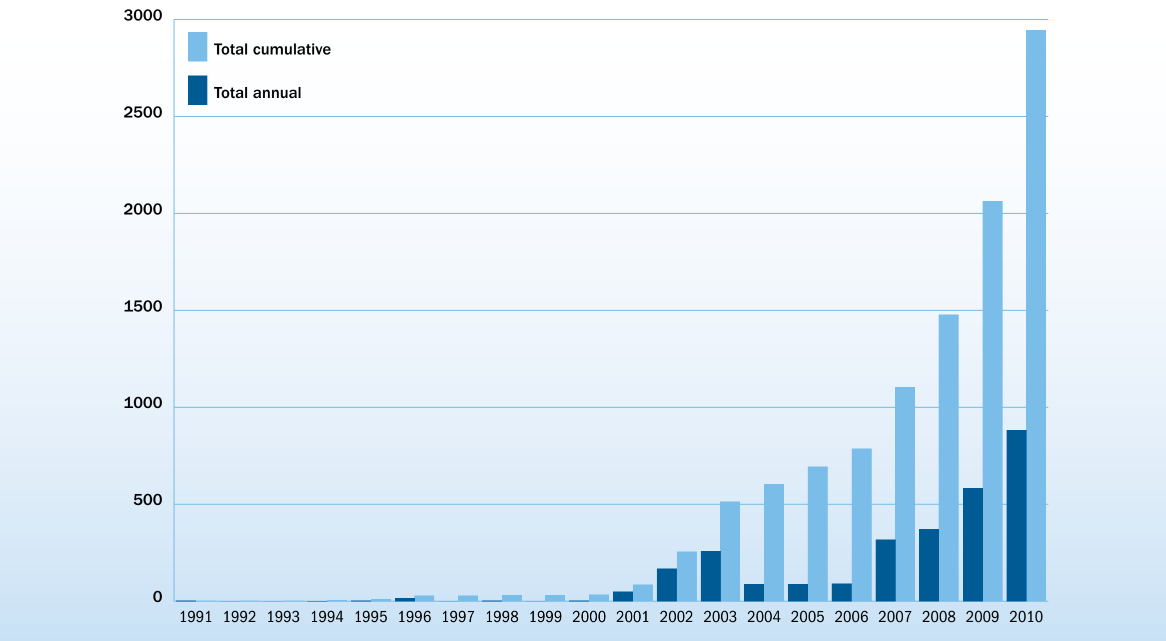
1. MAKE Consulting. Offshore Wind Power. October 2010

Cumulative market

A total of 1,136 offshore turbines are now installed and grid connected in European waters, bringing total installed capacity in Europe to 2,946 MW spread across 45 wind farms in nine countries. The offshore wind capacity installed by the end of 2010 will in a normal year produce 11.5 TWh of electricity. In 2010 Thanet in the UK became the biggest offshore wind farm in the world with a capacity of 300 MW installed. In 2009, Horns Rev 2 in Denmark was the biggest offshore wind farm with a capacity of 209 MW. The third biggest offshore wind farm is also in Danish waters, and was connected to the grid in 2010 - Rødsand 2 (207 MW).

The leading markets remain the United Kingdom and Denmark with 1,341 MW and 853 MW of installed capacity respectively. They are followed by the Netherlands (247 MW), Belgium (195 MW), Sweden (164 MW), Germany (92 MW), Finland (26 MW in near shore projects) and Ireland (25 MW). Finally, a floating 2.3 MW wind turbine is currently being tested in Norwegian waters.

FIG. 8: CUMULATIVE AND ANNUAL OFFSHORE WIND INSTALLATIONS (MW)



Country	UK	Denmark	Netherlands	Belgium	Sweden	Germany	Ireland	Finland	Norway	Total
No. of farms	13	12	4	2	5	5	1	2	1	**45**
No. of wind turbines	436	400	128	61	75	19	7	9	1	**1,136**
Capacity installed (MW)	1,341.2	853.7	246.8	195	163.7	92	25.2	26.3	2.3	**2,946.2**

FIG 9: INSTALLED CAPACITY: CUMULATIVE SHARE BY COUNTRY AT END 2010 (MW)

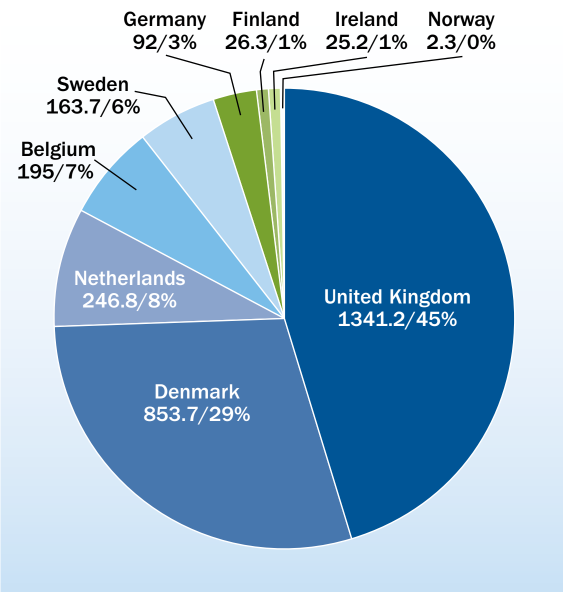
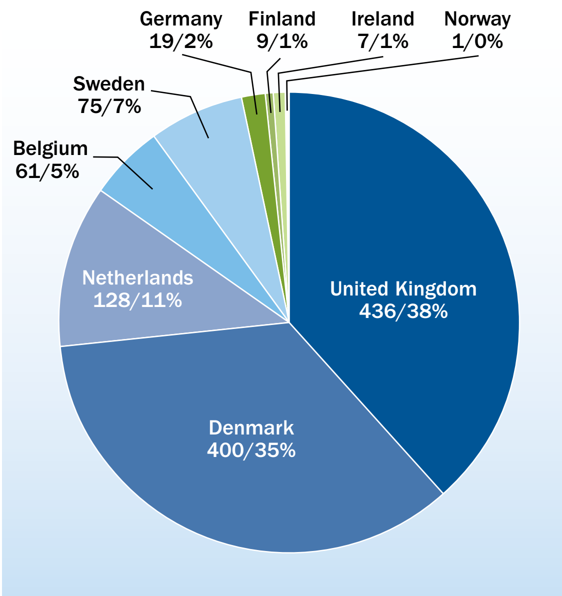


FIG 10: INSTALLED TURBINES: CUMULATIVE SHARE BY COUNTRY AT END 2010



Wind turbine capacity

The average offshore wind turbine capacity was 2.6 MW at end 2010.
Average size of turbines grid connected during 2010 was 3 MW, up from 2.7 MW in 2009.

Cumulative market share – wind turbine manufacturers

In terms of cumulative installed units, Vestas and Siemens maintain their market lead with 532 and 498 wind turbines respectively.

In addition, there are 18 WinWind turbines in operation, 14 REpower and GE turbines, six Areva Wind, five BARD and 49 turbines from other manufacturers.

FIG 11: WT MANUFACTURERS SHARE OF INSTALLED OFFSHORE TURBINES

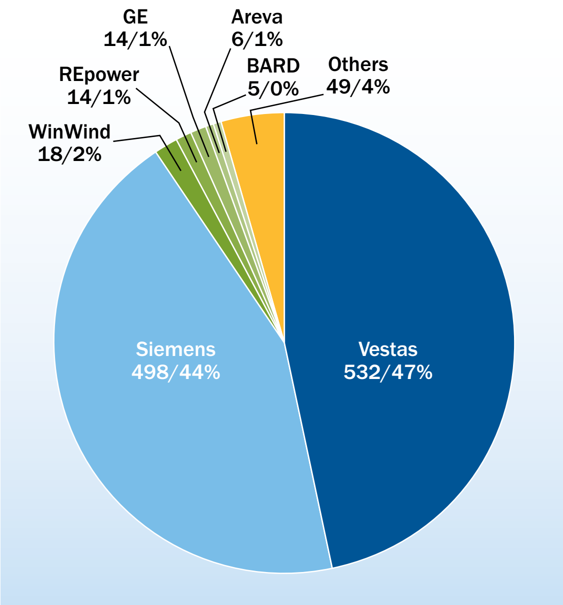
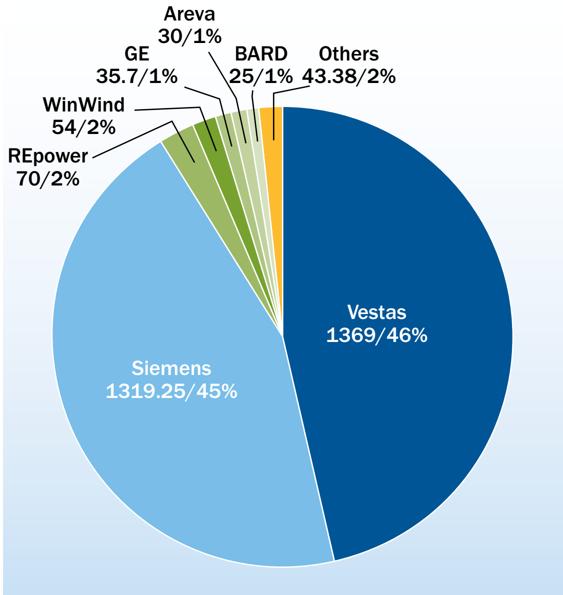
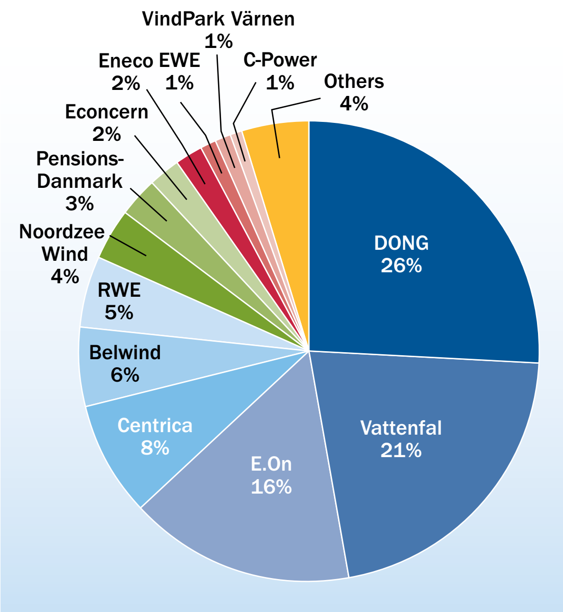


FIG 12: WT MANUFACTURERS: CUMULATIVE MARKET SHARE IN MW END 2010



Cumulative market share – wind farm owners/developers

FIG 13: OWNERS SHARE OF INSTALLED CAPACITY IN MW



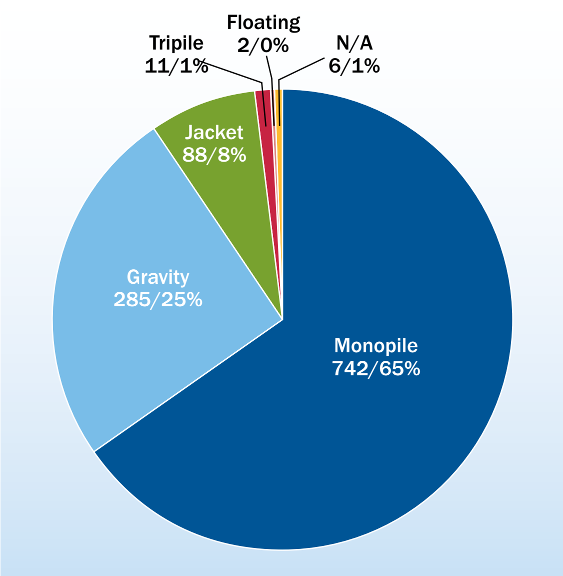
The vast majority of installed offshore capacity was developed and is owned by utilities. DONG and Vattenfall together have almost half the market: 26% and 21% respectively.

The Belwind consortium[2] was, at end 2010, the biggest independent offshore developer with the first 165 MW of its Bligh Bank project going online. By buying a 50% stake in the Rødsand 1 wind farm from DONG, PensionDanmark is the first pension fund to become a significant player in the European offshore wind market.

N.B. Market shares are indicative only. Projects owned or developed by several companies have been split according to the respective shares. Where the shares are not known, they have been split in equal parts between the partners.

Foundations

FIG 14: SHARE OF SUBSTRUCTURE TYPES FOR ONLINE WIND FARMS END 2010 (UNITS)



The main foundation technologies used offshore are monopile (65% of installed substructures) and gravity (25%). The third significant substructure type is jacket, representing 8% of installed substructures. Tripile and floating substructures remain, at end 2010, marginal. The shares per substructure type have not changed significantly from 2009.

2. The Belwind consortium is composed of Colruyt group, PMV, Rabobank, Meewind and SHV.

Market outlook: 2011 and beyond

2011

Currently offshore work is ongoing on seven wind farms in Europe. Total capacity of these projects is over 2 GW. In 2011, we can expect grid connection at Baltic 1 (48.3 MW) to be completed and significant work towards completion of the 400 MW BARD offshore 1 project.

Furthermore, preparatory work carried out in 2010 for five wind farms in UK waters (Greater Gabbard, London Array, Sheringham Shoal, Ormonde and Walney) should deliver a number of grid-connected turbines during 2011.

In total EWEA expects between 1,000 and 1,500 MW of newly installed offshore capacity to be fully grid connected during 2011.

Beyond 2011

Total capacity in the offshore wind farms where work has started on or off shore is 3.3 GW. With 883 MW installed in 2010 and a further 3.3 GW under construction, the current offshore build-out is in line with EWEA's 2009 Pure Power forecast.

Furthermore, EWEA has identified some 19 GW of consented projects in Europe, to which an offshore tender in France to deliver 2 to 3 GW, and an offshore tender in Norway, both expected to be announced in 2011, could be added.

FIG 15: 2010 OFFSHORE MARKET: PROJECTS UNDER CONSTRUCTION AND CONSENTED PROJECTS (MW)

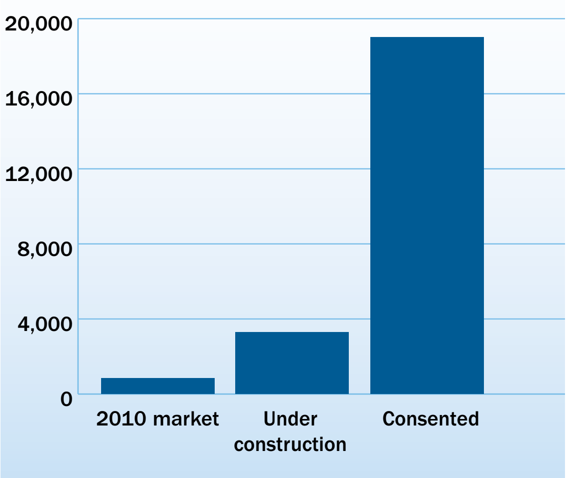
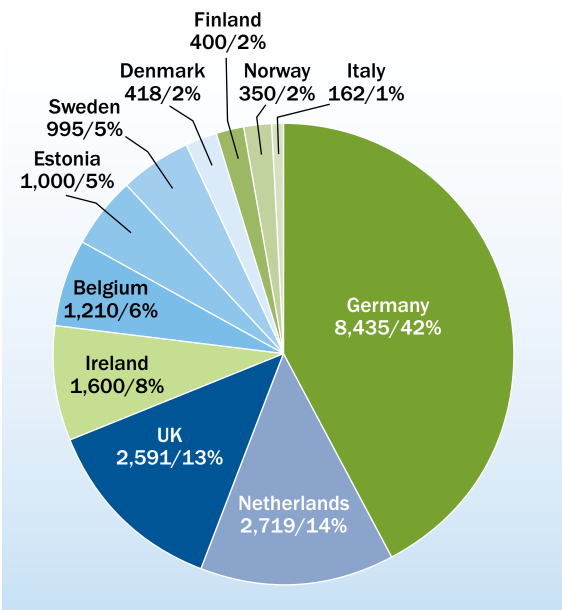


FIG 16: SHARE OF CONSENTED OFFSHORE CAPACITY (MW)

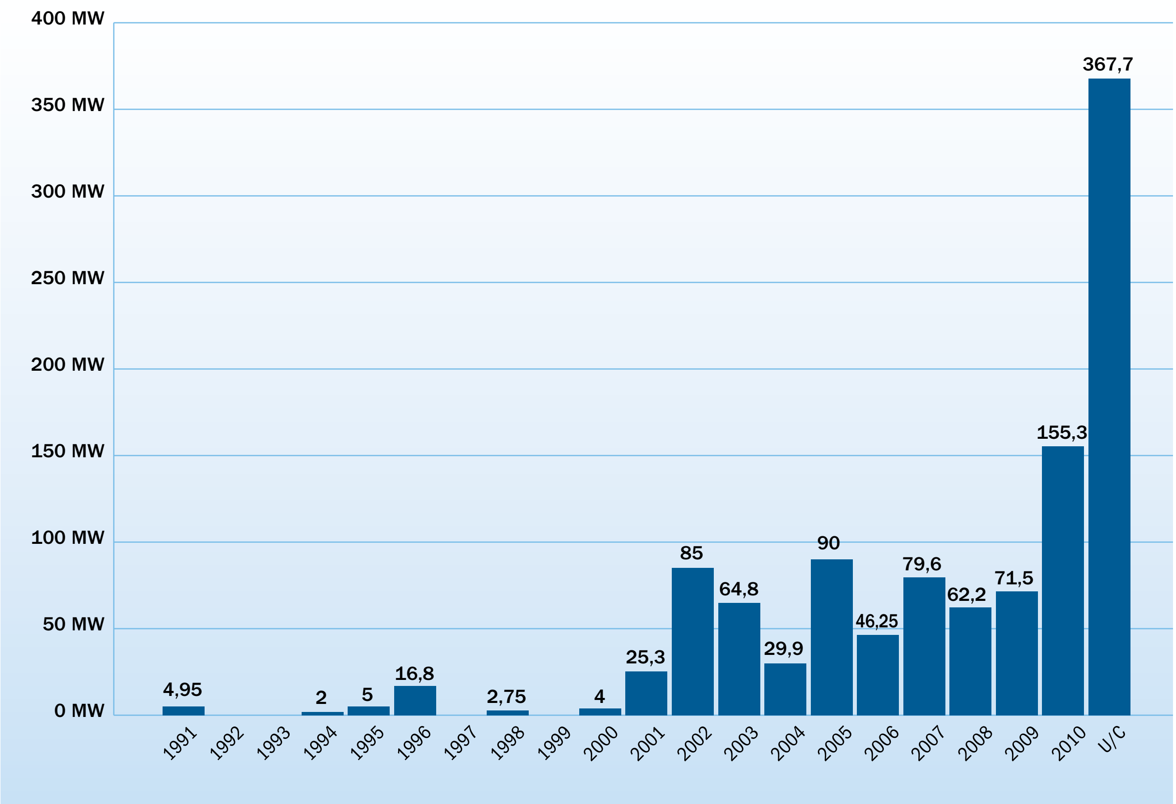


Trends: turbines, water depth and distance to shore

Wind farm size

The average size of offshore wind farms has been increasing steadily since 2008. In 2010, the average size of offshore projects was 155.3 MW. Looking at the wind farms currently under construction, the average size more than doubles to almost 370 MW.

FIG 17: AVERAGE WIND FARM SIZE IN MW

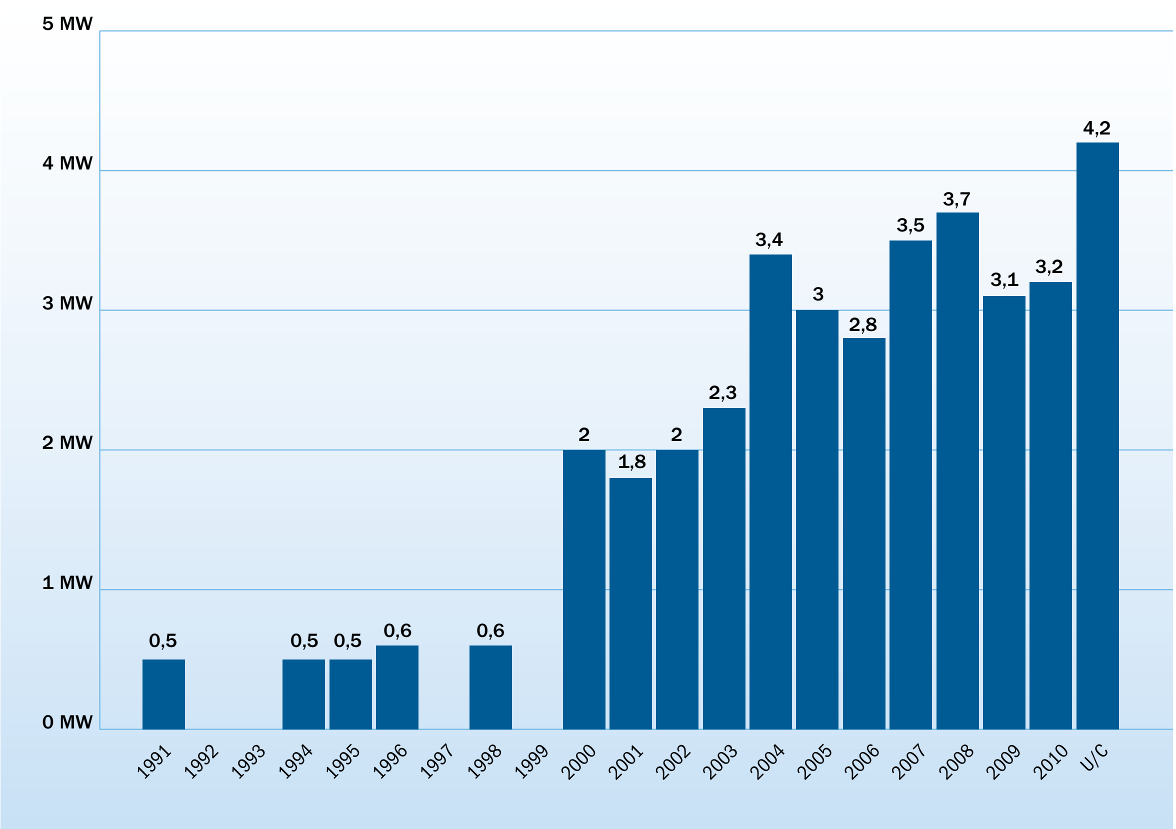


N.B. Only fully completed wind farms are taken into account in their year of completion. This graph does not take experimental projects into account.

Wind turbine size

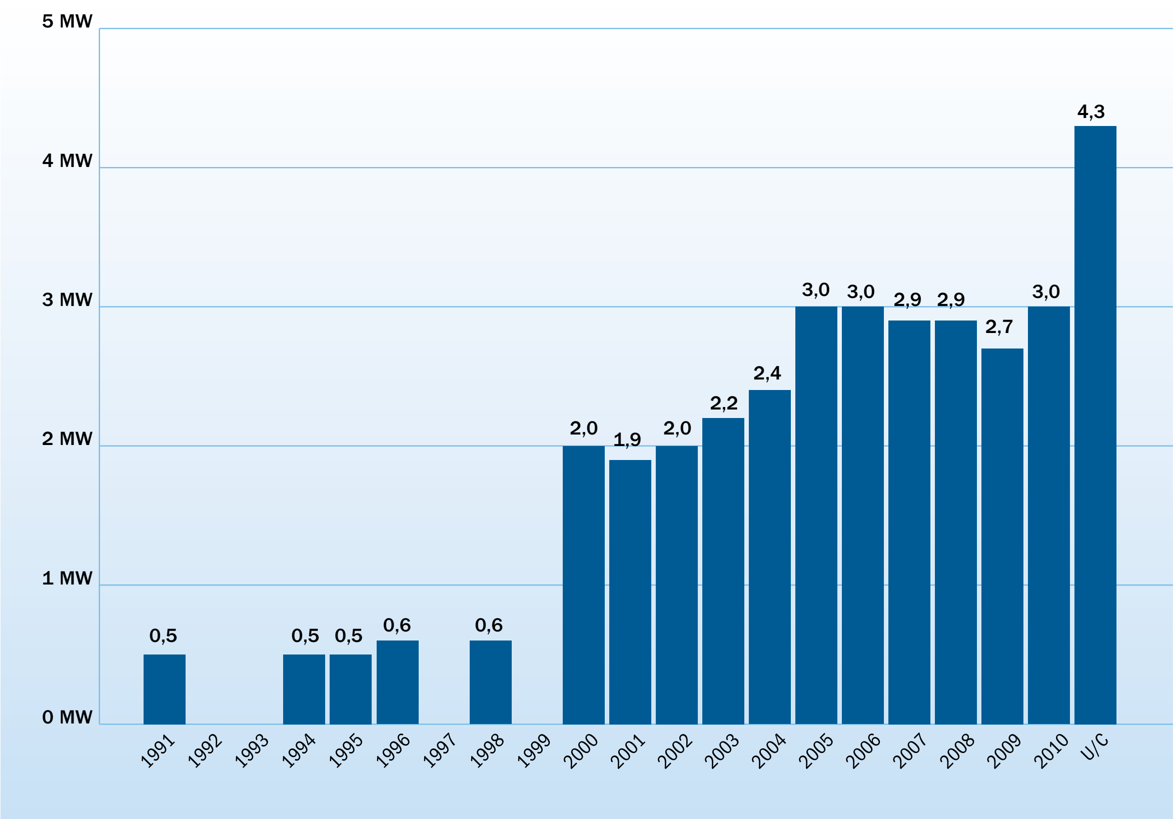
The average size of wind turbines installed at offshore projects peaked in 2008 at 3.7 MW due to the deployment of 5 MW machines at Hooksiel in Germany and Beatrice in the UK. The average size of wind turbines used in offshore projects decreased in 2009 to just over 3 MW and increased again slightly in 2010. Looking at the offshore wind farms currently under construction, average wind turbine sizes are set to increase to over 4 MW in the coming years. This trend is mainly due to the more widespread use of 5 MW turbines and the deployment of REpower's 6.15 MW machine in the second and third phases of the Thornton Bank in Belgium.

FIG 18: AVERAGE WIND FARM SIZE PER OFFSHORE WIND FARM IN MW



Taking wind turbines individually rather than as an average per wind farm, average turbine size in 2010 is 3 MW, increasing to 4.3 MW for the projects under construction.

FIG 19: AVERAGE OFFSHORE WIND TURBINE SIZES

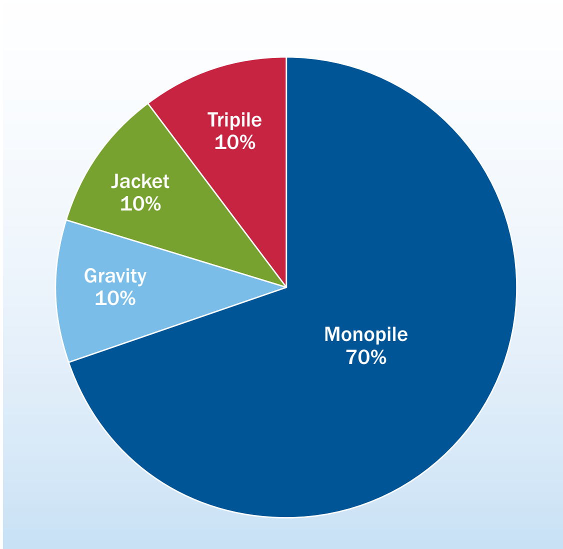


Substructure trends

Five different types of substructure were used in wind farms fully or partially grid connected in 2010. Excluding floating substructures that are still at an experimental phase, four types of substructures have been used since the first offshore wind farm went online in 1991: monopile, gravity, jacket and tripile.

Monopiles are, to date, the most common substructures (65% of all installed turbines), followed by gravity (25%), jacket (8%) and tripile (1%). The trend remains similar with monopiles accounting for 70% of substructures of the wind farms under construction. The other three main types represent 10% each, and no new turbines using floating substructures are currently under construction.

FIG 20: **SHARE OF SUBSTRUCTURE TYPES IN WIND FARMS UNDER CONSTRUCTION**



Water depth and distance to shore

Looking at the wind farms currently under construction, both average water depths and distances to shore are set to increase. In 2010 average water depths increased to 17.4m up from 12m the previous year. Average distance to shore increased to 27.1 km, up from an average of 14.4 km in 2009.

For projects under construction, average water depths have been calculated at 25.5 m and the average distance is set to reach 35.7 km.

FIG 21: AVERAGE DISTANCE TO SHORE AND WATER DEPTHS OF OPERATIONAL WIND FARMS (1991-2010)

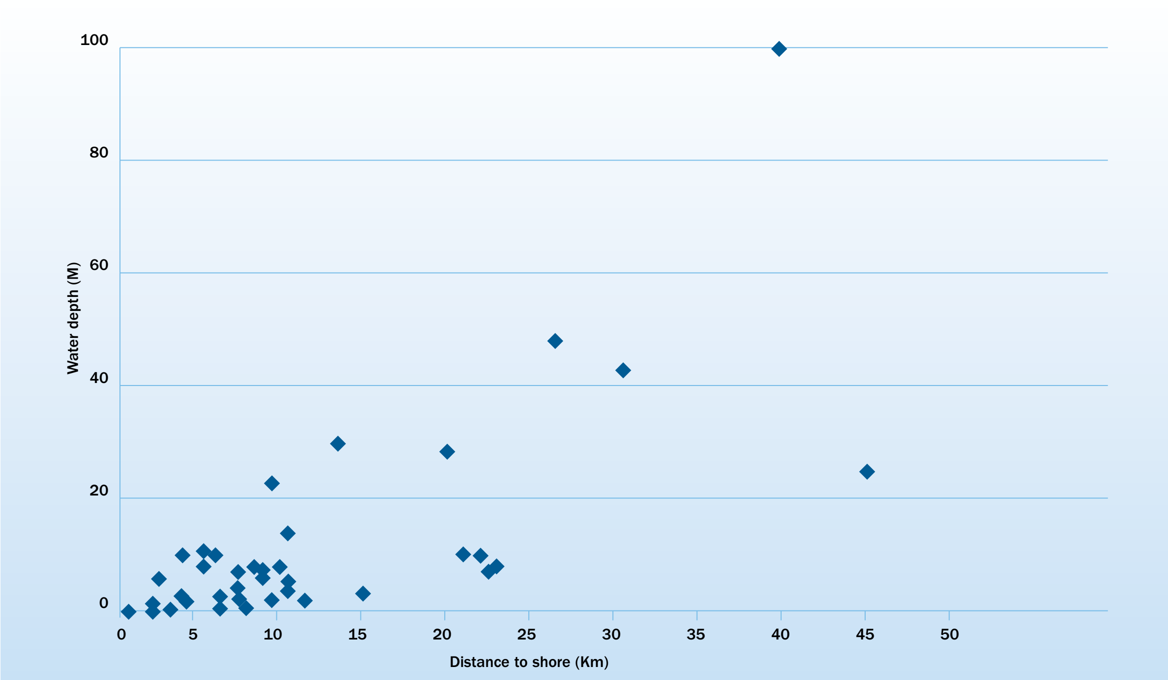


FIG 22: AVERAGE DISTANCE TO SHORE AND WATER DEPTHS OF WIND FARMS THAT BECAME OPERATIONAL IN 2010

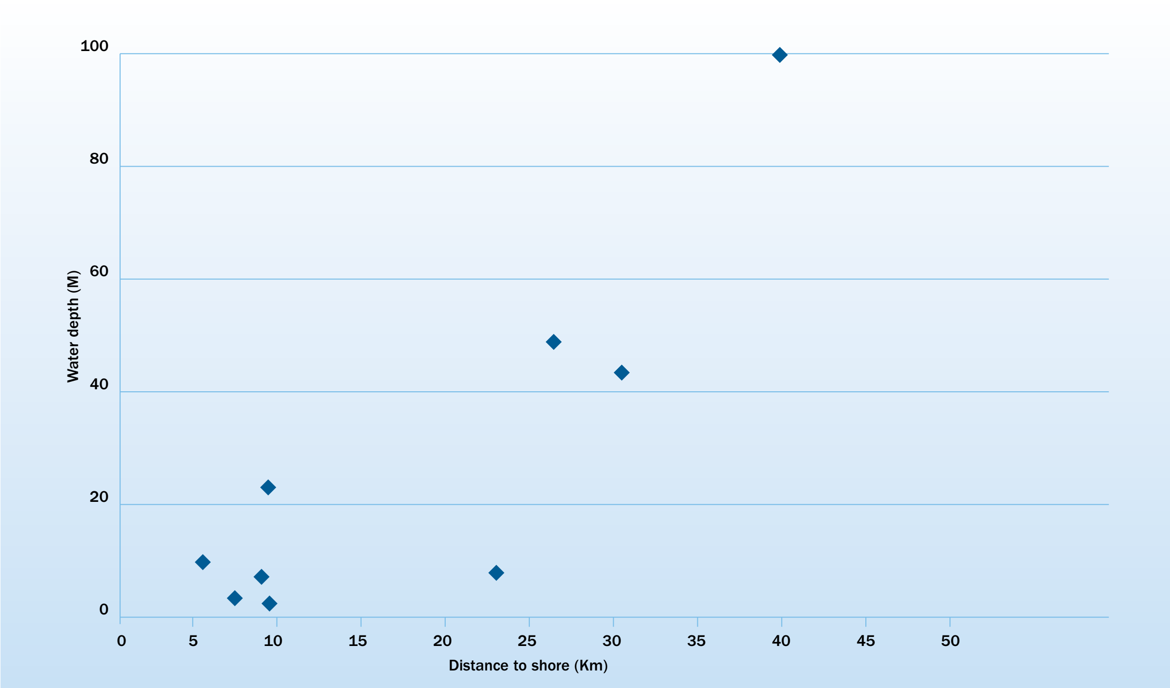
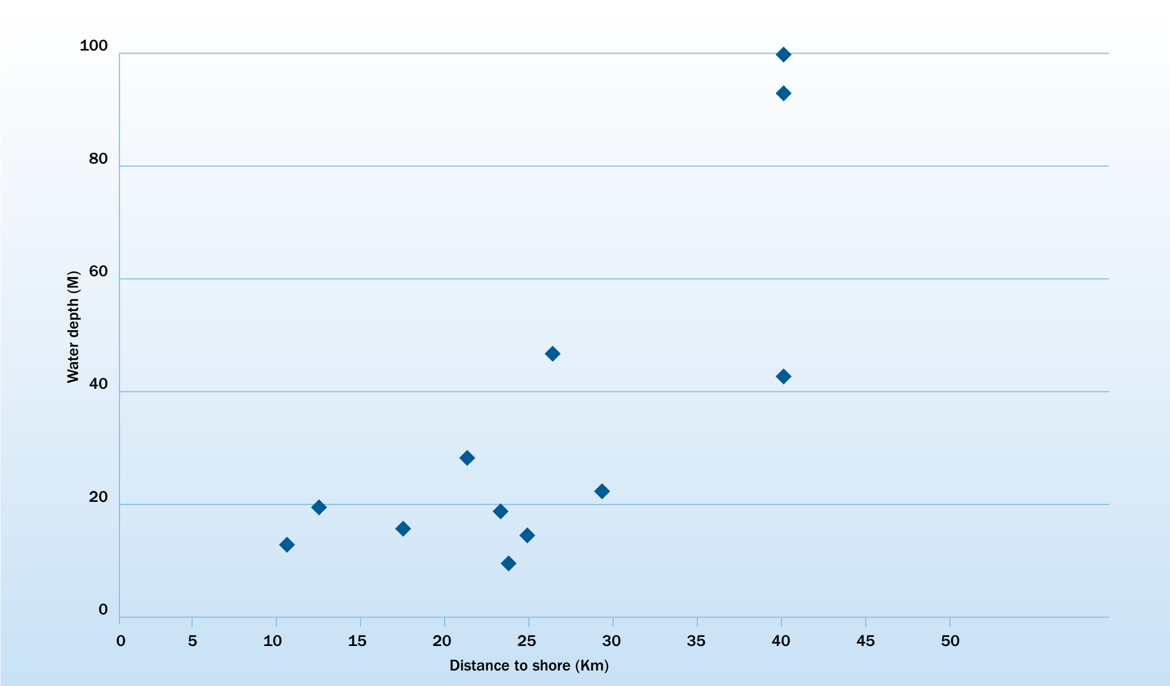


FIG 23: WIND FARMS UNDER CONSTRUCTION: WATER DEPTHS AND DISTANCES TO SHORE



Financing highlights and developments

Financing offshore wind farms on a non recourse basis is still a complex endeavour, but by the end of 2010, the year saw two major deals come to financial close: Thornton Bank C-Power (325 MW in Belgium in November) and Trianel Wind Farm Borkum West II (200 MW in Germany in December). Both were larger than the previous year's deals, involved new banks, and set useful precedents for the sector. This will most likely make subsequent deals easier and ensure that offshore wind increasingly becomes a mainstream activity for lenders.

The €913 million of financing for Thornton Bank C-Power was the largest sum ever for the offshore sector and included strong contributions from the European Investment Bank and Euler Hermes, the German export credit agency, as well as participation from EKF, the Danish export credit agency. The €550 million financing for Trianel Wind Farm Borkum West II was the first in Germany and also included a large tranche from the European Investment Bank, the European Union's European Energy Programme for Recovery, as well as support from regional development bank (NRW). With seven commercial banks in one transaction and nine in the other, the number of financial institutions with direct experience of offshore wind projects has substantially increased, especially as banks have accepted, with the appropriate mitigation, to take multi-contracting risk in both cases. This is all the more notable given that these two projects use large, recently developed turbines in the 5 MW+ class: Thornton Bank CPower will install 48 Repower 6M turbines, while Trianel Wind Farm Borkum West II will use 50 Areva Wind 5000M turbines. This indicates very positively that the large turbines likely to dominate the sector in the coming years are bankable. It also confirms that competition between manufacturers will broaden beyond the current market leaders, helping project developers negotiate terms which are acceptable to financiers.

Continuing restrictions on underwriting by banks means that large transactions will continue to require large numbers of participating banks at financial close, and entail complex coordination tasks for developers. But the two transactions completed by the end of 2010 create repeatable precedents for a growing number of banks able to join in such deals. 2011 should see an increasing number of transactions. Deals currently on the market and with a good chance of closing in 2011 include the Masdar portion of the London Array (20% of 630 MW in the UK), Lincs (270 MW in the UK), Meerwind (288 MW in Germany), Gode Wind 2 (252 MW in Germany), as well as the refinancing of Baltic 1 (48 MW in Germany).

In the meantime, utilities, which had been less affected by the financial crisis, have continued to increase their balance sheet commitments to the sector and 2010 saw a flow of investment announcements, such as those concerning Gwynt y Môr (576 MW in the UK), Baltic 2 (288 MW in Germany), Anholt (400 MW in Denmark), Dan Tysk (400 MW in Denmark), which confirmed this continuing trend. Additionally, manufacturers and other supply chain companies announced significant new investments in capacity during the course of the year. Traditional players in the offshore sector were also active during 2010, with developer wpd acquiring 100% of the shares of the German offshore wind farm Butendiek from SSE Renewables in September 2010, and the wind turbine manufacturer Nordex acquiring a 40% stake in the project company which is developing the "Arcadis Ost 1" offshore wind farm.

A separate positive trend has been the arrival of new financial investors - pension funds - as investors into the sector, with two notable transactions in the second half of 2010: the purchase of 50% of the Nysted offshore wind farm (165 MW, Denmark, built in 2003) by PensionDanmark in September, and the purchase of 25% of Walney (367 MW, UK, in construction) by PGGM and the Ampere Equity Fund. Such long term investors have long been seen as natural owners of offshore wind power assets, due to stable regulated revenues, but their involvement was seen as unlikely in the short term due to the relatively immature state of the industry; these two transactions are thus a welcome early sign of what is likely to be become a major trend.

Altogether, the outlook for the industry in terms of availability of funding for the expected wave of investment is looking more positive than even a few months ago. Banks are abandoning the reluctance to lend which was the key characteristic of the post-financial crisis period and are now demonstrating an increased willingness to take risks in the offshore wind sector for well structured transactions. Project finance will continue to become more available as more banks enter the market and individual commitments slowly increase. While financing structures remain conservative and difficult to negotiate due to the requirement to accommodate the needs of many different banks at the same time, 2010 showed that financing packages can be put together.

National and international finance institutions such as the European Investment Bank and export credit agencies (mainly from Denmark and Germany where much of the supply chain is currently located) have shown they were able to support the industry at a critical juncture through their involvement in the above transactions, and through separate funding facilities on a corporate basis to utility-led projects (for instance, the EIB and EKF provided a €300 million loan to DONG for the London Array project). They are likely to remain active in the sector in the near future, providing critical liquidity at low cost, and will help ensure a smooth transition towards a more mature market when commercial banks are able to carry out large transactions without them.

Industry highlights and developments

Driving force for innovation: emerging offshore markets

At a global level, 2010 was a record year in terms of announcements of new offshore wind turbines. 29 new offshore turbine models were announced by 21 manufacturers. The UK and German offshore markets are no longer the only drivers for innovation. The announcements by European, Chinese, South Korean, Japanese and US companies are driven also by the prospects of the substantial offshore markets emerging in those countries.

In Europe, the UK Round 3 and the upcoming German deployment are strongly driving the technological developments. UK Round 3 installations will start in 2014, and the announcement at the beginning of 2010 by the Crown Estate of successful bidders for each of the nine Round 3 offshore wind zones within UK waters was perhaps the most important development of the year. The 32 GW is expected to deliver a quarter of the UK's total electricity needs by 2020. Except for the Norfolk zone and Dogger Bank, most UK Round 3 sites are over 25m depth, and up to 80m depth. UK Round 3 is extremely challenging in terms of distance to shore and/or water depth, whereas the foreseen German developments are in shallower water, mostly in the 20-40m range (although far from shore). The future average offshore site will therefore be a challenge for the current technology.

The nature of the future sites will strongly influence the financing of the projects, since water depth and distance to shore are key cost drivers for the technology. In parallel, economies of scale are sought through:

- Larger installations: pipeline projects in the 500–1,000 MW range are not unusual[3];
- New O&M strategies for large installations, for instance with the development of offshore accommodation facilities for teams and crews, or concepts of shared O&M and spare parts storage facilities areas at sea;
- Sharing of cable connection costs, by connecting offshore wind farm clusters to interconnectors, or through multi terminal solutions;
- Improved reliability of turbines;
- Larger machines, enabling more energy capture, and to proportionally lower the installation costs, and O&M costs.

3 EWEA offshore pipeline, available to EWEA members.

A record year for new offshore turbine announcements

Figure 24 highlights that the European manufacturers were the first movers in developing 5 MW turbines. Chinese, South Korean and US manufacturers are developing dedicated 5 MW offshore turbines, while European manufacturers will be moving a step further, with 6 and 7 MW prototypes, including dedicated offshore concepts. These 6–7 MW turbine concepts are expected to decrease the cost of future deeper/further offshore projects foreseen mainly for the UK's Round 3 and the German developments, from 2014 onwards. The European developments in the 6-7 MW range are closely followed by Chinese and Japanese manufacturers. Innovation on offshore wind turbines is no longer taking place only in Europe, highlighting the importance of continued R&D support for European manufacturers from policy-makers.

European manufacturers' announcements

An offshore market leader, Siemens, had set up a strategic partnership with DONG in 2009, covering 500 turbines. To avoid bottlenecks during the development phase, Siemens bought 49% of offshore installation and service provider A2Sea from DONG. A new product was also launched: the new 3 MW Direct Drive turbine to increase reliability by lowering the number of moving parts. In the pipeline, Siemens announced it will be developing a direct-drive 6 MW offshore turbine at a new UK factory. The new 3 MW model will be tested by Statoil in Norway in cold climate conditions. Statoil is also Siemens' strategic partner to prepare the development of the next phase of the offshore market, with the HyWind floating demonstrator.

Another offshore market leader, Vestas, has launched an offshore version of its V112 3 MW turbine. Further to that the company announced the development of a new 6 MW model. Other technical details and the launching time scale have not yet been made available. Vestas has also announced it is working, with the support of the Danish government, on developing offshore foundations allowing wind turbine to be built in depths of up to 70m.

2010 saw several announcements from the Spanish wind turbine manufacturers for multi-MW offshore turbines. Their aim is primarily to supply the UK Round 3 market, as well as the future Spanish offshore market. Several offshore test/demonstration sites were announced in Spain (see overleaf).

During the first half of 2010, Gamesa discussed a strategic partnership with BARD. After the discussions stopped, Gamesa announced its intention to develop its own offshore technology, starting with a offshore version of its recent 4.5 MW machine. Moreover, Gamesa is expected to develop a prototype of its 6-7 MW offshore wind turbine by 2014. Gamesa set up an alliance with the naval construction company Northrop Grumman to build a 5MW prototype in the US end 2012. On a longer-term horizon, Gamesa teamed up with Iberdrola, Acciona and Altstom wind in a research programme investigating 15 MW designs, likely to be developed for offshore applications.

Nordex launched a 2.5 MW offshore model as part of its new Gamma generation of turbines, and is developing a new family of turbines in the 5-6 MW class. The Arcadis Ost 1 offshore wind farm will be used as a test site for the new offshore machines. The first four offshore prototype machines are due to be installed for testing at the Arcadis site in 2011, followed by up to ten machines at the site in 2014, with installations continuing in 2015.

Schuler, a new player in the wind energy sector, is entering the market with a new 2.7 MW model mainly for onshore applications and has announced a plan for a 6.5 MW machine in the near future, exclusively for offshore use. WinWind is planning to start commercial production of a 3 MW machine with a 109m rotor diameter in 2012. The first test machine is expected to be erected next spring in the harbor of Raahe in the Gulf of Bothnia. In France, the announcement of 6 GW installed offshore capacity by 2020, with a first call for tenders to be launched early 2011, is driving the development of the sector. French companies, including Alstom, Areva Wind, and the floating Winflo concept from DCNS, are developing their interest.

International partnerships

After a first wave of one-way technology spreading from Europe towards China and the US, the industry is further internationalising: the Chinese/Dutch company XEMC Darwind unveiled a 5 MW prototype and is seeking to set up factories in the UK and US; Mitsubishi Heavy Industry is partnering with SSE and locating in the UK with government support; the US company AMSC will export its 5 MW technology to Hyundai Heavy Industries; Sinovel and Daewoo bought the German manufacturer DeWind, and Daewoo may manufacture from its Romanian shipyard. GE is re-entering the offshore market with the acquisition of ScanWind, and its plans for manufacturing 4 MW turbines in UK, with R&D facilities in Norway, Sweden and Germany.

South Korean manufacturers are entering the offshore market targeting the future 5 GW South Korean market, and have global ambitions: Hyunday Heavy Industries set up a partnership with Hyosung for 2 MW turbines (factory in Weihai, China); Samsung Heavy Industries is seeking a partnership in Europe.

Future technology developments and research projects

In the future larger turbines will enter the European market. 10 MW concepts are based on the assumption that even larger designs may still enable economies of scale, although the concept of the upwind three-bladed horizontal turbine designed for 20 years may be challenged at these scales. A technology breakthrough is often sought at this capacity range, to drastically decrease the weight/capacity ratio on top of mast, ease installation and cut O&M costs: Clipper announced a 30-year design lifetime; the AMSC SeaTitan would be based on superconducting technologies; the Aerogenerator X by WindPowerLimited is a vertical axis; the Sway concept is a downwind technology based on a floating tower which extends far below the water surface, and the 2-B Energy concept is a two-bladed rotor on lattice tower.

The move towards larger and more efficient turbines should be supported by the development of testing facilities, assessing reliability. This is a crucial point for lowering the risks of offshore wind financing and investment:

- At EU level, the European Energy Programme for Recovery provided €565m to innovative elements of offshore wind energy projects;

- In 2010, the New Entrants Reserve (NER300) - see below - call invited Member States to make proposals for 6, 8 and 10 MW turbines in farms with a nominal capacity of 40 MW, and a floating demonstration with a nominal capacity of 25 MW;

- In the UK, four demonstration areas were awarded and are will be developed in order to test the next generation of offshore turbines:
  - Gunfleet Sands extension – DONG Energy Gunfleet Sands Demo Ltd for testing up to two next generation offshore wind turbines including a Siemens 6 MW;
  - Blyth Offshore Wind Demonstration site – National Renewable Energy Centre Ltd (Narec) for a 100 MW grid connected site to test and demonstrate up to 20 next generation offshore wind turbines and associated infrastructure. Narec is part of a wider plan supporting the development of an offshore wind industry in North East England, and developed as well a large blade test and drive train facility (up to 15MW), which may help to support Clipper's developments for its 10 MW turbine;
  - Methil Offshore wind farm – 2-B Energy to demonstrate two 2B-Energy offshore wind turbines;
  - The European Offshore Wind Deployment Centre – Aberdeen Offshore Wind Ltd, a company owned

75% by Vattenfall and 25% by Aberdeen Renewable Energy Group (AREG), to test and demonstrate up to 11 next generation offshore wind turbines and other technology in the Aberdeen Bay. This centre is co-financed by the EU Recovery Plan;

- The Carbon Trust called for a competition on offshore transfer technologies. The projects focus on solutions for transferring staff and equipment safely from vessels to wind turbines as far as 300 km offshore. Its main objective is to improve the operations and maintenance economics of offshore wind where developers will have to operate in harsh conditions;

- As a result of another Carbon Trust competition, seven foundation designs for wind turbines sited in deep waters have been shortlisted. The shortlist includes tripod designs and floating wind turbines anchored to the seabed.

- In Spain, different activities are ongoing:
  - Cener's *Laboratorio de Ensayos de Aerogeneradores* (Lea) was extended to test drive trains of up to 6 MW and blades of up to 100 m;

- The wind offshore laboratory of Cantabria will receive €70-100 million to develop an offshore test station;
  - Gas natural and IREC are developing the Zefir test station. The project has been extended to 70 MW, with a first 20 MW phase in 2012, and a 50 MW second phase for floating concepts 30 km from shore in water depth of 100m. A broad agreement was signed by Gamesa, Iberdrola and Siemens.

- In the Netherlands, the FLOW programme received funding, covering the entire innovation spectrum, from foundation concepts to installation.

- In Denmark, the Lindoe shipyard should host different component manufacturers and a large test bench for drive trains in the 10-12 MW range, developed in partnership with Risoe/DTU. Risoe/DTU is also developing a large onshore test area for turbines.

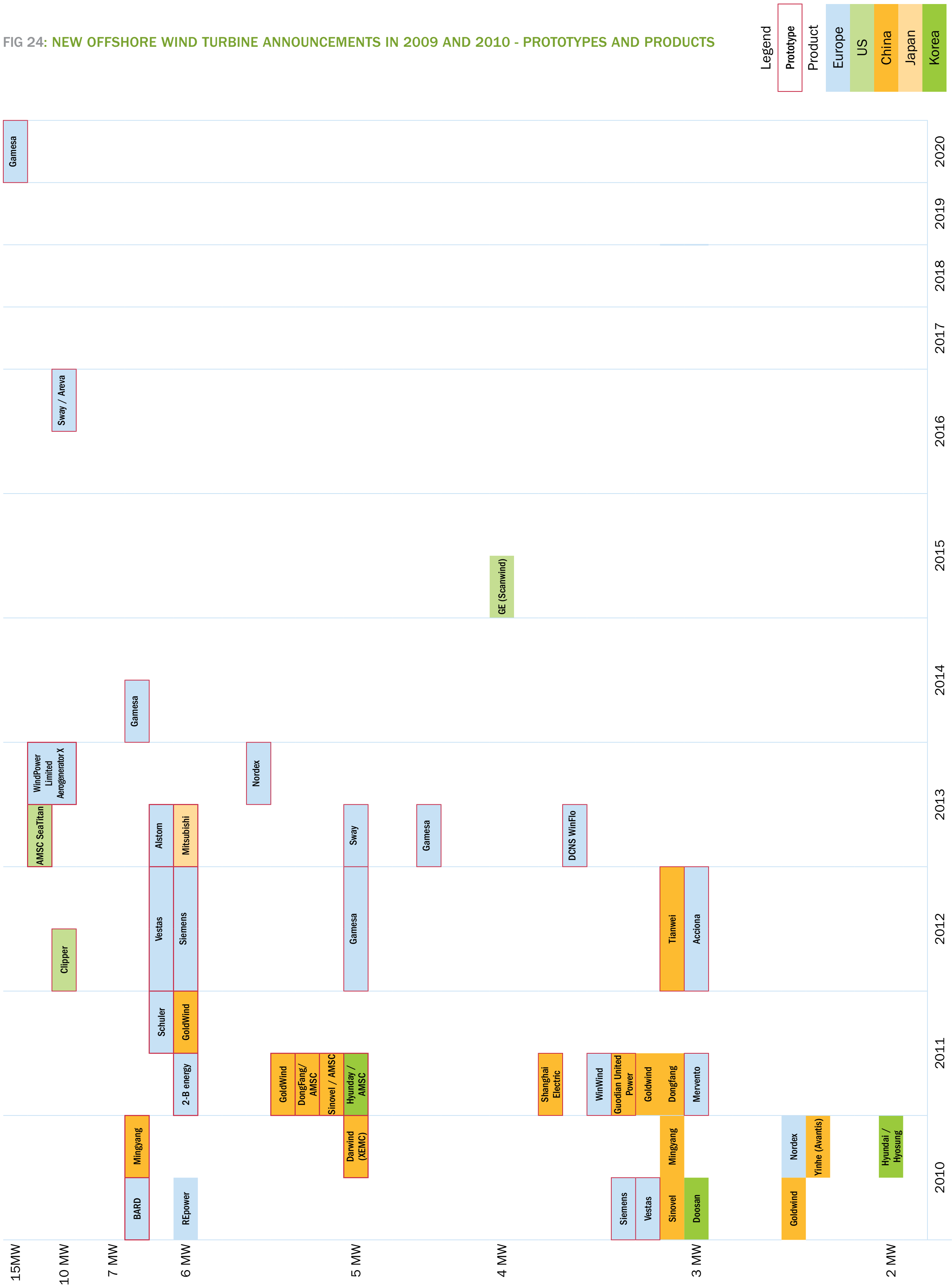
- In Germany, the Research at Alpha Ventus test site demonstrates 5 MW turbines on different types of substructures. It is part of a wider industrial strategy developed around the Bremerhaven area.

- In Norway the Department of Oil and Energy has provided a license to Vestavind Kraft to perform floating offshore wind turbine tests. A 20 MW test infrastructure has been established and consists of a 5 MW test position at Fure, a 5 MW test position at Kvalheimsvika, and a 10 MW test area at Bukketjuvane.

- In the US, the 2011 budget proposal from the Department of Energy (DOE) proposes $122m (€94m) for wind energy R&D, from which $49m (€37.8m) could be directed to offshore wind research.

- In China, the Ministry of Science and Technology is focusing on supporting several relevant research and development projects in the framework of the eleventh Five–Year Plan.

FIG 24: NEW OFFSHORE WIND TURBINE ANNOUNCEMENTS IN 2009 AND 2010 - PROTOTYPES AND PRODUCTS



Larger, deeper and further from shore projects are driving innovation on substructures and vessels

The Beatrice and the Alpha Ventus projects were the first to demonstrate the feasibility of deploying wind turbines in water depths of more than 30m. With the predicted boom in installations in water depth deeper than 30m, the substructure business is expected to shift progressively from the current dominance of the monopile technology towards other solutions, such as jackets or tripods.

For medium depth waters (up to 60m), the Carbon Trust launched a competition and shortlisted seven types of foundation design, with the aim to perform small scale demonstrations, and therefore preparing the substructure supply chain for the deeper parts of the UK's Round 3.

Scottish and Southern Energy bought 15% of the jacket manufacturer BiFab. A similar move was performed by SeaEnergyRenewables, through its partnership with the Chinese Shipbuilder Nantong Cosco Ship Steel Structure Co (NCSC).

Other companies are looking for alternative substructure technologies to cut the installation costs, such as Norway's Seatower, which developed an installation concept not requiring specialist vessels, or Vici Ventus. Both involve concrete or steel elements pre-assembled onshore, and floated on site for installation, which is a common practice in the oil and gas business.

While the mainstream medium depth markets are expected to take off, driving most of the industrial capacity in Europe, additional offshore markets are expected to develop in Europe (France, Spain, Norway, Portugal, Italy and Greece), the US[4], China, South Korea, Japan and Taiwan. These deep water markets will require floating concepts, which are currently under development by a few companies, with a set of announcements during 2010. Two clear driving forces are coming from Norway and Spain.

Norway identified 15 sites suitable for offshore developments, 11 are in water depths of up to 70 metres and four are targeting floating installations. Sway received funding from the Norwegian government for the development of its 5 MW model, and had announced a partnership with Areva Wind[5]. Sway expects to develop a 5 MW floating model in 2013 and a 10 MW in 2015-2017. Statoil's Hywind demonstration with Siemens is ongoing using a conventional 2.3 MW turbine. Statoil is now looking for a second demonstration site, likely to be located in Scotland, and is looking for a partner in the US as well. The Norwegian research programme will also fund Nowitech, which targets "deep-sea" (more than 30m) bottom-fixed and floating turbines. The Norwegian Centre for Offshore Wind Energy (Norcowe) will develop small-scale floating turbines for research.

In Spain, Acciona (FP7 Marina project and CENIT Eolia project) and the Spanish Emerge consortium (including Iberdrola, Alstom and Acciona) are active. Emerge is seeking to deploy the first Spanish floating turbine in 2011.

Other companies are positioning themselves on different projects, such as the Blue H developments with projects around Europe, the EDP and Principle Power partnership (WindFloat[6]), the Vestas R&D programme, the French DCNS group with Winflo, or the Swedish Hexicon company which is developing a concept of platform with several turbines. Along similar lines, Windsea (owned by Force Technology and NLI) is developing a new concept which consists of a floating platform, supporting three wind turbines.

4 Pushed by the Deepwater Offshore Incentive Act.
5 In this regard, the French government is preparing as well the future deep offshore developments with a call for demonstrations for marine technologies, including deep offshore.
6 Prototype of floating wind farm foreseen in Portugal in 2011.

The W2power project developed by Pelagic AS (Norway) combines two state of the art offshore wind turbines and an innovative wave energy conversion technology on a single floating platform. The project is in its validation and engineering stage and is expected to be commercially available by 2015.

The HiPRWind project, which was started in November 2010, is focusing on the development of an integrated floating wind turbine installation. With the involvement of nineteen companies led by the Fraunhofer research institute and including Acciona Energy (Spain), ABB Schweiz (Switzerland), Bereau Veritas, Angewandten Forschung (Germany) and Norges Teknisk (Norway), in the five year period, the project is expected to enrich the knowledge of the floating wind power sector.

Driven by the strong interest of several Member States in deep water applications, the European Commission launched a call for two demonstrators of floating systems[7], and the New Entrants' Reserve (NER300) funding scheme will provide support for the demonstration of a floating offshore wind farm with a 25 MW capacity to be up and running in 2015. This follows the logic of the previous FP7 calls on "future emerging technologies"[8], on "deep offshore multi-purpose renewable energy conversion platforms for wind/ocean energy conversion"[9], the "coordinated action on offshore renewable energy conversion platforms"[10], and the 2007 call on "wind mapping for offshore wind application"[11].

In parallel to the EU NER300 call, the US state of Maine will issue a call for a 30 MW pilot floating offshore wind farm. This announcement is in line with the recent award by the Department of Energy of $7.1m to the University of Maine to develop between one and three floating offshore wind platforms.

A major bottleneck identified by the European industry is the lack of sufficient installation and operation vessels to supply the foreseen demand. Different initiatives to build the necessary ships are ongoing. The new installation vessels are designed for far offshore operations in medium/high water depths. Those are mostly jack-up vessels, able to carry several 5 MW turbines:

- A2Sea has ordered its Sea Installer vessel. The delivery is scheduled for the second half of 2012. It can carry 10 turbines at once and jack up in water depths up to 45 m;
- Drydocks World Southeast Asia is building the NG-9000C-HPE vessel for the Northern European market. The vessel, designed for use in water depths of up to 45 metres, is equipped with a helicopter landing deck and an eight tonne heavy-duty crane with a reach of 24 metres. It can install turbines of up to 5 MW;
- A new entrant, Norway's Fred Olsen Windcarrier is ordering two offshore wind turbine installation vessels from Lamprell, a provider of engineering services to the oil and gas industry. The Gusto MSC NG-9000 design self-elevating and self-propelled offshore wind turbine installation vessels will be delivered in the second and third quarters of 2012, with options for two more of the vessels. The ship is designed to transport up to 10 wind turbines with 100m diameter rotors at a time;
- Offshore Wind Power Marine Services (OWPMS) is partnering Brook Henderson Group to provide a financial package in order to build a fleet of supply vessels for the industry.

7 Topic ENERGY-2011-2.3-1, ongoing call.
8 Topic ENERGY-2010.10.2-1, awarded to the DeepWind consortium a project aimed at developing new design tools for a vertical-axis floating offshore wind turbine. These tools will be then used to design a 5 MW concept and evaluate the prospects of an up-scaled, future 20 MW turbine.
9 Topic ENERGY-2009-2.9-1, awarded to the Marina consortium led by Acciona. http://www.marina-platform.info
10 Topic ENERGY-2009-2.9-2, awarded to the OREC-CA consortium. http://www.orecca.eu
11 Topic ENERGY-2007-2.3-6, awarded to the NorseWind consortium. http://www.norsewind.eu

Ports and harbours

Germany and the UK, in particular, have been very active in developing their ports and harbours, which is considered a way to diversify activities and create local employment.

In Germany, on 10 December, a round table discussion on port and infrastructure development took place with the offshore wind industry and the maritime sector in Cuxhaven, in the presence of three Deputy Secretaries from the relevant Ministries (Environment, Economy and Transport). It was the kick-off event of a process which aims to develop an offshore harbour concept during 2011. The major development announcements in 2010 which will have an impact on offshore wind energy in are listed below:

- The port of Sassnitz on the island of Ruegen (Baltic Sea) was selected by EnBW as major offshore port for the Baltic 2 project;
- The port of Bremerhaven is being further developed and accomodated for more offshore projects;
- The port of Cuxhaven hosts a prototype of the STRABAG gravity based foundation, and in the future a production facility of gravity foundations.

As regards the UK, several initiatives are underway to improve the offshore readiness of UK ports. Following the Department of Energy and Climate Change's 2009 report identifying the potential harbour candidates for the large-scale deployment of offshore wind[12], the government confirmed £60 million (€71.4m) in funding to support the development of port infrastructure for offshore wind in England, Wales and Northern Ireland. This announcement was followed by confirmations from major wind turbine manufactures (Siemens, GE and Gamesa) of investments in wind manufacturing in the UK. A few weeks later, a new fund of £70 million (€83.3m) was announced by the Scottish government to strengthen port facilities, testing sites and manufacturing for offshore wind. At some specific ports, the harbour infrastructures and services are being adapted and extended to support offshore wind development[13].

In Denmark in 2010 the ports of Esbjerg, Grenaa and Aabenraa expanded, as a part of a long term investment plan, their storage facilities for, among other things, wind turbines, foundations and other wind farm components. The three ports expanded their storing facilities with approximately 38 ha. Besides this the port of Esbjerg also expanded the quay by 500m. Aabenraa has also invested in new mobile cranes in order to move heavy goods. In general the investment plans of Danish ports are focused on the offshore wind industry. In addition, investments for offshore wind operations are planned at other harbours such as Aalborg and Lindoe.

12 UK Department of Energy and Climate Change. UK Offshore Wind Ports Prospectus, May 2009.
13 See EWEA Offshore Wind Industry Group (OWIG)'s draft report from its ports and harbours task force.

Offshore grid developments

North Seas Countries' Offshore Grid Initiative signs memorandum of understanding

Ten countries bordering the North Sea signed a memorandum of understanding on 3 December on joint coordination on an offshore grid in Europe's northern seas. Under this intergovernmental initiative Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the UK agreed to work together to coordinate investments in interconnections setting out deliverables with deadlines up to end 2012. They also agreed to set up a governance structure including three working groups on grid configuration and integration, market and regulatory issues, and planning and authorisation procedures in which ENTSO-E, the Regulators and the European Commission will be involved, together with input from stakeholders.

European Commission Communication "Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network"

In November 2010, the European Commission published its communication "Energy infrastructure priorities for 2020 and beyond – A blueprint for an integrated European energy network". The communication outlines four priority corridors for electricity including "offshore grid in the Northern Seas and connection to Northern as well as Central Europe". The European Commission aims to publish in 2011 a legislative proposal for a revised Trans-European Network (Energy) Instrument in the form of a new "EU Energy Security and Infrastructure Instrument" and guidelines for an improved cost allocation for cross-border transmission including the facilitation of permitting procedures.

NorGer

Statnett, Norway's national power grid company, acquired a 50% share in the planned NorGer HVDC electricity cable project between Norway and Germany in June 2010, while the previous project stakeholders Lyse, Agder and EGL, are now holding a 16.67% each. The agreement underlines the ambition of Statnett to control and coordinate all Norwegian interests in ongoing interconnection projects.

Furthermore, NorGer received a so-called revenue exemption by the German regulator on 25 November, while a similar exemption is still pending from the Norwegian side for this interconnector to be developed as a merchant line. The entire transmission capacity on this cable will be made available through implicit auctioning on the EPEX-Spot und Nordpool-Spot power exchanges. The cable will have a capacity of 1,400 MW and will be approximately 600 km long. The start of the operation is foreseen by 2015.

CobraCable

After having received a grant of €85 million from the European economic recovery plan (EERP) as a particularly innovative project, the Cobra Cable - a planned 700 MW HVDC interconnector between the Netherlands and Denmark – is now looking into the technical options to connect wind farms in the German Bight. As well as the voltage level of the cable (either 320kV or 450kV), legal questions regarding the alignment of differing national regulatory frameworks are still under discussion. If the decision to start construction of the CobraCable is made in 2012, the connection is scheduled to be operational by 2016.

East-West interconnector

Construction of the interconnector between Ireland and Wales commenced as scheduled in July 2010. The European Investment Bank (EIB) had agreed to lend the Irish TSO, EirGrid, €300 million towards the construction of the 256 km transmission cable in March. This will enhance urgently needed interconnectivity by adding to Ireland's only interconnector, the so-called Moyle cable, which links Northern Ireland and Scotland. The start of operation is foreseen for 2012.

BritNed

Construction of the EIB-backed interconnector between the Netherlands and the UK is well under way as the entire cable laying on the seabed was completed in July 2010. The transmission line with a cable 260 km long and with a capacity of 1,000 MW is foreseen to be operational by the first half of 2011.

NorNed 2

An official planning proposal for a second interconnector between Norway and the Netherlands was sent by Statnett to the Norwegian Water Resources and Energy Directorate (NVE). As most of the relevant planning work has already been performed in connection with the preparation of the first NorNed cable, a condensed planning proposal is now proposed by Statnett for NorNed2. NorNed2 will be connected to the grid at Feda in southern Norway, taking advantage of the existing NorNed infrastructure there with an envisaged transmission capacity of 700 MW.

UK/Norway interconnector developments

The UK TSO National Grid, and the Norwegian TSO Statnett, are continuing to study options for a new 1,400 MW HVDC bipolar connection between Western Norway and the UK via an 800 km subsea cable. Open questions include the DC voltage level and whether the cable could be used to connect wind farms in UK waters. The expected timeframe for commissioning would be between 2017 and 2020.

Skagerrak 4

The project to establish a fourth subsea cable between Norway and Denmark is progressing according to schedule after the go-ahead for construction was received from the Norwegian Water Resources and Energy Directorate (NVE) at the beginning of 2010. The Skagerrak 4 cable will have a capacity of 700 MW and is expected to be commissioned in 2014.

Kriegers Flak

Swedish TSO Svenska Kraftnät decided to temporarily withdraw from the Kriegers Flak project which envisaged a regionally combined solution for connecting 1,600 MW of offshore wind power in the Baltic Sea to Germany, Sweden and Denmark, as well as to provide additional transmission capacity between these countries. The two remaining TSOs, 50Hertz transmission and Energinet.dk, decided to continue with the project with EEPR funding with a combined solution between Germany and Denmark. Svenska Kraftnät may still re-join the project later on. Currently ongoing are a more detailed feasibility study and a survey on environmental data.

NordBalt

The Nord Balt HVDC interconnector project of 700 MW between Lithuania and Sweden suffered a major change as the Latvian state-owned power utility Latvenergo withdrew from the project in 2010. However, the remaining project stakeholders from Sweden and Lithuania are moving forward with the project as planned. Apart from this change, the project is on track with a seabed survey completed and the tendering procedures for the cable and converters ongoing. Territory planning documents are being prepared as well as an environmental impact assessment (EIA). The interconnector should be operational by 2015.

EstLink 2

The European Investment Bank signed a €75 million loan to Estonian grid operator Elering in November that will co-finance the second HVDC interconnector linking Estonia and Finland with an additional capacity of 650 MW. The construction of the Estlink 2 subsea cable complements an existing 350 MW interconnector between these two countries. Elering and Finnish grid operator Fingrid aim at commercial operation of the cable at the start of 2014. The remainder of the total €320 million financing will be in the form of an EU grant and a loan from the Nordic Investment Bank alongside funds from Elering and Fingrid.

FennoSkan 2

The extension of the FennoSkan cable between Sweden and Finland is on track with the start of operation foreseen by the end of 2011. This HVDC reinforcement with a capacity of 800 MW received a loan by the European Investment Bank of €150 million in 2010. Total length of the link will be approximately 300 km, of which the actual submarine cable will account for some 200 km.