Offshore wind power

While onshore wind power is a rapidly growing global industry, the offshore wind power market remains in its consolidation and globalization phase. This most mature of renewable marine energies continues to develop and can no longer be considered a niche industry. This fact sheet evaluates the market over the last several years, looking at its potential and its current rank in terms of electricity production costs.

The first offshore wind farm was built in 1991 along the Danish coast at Vindeby, at a depth of 5 m. Eleven 450 kW turbines were installed there. It was modeled directly from onshore wind farms.

In 2015, the British government approved construction of the world's largest offshore wind farm at Dogger Bank. Its total capacity will be 1.2 GW, spread across four sites totaling 200 turbines, each with a capacity of 6 MW and installed at a water depth of 18 to 63 m. Just one of these turbines will exceed the production of the Vindeby wind farm.

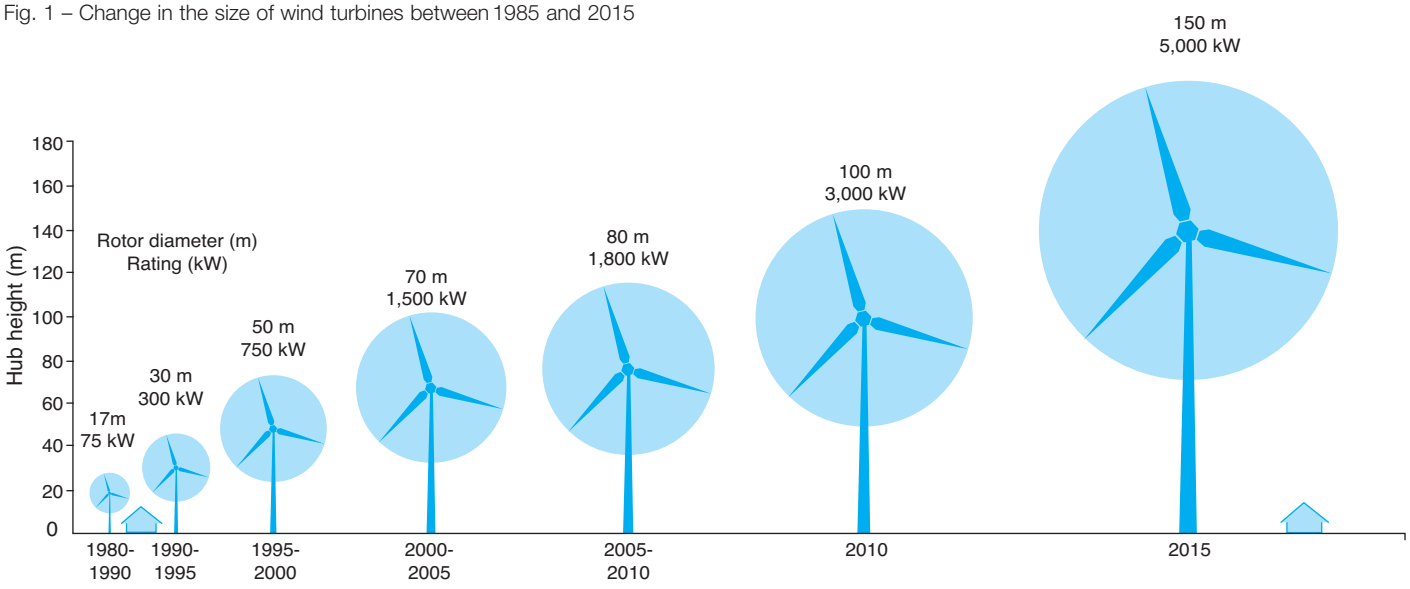
The changes in wind turbine size alone shows how the industry is growing in scale and striving to maximize its potential (Fig. 1).

An offshore wind power market with the wind in its sails...

The offshore wind power market has weathered the storm of the financial crisis. Although the market stabilized at approximately 1,000 MW connected annually between 2010 and 2012, the number of new installations doubled in 2013. After a consolidation phase during 2014 that posted average levels, 2015 was a landmark year, with the installation of over 4,000 MW in new wind farms (Fig. 2 and 3).

This record level resulted from new projects in Germany (2,400 MW) and in China (500 MW), with the United Kingdom posting consistent growth of 1,000 MW/yr.

Fig. 1 – Change in the size of wind turbines between 1985 and 2015



Source: European Wind Energy Assiociation

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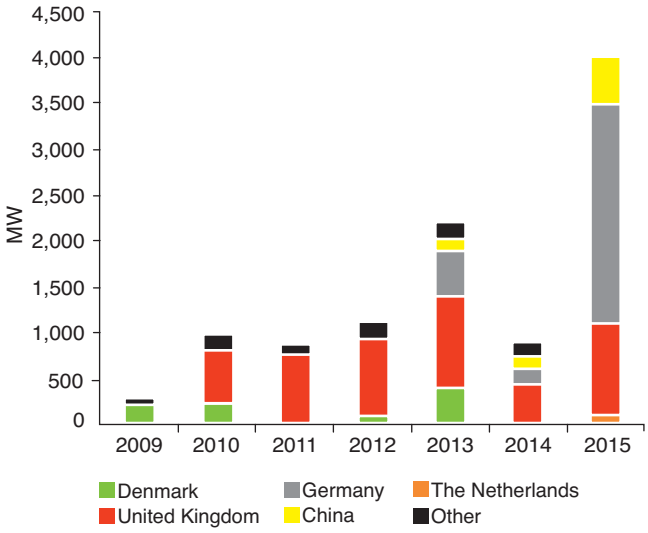
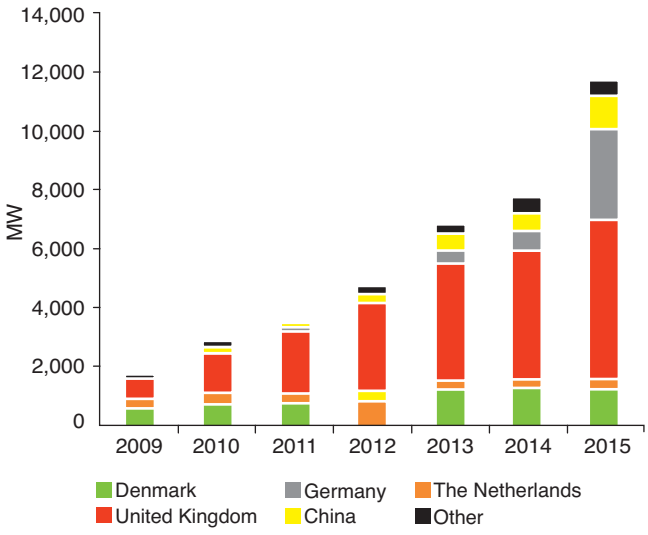
Fig. 2 – New installations between 2009 and the end of 2015



Source: European Wind Energy Association

Fig. 3 – Cumulative capacity installed by country (2009 to 2015)



Source: European Wind Energy Association

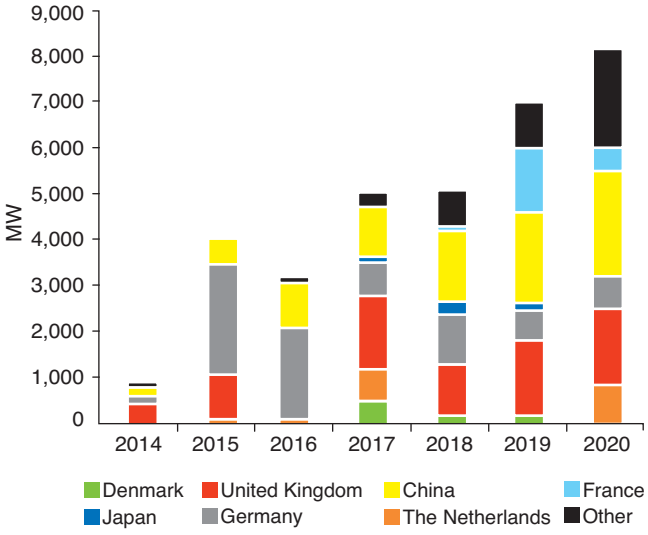
At this rate of installation, worldwide capacity is expected to grow exponentially and, by the end of 2015, should exceed 12,000 MW, most of which is in Europe, the historical birthplace of offshore wind power. Although the United Kingdom still has the largest offshore wind farm capacity with 5,400 MW, the surprises came from Germany, which took second place from Denmark, and from China, which has truly become a key player in offshore wind power.

All of this reflects new momentum and the emergence of new clusters of activity, aside from the traditional duo of the United Kingdom and Denmark which have typically driven the market.

...for a long time to come!

While the market is expected to lag in 2016, strong prospects for growth are anticipated in the global offshore wind power market. New installations are expected to exceed 5,000 MW/yr as from 2017, and should reach 8,000 MW/yr by 2020 (Fig. 4). To date, offshore wind farms are believed to represent a total of 40,000 MW.

Fig. 4 – Projected annual installations by country (2014-2020)



Source: Bloomberg News Energy Finance

Over the next five years, the United Kingdom will be joined by China and Germany as the driving forces of this industry. These three countries will represent over 60% of installations between 2015 and 2020, with China gaining importance with a rate of installation to exceed 2,500 MW/yr by 2020. This is consistent with the NEA (National Energy Administration) plan, which predicts 10,500 MW of offshore wind power capacity by 2020.

For Germany, the national energy transition program published in 2011 made offshore wind power one of its cornerstones, but did not set quantitative objectives. This is no longer the case today: 7,700 MW are projected by 2020 (instead of the initial target of 6,500 MW) with 15,000 MW projected by 2030, taking up part of the slack from nuclear power.

With regard to France, the first offshore wind farms from the initial call for tenders in July 2011 should be operational in 2018. This is the time to build up the national industrial sector: factories to build and assemble components opened during 2015 in Montoir-de-Bretagne and Saint-Nazaire.

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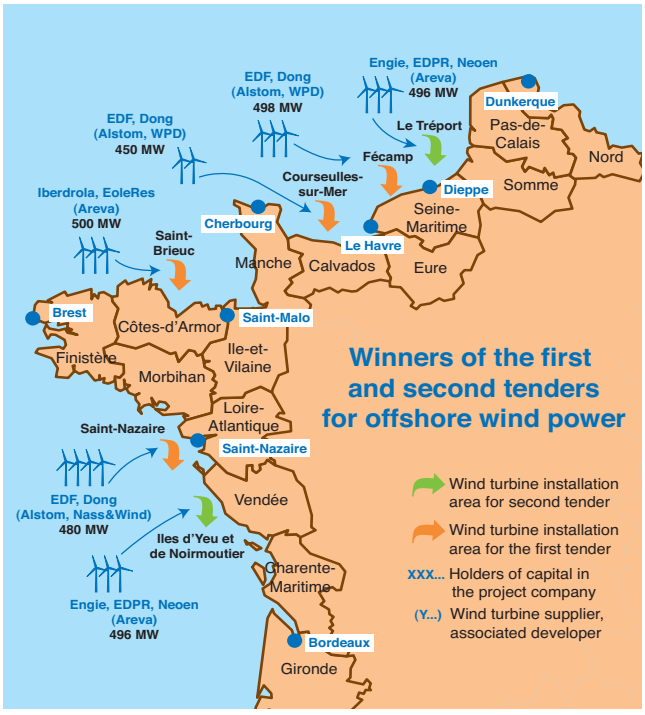
Note that during the initial call for tenders, four sites were allocated (including three to the consortium that includes EDF and DONG/Alstom) for a total capacity of 1,928 MW (Fig. 5) for future installation of offshore wind farms and their operation by ad hoc companies:

- in Courseulles-sur-mer (450 MW), the Éoliennes Offshore company of Calvados is 85% owned by Éolien Maritime France (EMF) (60% EDF Énergies Nouvelles and 40% DONG Energy) and 15% by WPD Offshore (developer of 2,500 MW of wind power worldwide);
- in Fécamp (498 MW), the Éoliennes Offshore company of Les Hautes Falaises is 70% owned by EMF and 30% by WPD Offshore;
- in Saint-Nazaire (480 MW), the project will be wholly operated by EMF;
- the Saint-Brieuc site (500 MW) was awarded to Iberdrola and Areva (Ailes Marines SAS).

During the second call for tenders in 2013, the consortium led by GDF Suez, which includes the Portuguese power producer EDP, Neoen Marine and Areva, won the offshore wind fields at Tréport (496 MW) and Yeu-Noirmoutier (496 MW).

Fig. 5 – Results of offshore wind power calls for tender in France



Source: French Ministry of Ecology, Sustainable Development and Energy

During 2015, a specific tender for floating wind farms was opened for bidding. It covers pilot farms with three to six full-scale turbines having unit capacity of at least 5 MW, within four defined areas in the Mediterranean and the Atlantic. Companies have until April 4, 2016 to respond.

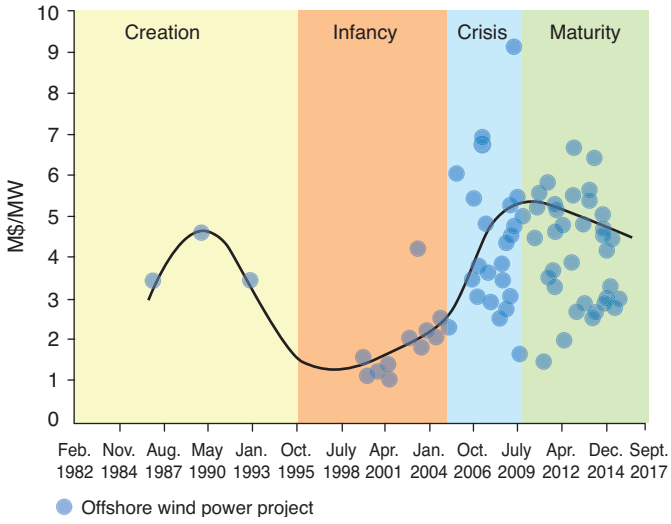
Focus on cost reduction

Since its beginnings in 1991, the cost of offshore wind power has fluctuated considerably (Fig. 6). Needless to say, early projects were costly since they were pilot projects. The end of the 1990s saw the emergence of the first industrial-scale projects, with significant cost reduction of around $2 million per MW.

Between 2000 and 2010, costs rose as projects grew in complexity. Wind farms were installed at greater distances from the coastlines, increasing network connection costs. They were also built in increasingly deeper waters (Fig. 7), which further increased the cost of turbine foundations. This was on top of growing tension between raw materials and some equipment between 2006 and 2009, up to the financial crisis.

Since then, offshore wind power has entered a new maturity cycle. Though projects are becoming more complex, technologies and installation methods are now fully understood, allowing further reductions in investment costs.

Fig. 6 – Trends in per-project investment (Capex) from 1987 to 2015 (funding year)



Source: Bloomberg News Energy Finance

Although reduction in the cost of invested capital helps to increase the competitiveness of offshore wind turbines, the real objective is to lower the discounted production costs (LCOE for levelized cost of electricity) which includes both operational expenses and investment costs.

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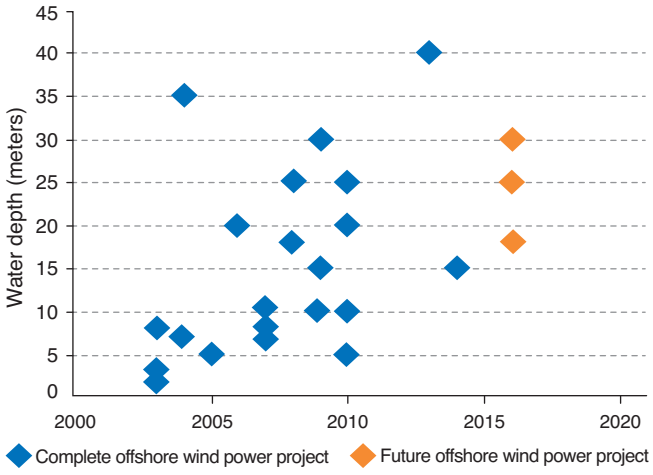
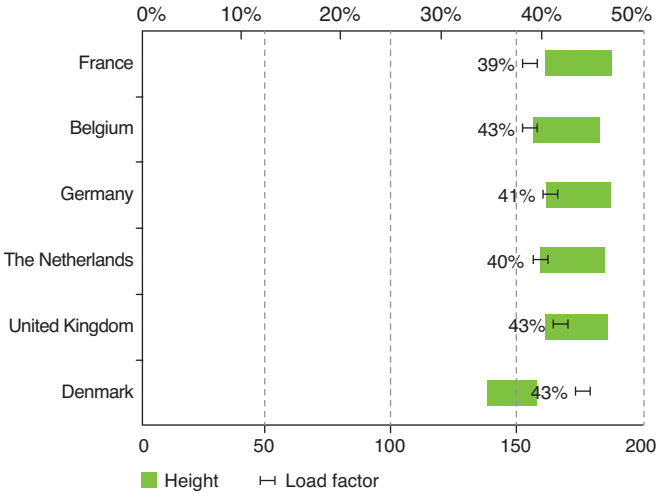
Fig. 7 – Water depth of wind farms, by year of installation



Source: IFPEN

Fig. 8 – Typical LCOE in European countries and load factors

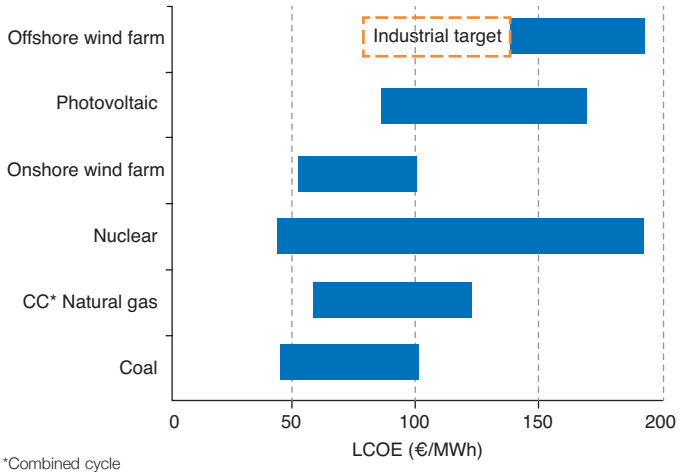


Source: Bloomberg News Energy Finance

For example, production costs currently fall between €132/MWh for the lowest-cost project in Denmark and €190/MWh for sites in France (Fig. 8). This variation can be explained by variable investment costs and operational costs, as well as a fluctuating load factor (the part of the year when the turbine produces electricity).

This factor, at 40% or higher versus 25 to 30% onshore is one of the parameters that explains the industrialists' preference for offshore wind farms. Yet this load factor

Fig. 9 – Comparison of LCOE in various electricity production industries



*Combined cycle

Source: IFPEN

is vital to inclusion in the network and to the profitability of projects and, at the end of the day, of the industry.

Industrialists face the challenge of further lowering investment and maintenance costs while maximizing their load factor. The goal is to bring down the production costs of offshore wind farms to the level seen in other renewable electricity production industries (Fig. 9).

Offshore wind farms are performing well. The market has momentum and is experiencing solid growth. New forces such as China and Germany have emerged to take the reins from Denmark and the United Kingdom. For its part, France is preparing the groundwork for its future and will enter the market in 2018.

Despite everything, the costs of offshore wind farms have fluctuated, generally rising up to this point. The current challenge for industrialists is to continue conquering new areas while lowering electricity production costs. This is well underway, as the Horns Rev 3 (Danish offshore wind farm) project was recently awarded at €106/MWh, and industrialists intend to move below €100/MWh by 2020. This will clearly make offshore wind power one of the most competitive industries for the energy transition.

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Final draft submitted in November 2015