PANORAMA 2012

a look at ...

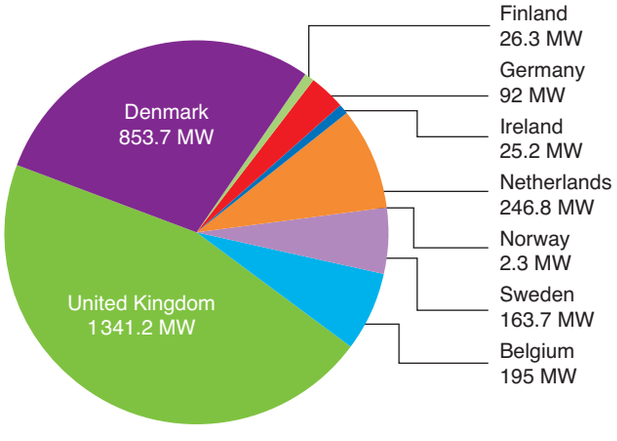
Marine renewable energy sources: their place in energy policy, projects and players

Marine energy sources are now a reality in the scientific landscape and, from now on, will be an increasingly important feature of the industry. Driven by public policy and renewable energy development targets, projects are multiplying, and industry players are jostling for maximum advantage in the first bidding rounds.

Marine renewable energy (MRE) sources are not all at the same level of technical, economic or industrial maturity. At present, only fixed offshore wind installations (wind turbines installed on foundations in water depths of up to 30-40 m) can be considered as a true industry sector, following the installation of wind farms off the coasts of Europe.

At the end of 2010, the European installed base of offshore wind turbines offered a total output of 3,294 megawatts (MW), led by the United Kingdom with 1,218 MW, Denmark with 866 MW and the Netherlands with 246 MW. France does not yet rate as a country with offshore wind power generating capacity (Figure 1). In the rest of the world, there are small wind farms in China, South Korea and Japan, but only one operational wind farm comparable in size to those found in Europe: the Shanghai Donghai Bridge wind farm in China.

Fig. 1 – Installed capacity of offshore wind power in Europe



Source: EWEA, The European Offshore Wind Industry Key Trends and Statistics 2010

With the exception of offshore wind power, tidal energy is without doubt the most technically advanced marine renewable energy technology at present. The Rance plant (in Brittany, France) has been injecting large quantities of energy into the grid since 1977 (240 MW installed capacity generating approximately 500 GWh per year). There are other installations around the world, but these projects are fairly rare due to the scarcity of locations suitable for new tidal plants. This limitation also prevents consideration of this energy source as a major opportunity for growth in marine renewable energy.

As far as other marine energy sources are concerned — wave power and ocean thermal energy (see Panorama 2011 "Ocean renewable energies") — the installed capacities are currently negligible in industry terms. The challenges posed by R&D projects have yet to be overcome in order to demonstrate the viability of these solutions on the basis of sea trials.

Targets for marine energy as part of the electricity mix

At European level, the 20-20-20 target is the basic landscape against which marine energy sources are being developed. This target requires European countries to achieve a 20% reduction in greenhouse gas emissions, a 20% saving in energy usage and a 20% contribution from renewable energy sources to total energy consumption. Onshore wind power is already well established and productively operational in many countries, and marine renewables, including offshore wind power, represent an additional energy source, or

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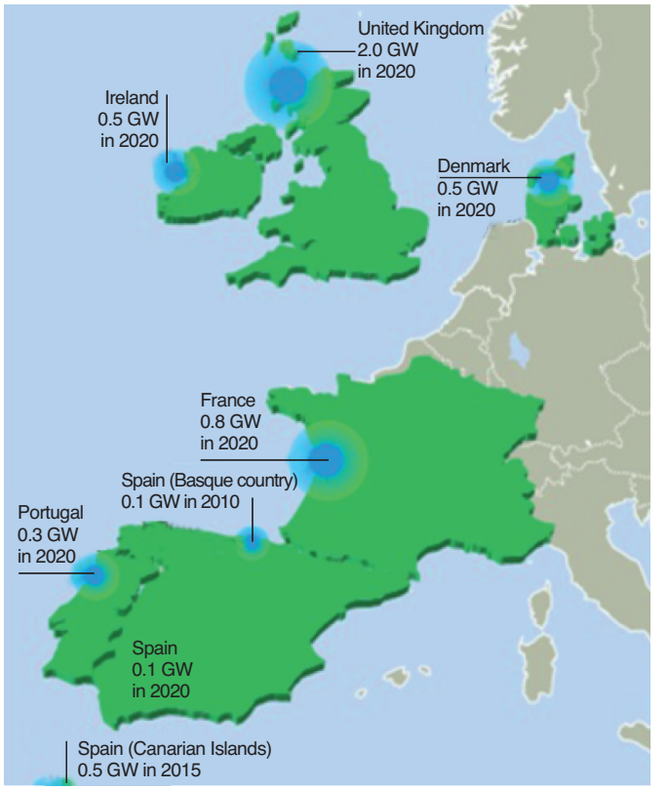
even a pre-requisite for isolated countries and regions, such as the French overseas departments and territories, in order to generate "green" electricity.

Europe has excellent resources in terms of recoverable energy, led by the United Kingdom and France. Those European countries with maritime coastlines have understood this potential, and have set ambitious strategies to develop marine energy sources.

Roadmaps have been prepared as the basis for exploiting this potential: the European Wind Energy Association (EWEA) quotes a figure of 40 GW for European offshore wind power installed capacity by 2020.

The most proactive countries have also set deployment targets. At 2,000 MW from wave and marine current power and 33,000 MW from offshore wind power by 2020, the United Kingdom target is the most ambitious, with Denmark and Ireland targeting 500 MW in the same timeframe. More modestly, Portugal and Spain hope to achieve 300 MW and 100 MW respectively by 2020 (from wave and marine current power alone) (Figure 2).

Fig. 2 – National MRE deployment targets for Europe (excluding offshore wind power)



Source: EU-OEA (European Ocean Energy Association).

France has set two targets: one of 800 MW for marine renewable energy from waves and marine currents, and another of 6,000 MW for offshore wind power installed capacity by 2020.

There remains the issue of understanding how these targets for intermittent energy capacity can be transformed into actual kWh generated and injected into the grid.

Countries are putting in place the resources needed to achieve their targets

In most cases, achieving these targets involves competitive bidding for contracts. This is currently the case in France, with a €10 billion project to install offshore wind farms with a combined generating capacity of 3,000 MW. Five sites have been earmarked: Saint-Brieuc, Saint-Nazaire, Dieppe–Le Tréport, Fécamp and Courseulles-sur-mer, each gaining a wind farm with a generating capacity of between 400 and 750 MW. Half of the 6,000 MW (approximately 600 turbines, each generating 5 MW) are due to be installed by 2015, for final commissioning in 2017/2018.

The launch of a new bidding round for 3,000 MW is planned for early 2012, and may include MRE sources other than wind power.

Abroad, the United Kingdom leads the way, because sites were earmarked in 2010 by the Crown Estate (the United Kingdom agency that manages the seabed with the 12 nautical mile limit) not only for offshore wind power, but also for wave and marine current energy projects. In all, 31 wave and marine current projects are planned, with a combined capacity in excess of 1.6 GW, which provides a good illustration of how far ahead our British neighbours are in this field.

The major challenges for research and development

In addition to tariff subsidies and allocated sites, and given the still insufficient level of maturity achieved by these marine technologies, research subsidies are also very significant. In the USA, R&D funding of $50 million per year for the period 2008-2012 was released on signature of the Marine and Hydrokinetic Renewable Energy Research and Development Act in 2007. Under this scheme, Alstom, the Massachusetts Institute of Technology and the National Renewable Energy Laboratory have received $4.1 million from the DOE to work on reducing the cost of offshore wind turbines.

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In Europe, Framework Programme 7 (FP7) includes provision for MRE with two bidding rounds: one for large-scale wind power to develop turbines of 10-20 MW, and the other to create the first grid-connected wave and marine current farms. FP8 is now at the definition stage, and it is to be hoped that even greater provision will be made in future bidding rounds for MRE-related projects.

Still at European level, NER300 is an initiative launched to provide funding for demonstration projects in carbon capture and storage, and in innovative renewable energy technologies. Four underwater generator projects have been submitted (for farms rated at between 8 and 20 MW), including one in France. Two British wave energy projects, two floating offshore wind projects and a French project to recover thermal energy from the ocean complete the well-represented MRE element of this unique initiative.

In France, Ademe has launched a Call for Expression of Interest (*Appel à Manifestation d'Intérêt* or AMI) called "*Grand Éolien*", where the goal is to develop components for large-scale fixed wind turbines (*i.e.* excluding floating wind turbines) and provide funding for a test installation. No other AMI has been issued for wave and marine current projects since that of 2009, but this situation could soon change, especially since such projects are already in existence, funded by Oséo and the *Fonds Unique Interministériel*.

In terms of R&D, Supergen Marine is the UK centre for marine energy research and a consortium providing resources for joint research projects. Its French counterpart — currently known as IEED[1] *France Énergies Marines* until a final decision upon its creation is taken — plans to invest €140 million over 10 years in MRE industry development (whilst removing the barriers that still limit this development, whether technical or otherwise) and test site implementation.

The industry sector response is coming together

In the same way as politics and science, the industry is also bubbling with activity. Industry players are jostling elbow-to-elbow to gain best position in the niche market for marine energy.

Recent years have seen the marine energy market come together as a profusion of small players with fairly limited resources; most of them developing their own technologies. This situation has changed significantly in recent months as we have seen the entry into this market of energy industry big-hitters, from equipment manufacturers and engineering specialists to power generators.

We would particularly highlight the EDF Energy partnership with OpenHydro to develop tidal power farms (also the focus for the Scottish Southern Energy Renewables/Aquamarine Power partnership) and the EON partnership with Scottish Power Renewables to develop wave power projects. This latter pairing has also secured Crown Estate sites, as has Vattenfall as part of its association with Pelamis Wave Power, the inventor of the famous sea snake wave energy converter.

At the moment, what we are seeing is a battle between market contenders which is reducing their number and in which the strongest will prevail. These victors will then be approached by major industry players attracted by the most promising technologies. In precisely this way, Lockheed Martin has formed an alliance with Ocean Power Technologies to market their concepts, and Siemens has invested in Marine Current Turbines technology.

The concept of ocean thermal energy has attracted two major defence industry players: Lockheed Martin and DCNS.

At the same time, many alliances between "major" players have been announced in recent months, with particular emphasis on offshore wind power. As a result, we are seeing companies like STX and Alstom pooling their expertise to develop offshore wind power, and DCNS and STX coming together to develop the structural and foundation components for MRE systems.

Lastly, manufacturers are structuring themselves into consortia (Figure 3). This is the case with Dong Energy, EDF Energies Nouvelles, Nass&Wind Offshore, Poweo ENR, Alstom Power and wpd offshore, which are working together to bid for the French offshore wind power contract, and Areva, Iberdrola Renewables and Technip, which have been joined by renewable energy project developer Eole-Res for the Saint-Brieuc and Guérande regions. Areva is also working with GDF Suez and Vinci (soon to be joined by EON) on the sites at Dieppe–Le Tréport, Fécamp and Courseulles-sur-Mer.

Further upstream, IFP Energies nouvelles (IFPEN) is working in partnership with Principia to develop the DeepLines™ software package, which offers integrated simulations of the dynamic behaviour of fixed and floating offshore wind power installations and their interaction with the environment. This package is also being used by the ISIFLOAT JIP (Joint Industry Project) to model wind turbine and float combinations for floating wind power installations as the basis for issuing recommendations to designers.

(1 IEED (Excellence institutes initiatives in the field of low-carbon energies)

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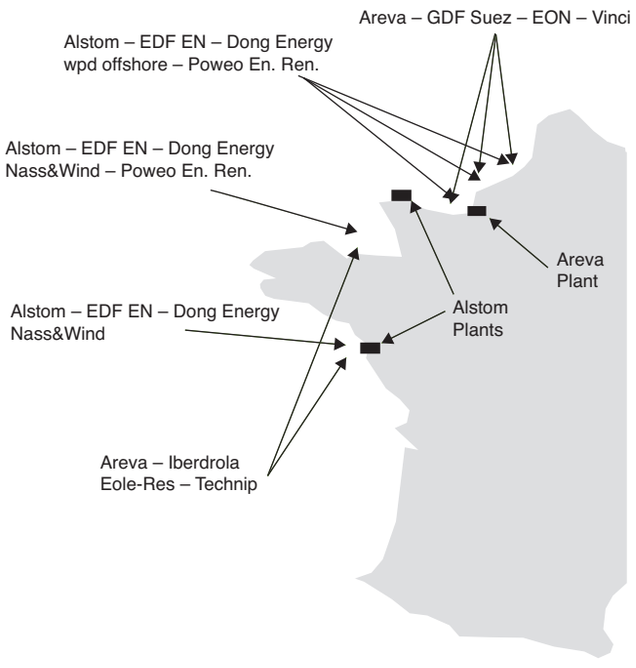
Fig. 3 – The consortia now operating in France



Source: IFPEN

Offshore installations are now a reality

Fixed offshore wind farms are already a reality, but 2011 has also seen a number of "firsts" in the field of marine energy.

We are beginning to see the emergence of floating wind farm projects. IFPEN is a contributor to the Vertiwind vertical axis floating wind power generator development project led by Technip, Nenuphar, EDF Energies Nouvelles and EDF R&D (Figure 4).

The first commercial-scale tidal energy turbine (designed to recover energy from marine currents and tides using a principle very close to that of the wind power generator) developed by Atlantis Resources Corporation is now connected to the national grid in Scotland. The installation has a power output of 1 MW. In France, the first OpenHydro tidal energy system was submerged at the Paimpol-Bréhat pilot site at the end of October.

In wave power, although the Pelamis articulated floating wave energy converter that recovers energy from the ocean swell has been around for some years, it has yet to demonstrate sufficient reliability, whilst the first oscillating water column wave energy system designed for commercial use has now appeared at Mutriku, in the Basque region of Spain. The Voith Hydro technology it uses has been tested for nearly 10 years in Scotland, and now delivers a rated power output of 296 kW in return for an overall budget of €6.7 million.

Fig. 4 – The Vertiwind floating wind power generator

Source: Technip – Vertiwind

Fig. 5 – The OpenHydro tidal energy system

Source: OpenHydro

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Fig. 6 – The Mutriku breakwater

Source: VoithHydro

The degree of technical maturity in ocean thermal energy recovery is such that its development will take longer than that required for wave and marine current systems. The first pilot project is likely to appear between now and 2015 in the French overseas departments and territories. La Réunion, which was — until recently — in pole position for this trial, is now competing with Martinique for the DCNS pilot project, which will generate 10 MW at total investment cost of around €400 million.

In summary, the marine renewable energy landscape has changed considerably in the space of one year. Offshore wind power is now an industrial reality, and marine energy sources are increasingly seen as essential components of energy policy in the USA and the leading countries of Europe. Roadmaps are already in place to achieve some ambitious goals, and industry players are now at the stage of positioning themselves in this market by taking over from small research projects and MRE pioneers to take these technologies to a new level in preparation for large-scale deployment.

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