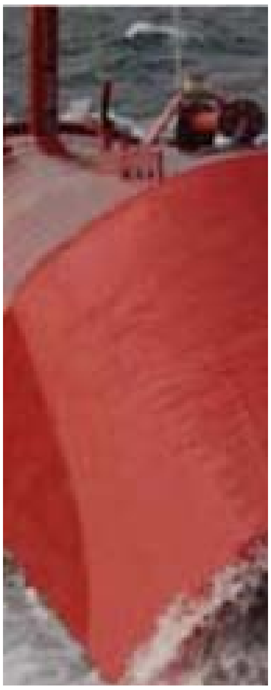

Accelerating the Deployment of Offshore

Executive Summary

February 2011
IEA-RETD

RETD
IEA - RENEWABLE ENERGY TECHNOLOGY DEPLOYMENT

Mott MacDonald

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Executive Summary

The Implementing Agreement on Renewable Energy Technology Development of the International Energy Agency (IEA-RETD) has appointed MacDonald (MM) to support its role of assisting policy makers and project developers to better understand the specifics of offshore renewable energy and to give them practical guidelines on how to foster its deployment. The report focuses on the ten RETD member countries (Canada, Denmark, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, UK) as well as eight other countries which have shown activity in the marine renewable industry (Belgium, China, Finland, Portugal, Spain, Sweden, Taiwan and USA).

World electricity production continues to increase and in 2009 reached approximately 17,000 TWh/year. The electricity production process is creating a significant burden on global resources and renewable energy technologies are increasingly part of the mix to meet the challenge of rising energy demand whilst minimising negative environmental impacts.

World electricity production in 2009: **17,000** TWh/year

Theoretical potential of offshore resource: **260,000** to **330,000** TWh/year

The world theoretical resource from offshore renewables (wind, wave and tidal) is estimated to be between 260,000 and 330,000 TWh/year, illustrating the potential significance of the available resource. The opportunity to harvest this vast resource has been identified by governments and academia together with commercial project and technology developers, who aim to capitalise in a rapidly expanding market.

Of all the marine technologies, offshore wind is the front runner with projects operating since the early 1990s. Even though the offshore wind sector is experiencing high growth, the industry is far from mature and big challenges lie ahead with projects being planned for deployment further offshore, in deeper locations, with larger machine and technological advancements.

For the wave and tidal sector, a large number of devices are under development with no particular design having yet emerged as clear front runner. The various technologies are at different stages of development with some prototypes currently being tested at full scale and commercial projects expected in the near future.

The risks are higher for offshore technologies, but mitigation measures can reduce these to an acceptable level for development

Due to the harsh and difficult to access environment in which these devices have to be installed and operated, the associated risks (technical and non-technical) are higher than for onshore technologies. Complete removal of such risks is not feasible; however, mitigation measures can reduce these risks to an acceptable level to facilitate project development.

Costs

Financing is the biggest barrier to the deployment of marine energy projects

Regardless of the mitigation measures, the costs of marine projects remain high and uncertain, resulting in financing of a marine project being the biggest barrier for their deployment.

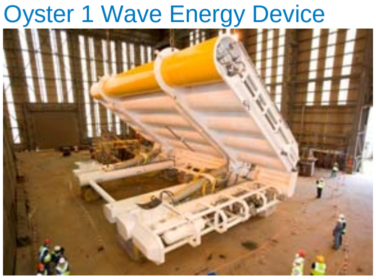
Offshore wind is currently the cheapest of the marine technologies in terms of cost of energy for an installed project (including transmission connections to the shore) with a range of 120-250 €/MWh. Cost of energy estimated for near future pre-commercial wave energy projects are in the region of 140-530 €/MWh whereas for tidal energy arrays these costs range from 110 to 220 €/MWh installed. Cost of energy for commercial wave and tidal devices should be treated carefully as the uncertainty inherent in these estimates is very high.

Financing

A range of financing options is available – project finance has been used for offshore wind

There are a number of financing options available for projects developed by the private sector which are primarily balance sheet and project finance. Each option has its benefits and drawbacks. The characteristics of individual projects and their sponsoring organisations typically dictate which one of these financing options is best suited for a particular project. Balance sheet finance using debt raised corporately is cheaper, involves less parties and control of the project remains firmly with the owner; it is however capital intensive and the risk of failure lies entirely with the owner. On the other hand, project finance allows greater leverage from the available funds for sponsors' equity investment; however, it is typically more expensive and complex and an element of control over the project is afforded to the lenders. One solution is to finance construction projects on balance sheet and move to project finance on completion, recycling development capital into new projects.

Oyster 1 Wave Energy Device



Source: Aquamarine Power

To date, wave and tidal stream projects have not been project financed. With the most advanced technologies typically at a pre-commercial/prototype stage, they are seen as containing large amounts of technology and performance risks. Funding for technology deployment to date has tended to tap venture capital or public sector development support sources. Project developments are mainly pursued by utilities. A project finance model may emerge in the future once the technologies have been de-risked.

Tariff Support

The lack of long term or stable policy commitments from governments is another significant barrier as it affects developer and market confidence. Furthermore, in many countries, the level of financial support provided (feed in tariff or tradable certificates) often appears either insufficient or at best marginal in order to provide sufficiently attractive returns to investors compared to lower risk investment options in other sectors.

Confidence in long term market opportunities is instrumental for the private sector investors – countries with strong leadership have enjoyed success with offshore wind

Confidence in long term market opportunities is required from the private sector in order to trigger the investment decisions necessary to the development of a supply chain for the offshore renewable sector. At the national level, governments can heavily influence and coordinate the development of required infrastructures (such as harbours and grid). The importance of public support for marine technologies is illustrated by the success offshore wind has had in some countries were such barrier was removed. Countries that have shown strong political leadership and tailored financial incentives, such as Belgium, Denmark, Germany and the UK, are leading the way in terms of deployment.

Planning and Permitting

Complex permitting processes are a barrier to offshore projects

Complex permitting processes are another major barrier to offshore renewable energy projects development in most countries. Prescriptive planning conditions or requirements limit projects and technologies design options and can significantly increase timescale and development costs. A number of regulatory barriers are also delaying or preventing the changes required in the onshore and offshore grid infrastructure in order to accommodate offshore (and onshore) renewable expansion plans. Deployment timescales can be greatly increased as a result of these barriers.

One-stop shops and pre-permitted areas could remove this barrier

While the permitting processes are diverse and country specific, lessons can be learned from the countries that have had more success with offshore wind. Streamlined application procedures, one-stop shops, pre-permitted areas are some of the potential mitigation measures to planning and permitting barriers. The allocation of seabed rights to competent and construction focussed developers is also important in order to avoid sites being leased to developers more interested in speculative applications or without the necessary resource to progress the development of projects.

Technologies

3-bladed horizontal axis turbine offshore wind turbine at EnBW Baltic 1 offshore wind farm

Source: Mott MacDonald

Offshore wind turbine technologies are based on the three bladed upwind horizontal axis design, although new concepts are being developed. Offshore wind foundations can be split into six broad categories (monopile, multipile, gravity base, jacket, suction cup and floating foundations). Their suitability is mainly linked to water depth and seabed conditions.

Wave and tidal energy technologies are at a much earlier stage of development compared to offshore wind. A wide range of technologies and designs are currently being developed. The main tidal energy designs include horizontal axis turbines, vertical axis turbine, and oscillating hydrofoil. Wave energy designs are more diverse and main categories include attenuators, point absorbers, oscillating water column (OWC), oscillating wave surge converters, and overtopping designs.

Floating marine energy devices require mooring systems, for which there are various designs available or under development.

Seagen horizontal axis tidal turbine

Source: Marine Current Turbines

The main technical challenges and barriers shared by all marine renewable energy technologies include technology and design optimisation, reliability, installation and decommissioning, operation and maintenance, grid connection and integration. Considerable investments will be required in onshore and offshore grid infrastructure in order to accommodate for the large expected expansion in variable generation capacity from offshore renewable energy projects. In some parts of the world, the optimal topology of this expansion needs to be considered at a supra-national rather than national level. Technical barriers are surmountable but usually impact the cost of offshore renewable energy project and technologies.

Research, Development, Demonstration and Green Employment

Research, Development and Demonstration (RD&D) activities performed directly by the private sector or financially supported or promoted by public funding are instrumental to the removal or mitigation of technical barriers and through creating domestic intellectual capital can also support green employment and the development of future industries. The importance of the support that can be provided by publicly funded RD&D activities is particularly relevant for the more immature technologies given the lower investment capacity of the private sector and longer timescales involved. Direct involvement and possibly co-investment from private companies into RD&D activities should be maximised.

Other Barriers

Health and safety, the environment, other sea users, supply chain constraints and skills shortages are also key barriers

Other barriers include health and safety, environmental and other sea users considerations, supply chain constraints and skills shortages. While all these issues are important and have to be dealt with, mitigation measures can reduce their impact.

The reduction or mitigation of health and safety barriers can be achieved by a strong industry culture, supported by staff training, compliance to legislative requirement, best practices and standards, as well as through technical innovations.

The main mitigation measures in order to ensure the minimisation of environmental barriers and acceptance from other sea users are early engagement with all stakeholders, appropriate marine spatial planning and adoption of the recommendations from the Environmental Impact Assessment (EIA).

Substation installation by floating crane at EnBW Baltic 1 offshore wind farm

Source: Mott MacDonald

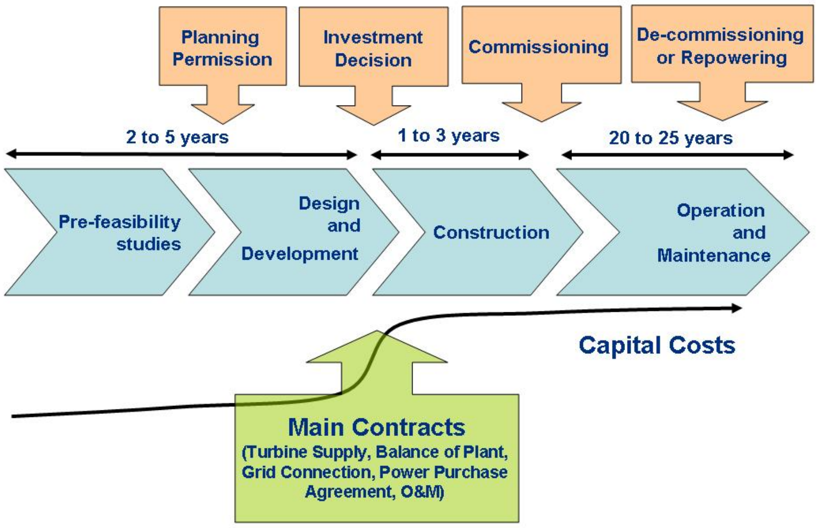
The infrastructure, products and services supply chains need to be vastly developed in order to increase competition and avoid shortages. This can be delivered by private sector investment, but only if governments establish sufficient confidence in the long term market opportunities.

The removal of skills barriers requires the active promotion of the various employment and careers opportunities provided by the offshore renewable energy industry, as well as the development of training courses and programmes tailored to the needs of the industry.

Project Development

Developers should follow best practice to reduce the risk of failed projects

Developers are recommended to follow best practice at all stages of projects lifecycle, from pre-feasibility, development, design, construction, operation and decommissioning.



Examples of such best practices include definition of clear project objectives and development strategy, early consultation with other stakeholders, and creation of a risk register to be maintained as a live document throughout the project life as a tool to record and then address the key project risks.

Model Policy Framework

A Model Policy Framework will include clear actions to remove barriers and accelerate deployment

A conceptual Model Policy Framework that promotes offshore development needs to include strategic support mechanisms, stable regulatory regimes, efficient permitting and grid connections and access to finance. Such framework also needs to include measures supporting innovation and competition. The support mechanisms will have two distinct roles:

- Create an orderly environment in which developers can work; and;
- De-risk this new industry.

The latter mechanisms will need to be formulated so they can be diminished or withdrawn as experience is gained to reduce costs to taxpayers or electricity consumers, and give developers rewards proportionate to their risks.

The proposed Model Policy Framework should include the following aspects:

Dedicated flexible support mechanisms will help create markets

- **Market Creation** – Provide flexible support mechanisms appropriately sized for the size of risk undertaken and the overall desired capacity to be derived from offshore renewables. This may take the form of:
    - "Phased" tariffs, whereby initial prototype/pilot projects are implemented in relatively calm waters to enable to industry to go through a lessons learned process, with later projects receiving less support once learning has occurred, and/or
    - Tariffs that are flexible depending on the offshore resource, water depth and distance from shore of particular sites, or
    - A tendered capacity model where tariffs are bid to develop projects at particular sites.

One-stop shops lead to straightforward permitting

- **Straightforward Permitting** – One-stop agencies instead of engagement with a large number of government agencies. Permitting requirements should be clear from the outset. Defining offshore development zones whereby offshore projects can be developed.
- **Grid connection facilitated** – Clear arrangements to provide the necessary grid connection (onshore and potentially

offshore) in a timely manner, with adequate commercial recourse should grid connections not be available in time.

- **Early development supported and de-risked** – Offshore resource measurement campaigns, seabed surveys and other measures in areas of interest, such that developers can assess the basic feasibility of project investments. As the industry matures, the level of such support can be reduced over time. Licenses should include expiry dates and require clear achievement of milestones from the developers in an effort to minimise sites being reserved for projects that will not materialise.

Governments should support early projects with funding and financing

- **Access to Capital** – Fund pilot projects with the industry (demonstration projects, measuring campaigns etc). Create support mechanisms aimed at providing early investment (grants for device development, tax relief, financing for projects, underwriting of a project, etc). Other measures could include the creation of a government financing body for projects to support commercial bank financing and provide a further signal to the lending community that the government is strongly supporting this industry. These support mechanisms will diminish as the industry begins to mature.

Bremerhaven port current facilities and planned extension for offshore wind

Source: offshore-windport.de

- **Supply Chain Creation** (for countries wishing to provide a supply chain) – Provide funding for device, foundations, mooring and other peripheral services development and support research in the relevant field. Provide suitable manufacturing bases and suitable harbours with further support (tax breaks etc). Create centres of excellence and strongly market to the rest of the world. Support conferences, seminars and other forms of networking and knowledge transfer.

Important investments in the supply chain, development of a skilled workface, and strong health & safety and environmental guidelines are all required

- **Skills development:** Identification of shortage skills, and a programme tailored to their proactive development, as far as possible, over the required timescales.

- **Clear environment, health and safety legislation** – Outline clear environmental requirements in line with Equator Principles. Adopt strong internationally accepted H&S guidelines.

The Policy Framework should receive strong visible support from government and government organisations to emphasise the commitment to the industry. Nevertheless, once the projects are in the construction phase, government intervention should be kept to the minimum.