SET Plan meeting May 7th, 2007

Technological maturity of ocean energy

The status of the ocean energy sector has improved highly over the last 5 years. A number of large scale test installations are either developed or under development today. Below only the European systems are listed, but worldwide other developments are in progress as well (e.g. 500 kW Energetec device, 500 KW Trivandum device, Tidal projects in Korea and China…)

There is only one operational ocean energy system in Europe which has been operating for many years. This is the tidal barrage system at La Rance, France which has an installed power of 240 MW and produces on average 600 GWh/year.

At present, several companies are testing large-scale systems in real sea conditions using different technologies e.g.

Wave Energy systems:

- Limpet, Islay, UK
- European Pilot Plant, Azores, Portugal
- Pelamis, Orkneys, UK and Portugal
- Wave Bob, Ireland
- OE Buoy, Ireland
- FO^3, Norway
- SSG, Norway
- Wavestar, Nissum Bredning, Denmark
- Wave Dragon, Nissum Bredning, Denmark

Tidal Stream systems:

- Marine Current Turbines; UK
- Ponte di Archimede, Italy
- Open Hydro, Ireland

Considering the harsh marine environment, the main challenge in the design of ocean energy systems is to achieve high reliability, low cost and safety. The learning experience during prototype testing is very expensive because of the high deployment and operational costs especially for off-shore devices. However learning experience is required in order to improve the designs and carry out the optimisation of the design or systems that can lead to further reduction in cost.

Taking into account the relatively few and geographical spread of systems being tested at sea - a better reporting of experiences should be stimulated so that lessons can be learned from past experience and used in to further development. EC could contribute to this by stimulating the publication of results from EC funded projects and the European Ocean Energy Association will build up a database making available research results to the ocean energy community.

At present there is no commercially leading technology amongst ocean energy conversion systems. In contrary to wind it is expected that there will be different technologies depending on the location.

Resource availability

The global resource for wave energy is estimated to be in the order of 8000 - 80000 TWh/year, of tidal current energy in the order of 800 TWh/year, of salinity gradient energy in the order of 2000 TWh/year and of OTEC in the order of 10000 TWh/year[1]. As such ocean energy has the theoretical potential to cover the present global electricity consumption. However, each type of ocean energy has a limit with regard to the practically possible energy extraction. The energy extraction from marine currents is, at present, only practical in areas where the currents are concentrated near the periphery of the oceans or through narrow passages between islands and other landforms. When assessing the technically achievable resource from wave energy, account must be taken of limitations on device deployment and losses in the energy conversion and transmission schemes. The best wave climates, with annual average power levels between 20 – 70 kW/m or higher, are found in the temperate zones (30 – 60 degrees latitude) where strong storms occur. However, attractive wave climates are still found with 30 degrees latitude where regular trade winds blow, which is the case for the Canary Islands, Azores and Madeira within the Macarronesia, the lower power levels being compensated by the smaller wave power variability.

On a European level, for wave energy the total practical offshore resource has been estimated to be in the order of 120 – 190 TWh/year[2], the near shore resource has been estimated to be in the order of 34 – 46 TWh/year. Conversion of the wave resource could supply a substantial part of the electrical energy demand of several countries, in Europe, particularly Ireland, Portugal and Spain. The electricity demand on Islands in remote areas could entirely be met by converting a small fraction of the available resource. The resource from marine currents, using present day technology, is estimated to be able to supply 48 TWh/year to the European electrical grid.

The decision by the EU Council of ministers of March 9th, 2007, sets a binding target of 20% from renewables by 2020. This ambitious target is challenging given that to date, only 6,5% of EU energy supply comes from renewable energy sources. However, it is absolutely necessary to meet up with the target if EU wants to secure its energy supply and to combat global warming by producing less greenhouse-gas emissions. Ocean energy can contribute significantly to the energy mix, tackling these two major challenges EU is facing.

Besides this, an increased share of renewables will limit exposure to high fuel prices. Energy importing countries would be able to invest the money in their own economies. The creation of an ocean energy industry will result from the development of the sector leading to a huge increase of jobs which is estimated to be in the range of 10 – 20 jobs pr. MW in the coastal regions.

In the start-up phase of building the Ocean Energy industry – large capital investments will be required. In order to attract investors and for the start-up companies to develop, a certain high feed in tariff is required. A tariff of the order of 50 euro cent per kWh (same magnitude as the feed in tariff for photo voltaic) is the magnitude that is required to get development moving. If this tariff is kept constant until 1 % of the EU + NMS electricity demand is covered by Ocean energy (10.000MW installed) – the Ocean energy community expects that this could be achieved by year 2020.

Research needs

The basic technology is present. However, to come to an optimal and cost-effective design, there is a need for continued demonstration and operating experience in generating grid connected electricity production. The majority of the developers are SME's with limited financial resources. Additional and parallel R&D would help to mitigate the substantial technical and non-technical risks.

This requires long-term funding for a period of 5 – 10 years or even longer to allow developers to go from large scale testing to commercialisation.

New technological concepts are still to be encouraged, but not at the expense of improving the cost of power and efficiency of leading technologies. Co-operation between developers should be encouraged and here a split between generic research and targeted research could help. Generic research applies to many different types of devices and covers a range of problems. Targeted research is beneficial where work is required on a particular concept or component. However, FP7 and beyond should also take into consideration the next generation of ocean energy technologies that have a large global potential such as ocean thermal energy conversion (OTEC) or osmotic power.

Importance and role of global weather forecasting system, satellite applications, etc.

Forecasting techniques appropriate to the development of ocean energy systems should be developed to help reduce the risks and uncertainties in operating the devices. Waves travel over vast distances and their arrival at a certain location can well be predicted from satellite observation and tracking. With proper forecasting the variation in ocean energy produced can more economically be integrated into the electrical grid. If the output can be predicted then the value of the electricity is higher.

In order to identify ocean power conditions and optimal installation sites over the vast ocean areas - long lasting measurements (10 – 20 years) of the ocean environment is required. To achieve this a combination of satellite measurements accompanied by wave measurements from buoys and bottom mounted instruments and numerical models could prove valuable.

Main bottlenecks

To date, the main bottlenecks that have been identified are :

- grid connection : cost of the cable to bring the electricity onshore is very high. Additionally, the onshore grid is not adapted to the large amounts of electricity that ocean energy can deliver. Examples are Scotland and Ireland that have a large resource potential but no grid available.

- cost competitiveness of ocean energy : biggest challenge is to advance the technology to a point where it can generate energy at a cost that is competitive to conventional sources. To achieve this a better understanding is needed of the behaviour of systems in the environment in order to improve their designs.

- Regulatory framework : there is an urgent need for a public policy environment that encourages more private sector involvement. More stable market framework conditions are needed to accelerate the technological development and commercialisation. There is a need for a national and an European regulatory framework, that fixes the feed in tariff eg. for photovoltaic power.

- Simplified licensing procedures: to date the licensing procedure is long, uncoordinated and expensive.

- Environmental impact: studies have shown that, in contrary to common understanding, environmental impacts are in general positive where wave and tidal stream systems are concerned. The study of environmental impacts could be undertaken in a global analysis.

International cooperation

Many of the technological activities would benefit from international cooperation. Where there is a scope for information exchange between industries it is important that this happens on an international level. Some countries have better resources than others and many countries have industries that can help develop ocean energy technologies. Other activities where international cooperation would benefit the future development is: resource assessment (good cooperation can avoid duplication of effort to analyse the resource), testing and certification, environmental impacts (the environmental impacts of ocean energy are similar around the world and so international cooperation to research the different aspects is possible).

Synergies with other technologies

There is a need for investigating possible synergies with other technologies : ocean energy could partly build on the experience of the offshore oil sector for its mooring systems, horizontally rotating axis turbines will benefit from the development in the wind industry and grid connection issues have similarities … . Some of the different technologies have similar issues to consider when commercially developing their technologies. E.g. with regard to coastal management planning there might be a conflict of interest in the different demands on the available space in the sea. One solution could be to explore the possibility of designation of sites suitable for different types of offshore generating plants.

Conclusions

It is the opinion of the ocean energy sector that the expectations from EC with regard to the cost per kWh by 2020 are too ambitious. In the work programme[3] it is stated that the current cost per kWh is estimated to be in the order of 8 to 20 eurocent/kWh.

The Carbon Trust has reviewed the 4.4 M€ it spent between 2003 and 2005 on its research and demonstration programme 'Marine Energy Challenge' and concluded that the current costs of wave electricity are around 33-37 c€/kWh[4]. The report contains learning curves for the expected future costs of wave devices. An investment of about €3.3 bn would achieve electricity generation costs of 9 c€/kWh if the learning rate of the technology were 15%. With so little wave energy capacity in operation thus far, it is rather hard to determine what the actual learning rate is.

The Marine Institute and Sustainable Energy Ireland also commissioned a study of the costs of developing marine energy. The Irish study used 'Pelamis' as the reference offshore energy converter. The company that manufactures it, Ocean Power Delivery, estimates that with an initial installation of 30-40MW, it will be producing electricity at around 23 c€/kWh[5].

An important factor is that the cost of the energy produced is dependent on the local wave climate and so an expected cost/kWh of 0.10 to 0.25 €/kWh, which is comparable with photovoltaic, appears to be a more realistic target by 2020.

From a technological point of view, estimating the installed capacity by 2020 is highly dependent on the support schemes. Assuming a similar support scheme as for solar power, 0.50 €/kWh then 10.000 MW could be installed. However, a mechanism for feed-in tariffs is absolutely necessary to achieve these targets. A reliable mechanism for feed in tariffs has proven to stimulate development and investment. It also reduces the high risk for SME's. In addition, investor incentives are required. Several EU countries already introduced a feed in tariff for other renewable technologies (example Denmark and Germany). For Ocean Energy the UK and Portugal have introduced a combined tariff / capital grant scheme. Ireland envisages the same in the near future.

The European Commission's support is necessary creating a favourable climate for ocean energy, more specifically :

- There is a need for a more realistic approach to setting the cost targets for ocean energy by 2020 and beyond. False expectations will lead to the technology appearing to fail regardless of the progress made. An expected cost/kWh of 0.10 to 0.25 €/kWh is a realistic target by 2020.

- There is an urgent need for a long-term predictable and reliable feed in tariff mechanism and investor incentives. Though maybe preliminary, an EU mechanism for feed-in tariffs would be very beneficial.

- There is a need for a coordinated approach: concerted efforts are needed to tackle technological as well as non-technological barriers to allow ocean energy to develop to its full potential. EC can contribute by providing funding for coordinated research projects.

- There is a need for long term public support to allow developers to overcome the gap between scale testing and commercialisation. The funding periods in FP7 and beyond should be extended to 5 – 10 years or even longer. An alternative could be to provide a funding mechanism that allows subsequent funding periods.

References

[1, 2] Review and analysis of ocean energy systems development and supporting policies, IEA-OEA, 2006
[3] Workprogramme FP7 energy call, call identifier FP7-ENERGY-2007-1-RTD
[4] Future Marine Energy, Carbon Trust, 2006
[5] http://www.ifremer.fr/dtmsi/colloques/seatech04/mp/proceedings_pdf/presentations/5.%20houle/OPDLtd.pdf