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Methods for Utilizing Renewable Energy Resources - Sea and Land Based Energy Converters

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Natural fossil resources for energy production have been utilized for quite some time, with a lot of consequences arising from this action, e.g. occurrence of acid rain, contamination of streams etc. On the other hand, production and society demands energy to be readily utilizable. During the last thirty years or so, renewable resources have become more and more utilized, e.g. wind energy, solar energy, and wave energy, just to name a few. During the last twenty years, the Danish wind turbine industry have been benefiting from this development. At the same time plans for larger on- and off-shore wave energy converting structures have been known. But as this technology has not yet been developed to a commercial level, it has not yet become an important player in the energy market. This must be seen in the light of the potential worldwide wave energy contribution to energy production which has been estimated to be approx. 10 to 50 % of the world's electrical energy consumption.

From theoretical and experimental research, and in close cooperation between universities and private enterprises, a number of on- and off-shore energy converters have been developed. One of the most promising ones is the Wave Dragon device, representing a sea based wave energy converter of the overtopping type. Deployment of such devices, with dimensions varying according to the expected wave-climate at the deployment site, is most suitable at areas with a water depth of min. 25 m, in order to be able to take advantage of high energy ocean waves. The deployment of a 4 MW power production unit is scheduled to take place in 2008 off the coast of Wales. The power production of such a device, when deployed in a 24 kW/m wave climate, will be approx. 12 GWh/y. In Denmark the consumption of electrical energy is approx. 36 TWh/y (2005) with 18 % of the consumption covered by renewable energy sources (primarily wind). This share is expected to increase further. If e.g. another 10 % of the consumption were to be covered by Wave Dragon devices (4 MW units placed in the most energetic part of the Danish sector of the North Sea), a total of approx. 310 units would be needed. If these units where deployed in line with appropriate spacing between them, the line will be approx. 150 km long. However, since these devices would only extract approx. 11 % of the wave energy passing the line, it is possible to cut up the line and place segments behind each other.

It is probable that such plans would run into opposition by different organizations and stresses the importance of further research on the topic. The same holds true for the development and later deployment of on- or near shore converters, such as the Seawave Slot Cone-Generator (SSG). This device is a bottom fixed structure well suited for integration in a breakwater, but can also be deployed on a suitable coastline. In a 24 kW/m wave climate the expected power production is approx. 52 MWh/m/y. The deployment of a 10 m wide prototype of this device is scheduled within 2007. Thus, in this case a line of 70 km of SSG's would be needed to cover 10 % of the Danish electricity consumption. However, it should be noted that going from offshore to near shore conditions typically reduces the wave energy available dramatically, unless deep water is present all the way to shore, which complicates direct comparison between the Wave Dragon and SSG.

The presented facts motivate a comparison between the area usage pr. produced kWh/y for different renewable energy sources placed at sea vs. location on shore. Furthermore, it underlines the need for research into increasing the efficiency of wave energy converters in order to meet the future demands of sustainable energy production is needed.