



OTC 19093

## Wind Energy Construction and Operation Experiences From North European Offshore Wind Farms

Jens Wittrock Bonefeld, DONG Energy E&P

Copyright 2007, Offshore Technology Conference

This paper was prepared for presentation at the 2007 Offshore Technology Conference held in Houston, Texas, U.S.A., 30 April–3 May 2007.

This paper was selected for presentation by an OTC Program Committee following review of information contained in an abstract submitted by the author(s). Contents of the paper, as presented, have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material, as presented, does not necessarily reflect any position of the Offshore Technology Conference, its officers, or members. Papers presented at OTC are subject to publication review by Sponsor Society Committees of the Offshore Technology Conference. Electronic reproduction, distribution, or storage of any part of this paper for commercial purposes without the written consent of the Offshore Technology Conference is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of where and by whom the paper was presented. Write Librarian, OTC, P.O. Box 833836, Richardson, TX 75083-3836, U.S.A., fax 01-972-952-9435.

### Abstract

The construction of offshore wind farms in Northern Europe commenced in the early nineties. In the beginning, only minor test offshore wind farms were built, but from 2002 and onwards, large-scale offshore wind farms have been erected. Construction and operation experiences from these wind farms are now being collected, and this paper discusses construction and operation experiences obtained from selected offshore wind farms. Differences and similarities between the wind industry and the oil and gas industry are discussed with a view to raising the awareness of this new and growing industry among market players in the oil and gas industry.

### Current status and plans in Europe [1]

In the European Union (EU) the development of wind power is very impressive. Over the past five years, 30% of all newly installed electricity generating capacity has been wind power. The installed capacity is now 40.5 GW, and the generated power is enough to supply 21 million households. However, wind power still only covers 2.8% of the total European electricity demand.

Only 680 MW of the above-mentioned 40.5 GW capacity are installed off shore. Recent projections of the future development suggest that by 2030 the installed capacity may reach 300 GW of which 150 GW are expected to be installed off shore. Whether the targets for offshore wind power will be met depends crucially on technology development, grid infrastructure and the existence of political incentives to encourage investments.

A renewables target of at least 20% of EU energy by 2020 will be a significant driving force behind this development. It will only be possible to meet this target with a strong contribution from wind power. Another driving force behind the wind power development is the increase in fossil fuel prices.

### Current status and plans in Denmark [2]

Denmark has been and is still a frontrunner in the development of on- and offshore wind energy. Only in Denmark, Spain, Germany and Ireland does wind power cover more than 5% of the electricity demand. In Denmark, the actual figure is close to 20%.

The installed capacity is 3100 MW of which 420 MW are located off shore (two large-scale wind farms contribute 325 MW). Recent wind farm developments have been located off shore, and future plans aim to expand offshore wind power event further. Currently, investment decisions to erect two offshore wind farms of 200 MW each are in the pipeline.

### Challenges going off shore

The main reasons for going off shore are access to large energy resources and potentially less complicated planning processes. Although the wind resources are vast, the investment in foundations and electrical infrastructure (cables and substations) are dramatically higher than for onshore wind farms, and operation costs increase as well. At first glance, the planning process, including the environmental statements, seems to be easier off shore, but experience shows that there are many stakeholders in the offshore areas, who make the offshore process as difficult as the onshore process.

The project economy in the offshore wind power projects is governed by some key conditions: soil conditions, wind climate, wave climate, water depth, distance to shore, distance to the main grid, available turbines and turbine size.

Increasing the turbine size will decrease the number of foundations and array cables necessary to obtain the same installed capacity. Developers put pressure on manufacturers to develop larger machines, and there is internal competition between the manufacturers to be in front. This has resulted in some severe problems, and the fact that large turbines create large design challenges has made the developers and manufacturers more humble and cautious.

An offshore wind farm consists of many small installations, and therefore the installation process is difficult, because the installation equipment must carry out many operations (positionings, jack outs, jack ins, lifts). The number of suitable