

The future goes offshore...

Robert Hoyer, Henry Römer, and Jonathan Saudhof

Abstract—Within the renewable energies wind parks are playing an important role. Since onshore wind energy market is already high developed and concerns are more about repowering, offshore wind plants have gained enormous popularity. In consideration of the high potential German government set the target to accommodate 15 percent of the energy demand with the help of offshore wind plants in 2030. Despite the high potential there are still risks and problems hindering the installation of huge offshore plants. In fact there is still no such wind park completely installed in Germany.

Index Terms—Economic potential, offshore, Renewable energy, wind energy

I. INTRODUCTION

Germany is one of the leading countries in using renewable energy. The German government and others try to reduce their CO₂ emissions rapidly. Besides expanding solar- and photovoltaic techniques the main energy source is wind power. 2005 4.3 % of the produced energy were generated by onshore windmills [3]. In the future the expansion and new installation of those wind farms is limited due to the present legal conditions for ecological safety. In this context new ways are going to be approached. Offshore Wind parks are actually the best choice to extend the use of wind power simultaneously with an increase of efficiency.

The advantages of these offshore solutions in contrast to wind parks are the stable and higher level of wind speed. Currently the using of wind power is connected with occurring gaps between generated power and the actual system load due to the onshore wind speed fluctuation.

Actually in Germany no offshore projects have been realized yet. 2008, the installation of the first test park “alpha ventus” has been started. Twelve wind turbines with 5-6 MW turbines are going to be built in 30m depth [1]. In the international comparison of realized offshore projects Germany shows that

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the installed number of turbines in Germany is irrelevant to the United Kingdom with 591 MW, Denmark 426,35, Netherlands with 246,8 MW and Sweden with 132,5 MW [2]. The prognosis says that a possible capacity of 20000 up to 30000 MW can be realized. In long terms offshore wind power will affect the market of renewable energy sources [4].

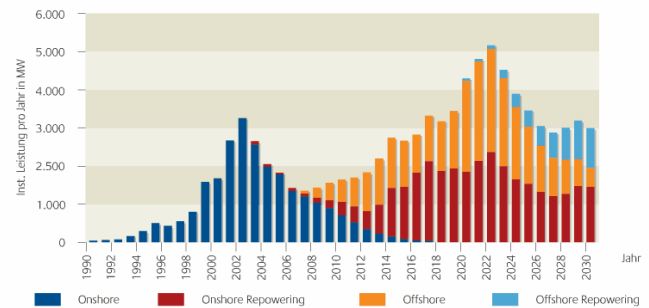


Fig. 1 Development of renewable energy

Chances:

Wind speed and development:

As mentioned before the less fluctuation and higher wind speed is a major advantage of offshore wind parks. This means a push of generating efficiency and the possibility that wind turbines can supply with base load current.

Figure 2 shows the differences in wind speed per minute depending on the geographical location and gives an inside of benefits from those installations.

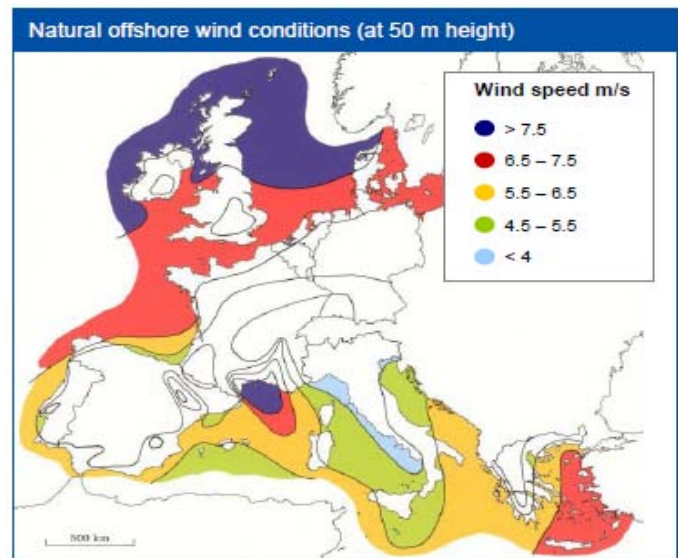


Fig. 2 Offshore wind conditions in Europe

The future of windmills in Germany is in offshore farms. New installations of onshore turbines will be stopped due to the present legal conditions for ecological safety. This means a limited size for turbines because of their air noise emission and the casting of shadow. The target for Germany is to explore and lead the market after the United Kingdom within the next years. Figure shows the size of installed turbines planned till 2015.

Parallel to reducing new installations repowering is going to be the key for increasing the efficiency of existing windmills. Learning effects in various technical sciences will determine the development of future turbines. Material science, Aerospace and experiences in the installation of offshore platforms will highly influence the future offshore wind parks. A project actually presented in the press called 'FloDesign Wind Turbine' is a new way for designing windmills to maximize the used wind power.



Fig. 3 Operating offshore wind farms

II. ECONOMY

The initial costs of wind energy onshore have drastically decreased because of the gradual technical advancement of the arrangements. In Germany the costs of wind energy arrangements per kilowatt of achievement were lower according to the federal association Windenergie inc. in 2000 almost around half than still in 1990. According to the European wind energy association EWEA the actual costs of modern wind strength arrangements in good wind locations are at the moment to 5.1€cent / kWh. Up to 2013 3.2€of cent / kWh are accessible according to this association in such locations [5].

a) Actual cost of power generation

In 2001 the external research project of the European commission came to the result that the average stream actual costs amount to 4€of cent / kWh in the European Union. The Institute of energy industry and rational energy use (IER) of the University of Stuttgart estimates the stream actual costs

for gas and steam power stations established in 2005 at 3.6€ cent per kWh. For brown coal-fired power stations the IER comes on approximately 3.1 and for coal-fired power stations on approximately 2.8€ cent per kWh. According to the external investigation done by the IER in Germany, the external costs of the stream production of coal or brown coal amount from 3 to 6€cent per kWh. Wind energy – onshore or offshore - has extremely low external production costs in comparison.

Average stream actual costs in the EU	4 €of cent/kWh
In 2005 established gas and steam power stations	3,6 €of cent/kWh
Brown coal-fired power stations	3,1 €of cent/kWh
Coal-fired power stations	2,8 €of cent/kWh
Additional external costs for coal-fired power stations and brown coal-fired power stations in Germany	3 – 6 of cent/kWh

b) Present Offshore experiences

For the first smaller Offshore-wind parks close to coast stream actual costs have been determined abroad in the area from 6 to 8€cent. Besides, the later projects show a sinking trend. The DEWI (German Wind Energy Institute) has published estimates, for which the planned wind parks in Germany, standing 40 kilometers far from the coast remotely will reach stream actual costs of from 7.4 to 8.1€cent per kWh. At the moment installed power is 2 MW [5]. However, the applications planned from 4 to 5 MW arrangements what will lead probably to a lowering of the costs in the future.

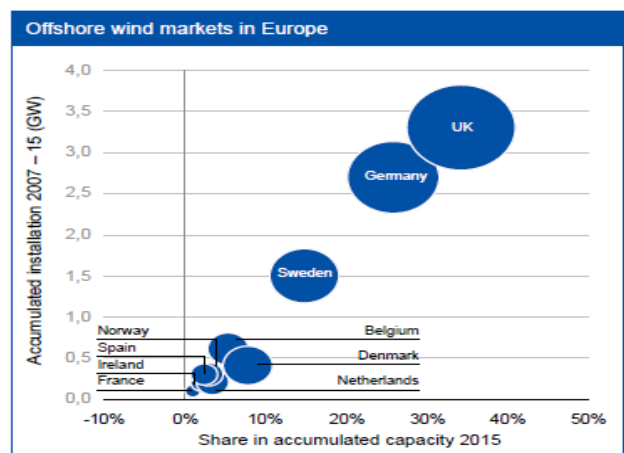


Fig. 4 Offshore wind markets in Europe

III. RISKS

Despite the fact offshore wind energy to be a solution with high potential within the renewable energies it is still facing a variety of problems to solve. On the one hand there several

concerns about how offshore wind parks may influence the maritime environment negatively. Among conservationists the threat of collision of birds with rotor blades are mentioned as well as their displacement from their native environment. In fact there is still no scientific evidence of a high rate of collisions. Indeed Danish researchers with the help of their Thermal Animal Detection System (TADS) could show that the number of incidents is quiet small. Nevertheless this problem is considered to be locally different. But not only birds seem to be threatened. Sea fish and marine mammals may suffer the artificially created magnetic and electric fields by the cables connecting the plants offshore with the electrical network. For this reason these animals such as whales might lose orientation. Additionally benthos are losing their habitats because of the building of the fundament at the ground of the sea [6]. Nevertheless research in this field is ongoing, e.g. considering the research station Fino I near the Island of Borkum, Germany and there is still no conclusion [8]. But there are not only environmental concerns to deal with. The installation of wind parks is still not only a technical challenge but a financial risk as well [7]. A wind park planed consisting of 150 to 180 plants by the German Enterprise RWE near the island of Juist will take an investment of ca. 2.8 Billion Euro. Aware of that fact high investments are needed only the huge energy provider will be able to build the first commercially used offshore wind parks. The installation of wind parks is much more complicated and referring to that expensive. Installing a 1 Megawatt plant offshore takes about 2.5 Million Euro, two times the price for a plant to build onshore [9]. According to a study by Price Waterhouse Coopers (PWC) financing offshore projects suffer two significant problems. First there has been a high increase of investing costs due to higher price for natural resources, especially steel and copper. Furthermore the increasing demand for onshore plants has raised the price for offshore plants too since these are technically based on onshore technologies although there have been built prototypes specially designed for offshore operation. Additionally the uncertainty of investment and maintenance cost at the beginning of a project is still an obstacle for potential investors considering that the experiences regarding wind parks far from the shore in thirty meter depth are low. The second issue concerns the so called interface problem. An offshore project joins a number of enterprises for building the wind park whereas onshore plants are built by one corporation normally. Next to the plant the building of the electrical and structural connection has to be done too. But these different works refer to different amount of risk. The organization of the project must guarantee a fair distribution of risk for any enterprise within it in order to make enterprises invest and reduce risk surcharge. A very important point determining the economic success of offshore projects refers to maintenance. Because plants are located at difficult accessible locations availableness is threatened in the case of technical breakdown. So, in fact there might be the problem of delayed repairs when weather conditions are bad [7]. Another risk pronounced by inhabitants of cost regions is

the peril of collisions with oil tanker leading to environmental catastrophes.

IV. CONCLUSION

Although Germany is supposed to be the vanguard considering renewable energies, especially in wind energy it has lost this role in the field of offshore wind parks just by taking a look at the number of installed plants. First commercially used plants are already running near the costs of its European neighbors Great Britain and Denmark [10]. At least there is no doubt offshore wind energy will face a high growth during the next years in all countries verging on to the sea. Nevertheless with the construction of the Alpha Ventus wind park by the German RWE a large step for the future of offshore wind energy has been done.

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REFERENCES

- [1] Dena (2009, February). Internationale Windprojekte: <http://www.offshore-wind.de/page/index.php?id=4765&L=0&fs=1>
- [2] Deutsche Windindustrie in Deutschland (2009, February). Onshore-Windenergie und Repowering: <http://www.deutsche-windindustrie.de/fakten/onshore/index.html>
- [3] Dena (2009, Februar). Offshore-Testfeld alpha ventus: Deutschlands erster Windpark auf dem Meer: <http://www.offshore-wind.de/page/index.php?id=9352&L=1&fs=1&L=0>
- [4] Köller, Julia. Offshore wind energy. Berlin: Springer, 2006
- [5] Dena. (2009, February). Fakten Wirtschaftlichkeit. Available:<http://www.offshore-wind.de/page/index.php?id=2601>
- [6] T. Merck, H. v. Nordheim (1999) Probleme bei der Nutzung von Offshore-Windenergie aus Sicht des Naturschutzes. German Journal of Hydrography Supplement 10
- [7] J. Ondraczek, H. Stohlmeyer, S. Küver (2006). Finanzierung der Offshore-Windenergie in Deutschland: Probleme und Lösungsansätze. Available: <http://www.PWCglobal.com>
- [8] D. Asendorpf. (2008, June). Viel Energie auf hoher See. Available: <http://www.zeit.de/2008/27/windpark>
- [9] M. Uken (2006, November). Riskante Wellenbrecher. Available: <http://www.zeit.de/online/2006/46/Offshore-Windkraft>
- [10] RWE (June, 2008). Fact Book Renewable Energy Available:<http://www.rwe.com/web/cms/de/184208/rwe/innovationen/services/infothek-forschung-entwicklung/>