Till Jeske

ALTERNATIVE GRID EXTENSION MEASURES DUE TO ADDITIONAL OFFSHORE WIND ENERGY IN THE GERMAN NORTH SEA - A MODEL WITH PARTICULAR CONSIDERATION TO CROSS-BOARDER FLOWS TO BENELUX COUNTRIES

Dresden University of Technology, Department of Business Management and Economics, Chair of Energy Economics
D – 01069 Dresden, Germany Phone: +49-(0)351-463-39767, Fax: +49-(0)351-463-39763
E-mail: till.jeske@mailbox.tu-dresden.de, www.ee2.biz

Overview

In Europe and especially in Germany the deployment of renewable energy sources experienced significant progress over the past few years. Due to relatively low production costs especially wind energy seems to get a substantial part of the future energy supply. With a price-driven feed-in tariff scheme and long time stable tariffs the installation of 17 GW of onshore wind energy in Germany could be made possible[1]. A chance for further growth of wind energy in Germany is the utilisation of offshore wind energy mainly in the German North Sea. The DEWI (2005) and DENA (2005) studies forecast about 9 GW of additional offshore wind energy capacity up to 2015[2].

The decentralized installation of high fluctuating wind power capacity at low demand areas, that are mostly located in Northern Germany, gives rise to a new challenge for grid operators and stakeholders, for the grid has been designed for centralized generation. The current is mostly sold via contractual flows to South Germany or neighbouring countries. The real physical flows follow Kirchhoff's law and lead to cross-boarder flows that stress the grid, in particular of the Benelux countries and of Northern France. Stakeholders agree that grid extension measures have to be realized. The study of the German Energy Agency (DENA) identifies weak lines in the grid under several scenarios and proposes upgrades and additional installation of transmission capacity[3]. This approach may fix national problems but does not solve the issue of highly stressed grids of UCTE neighbouring countries, especially the Benelux.

Methods

The objective of this study is the comparison of the efficiency of grid extension measures. Two Scenarios and the status quo are compared: the DENA-approach, and an own approach that provides an overlay grid using high voltage direct current technology (HVDC) for the transport of additional offshore wind energy directly to high demand areas in South Germany. The aim of the HVDC approach is to minimize the utilization of the Benelux grid. For this purpose, each offshore wind farm has its own offshore HVDC converter station and a low section cable that transports the energy to an offshore-located bus that cumulates the energy wind farms close to the bus produce. From the bus the energy is transported via one bipolar HVDC cable directly to a converter station located in a high demand area (e.g. Frankfurt). To assure maximum transmission capacity over long distances a voltage level of 500 kV is chosen.

Furthermore, the study compares the effects of the different approaches on the grid of the Benelux countries in 2015. For this purpose a model based on a simplified static UCTE grid topology including all lines and nodes within the investigated area has been programmed in

[1] DEWI (Hrsg.) (2005) S. 24

[2] z.B. DENA (Hrsg.) (2005); DEWI (Hrsg.) (2004)

[3] DENA (Hrsg.) (2005)

GAMS. We use a DC load flow model following Schweppe et al, (1988) and Stigler and Todem (2005) that neglects reactive power[4].Investment costs, social welfare and possible sanctions of the UCTE board for disproportional grid utilisation of the different scenarios in 2015 are calculated and analyzed via a long-time economic evaluation.

Results

First model runs seem to indicate that the grid of neighbouring countries will be highly stressed under additional 9 GW of offshore wind energy in 2015. Even at the status quo the neighbour grid is used disproportionally high at times with strong wind. Simple grid extension measures, as recommended by DENA, do not produce relief. Regarding the HVDC overlay-grid scenario, the expected finding that additional cross boarder flows can be avoided could be approved. The approach avoids the laying of up to 50 parallel submarine cables through the ecological highly sensitive German wadden sea and results in investment reduction of about one billion Euros. Furthermore the long-time economic evaluation seems to show that total costs for society are lowest and welfare is highest when using the HVDC overlay-grid approach.

Conclusion

Fixing holes in the German grid, as recommended by DENA, is perhaps not cost-efficient. The HVDC approach seems to be the more efficient way a) to fix the problems of cross-boarder flows to Benelux and b) to minimize additional social burden. The condition for a realistic practical implementation of the HVDC approach is an expansion of the postulated discrimination free unbundling on the German renewable energy act (EEG). By providing grid access by the utility, the feed-in tariffs can be lowered and the presently existing investment hold-up in offshore wind energy could be eliminated.

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[4] SCHWEPPE, F. C. et al (1988); STIGLER, H.; TODEM, C. (2005)