Opportunities and Challenges for the Repowering of Onshore Wind Energy Power Plants in Germany

Masterarbeit

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1 Introduction

The Federal Republic of Germany (BRD) has committed to very ambitious climate change targets with the ratification of the Kyoto Protocol in 1997 and in the following years.[1] By 2020, the greenhouse gas emissions should be reduced to 40% compared to those in 1990. The use of renewable energies shall support this aim by decreasing the CO_2 output. Renewable energies are supposed to generate 35% of the total energy demand by 2020. The fact that global resources of fossil fuel are limited as well as environmental catastrophes such as Tschernobyl and Fukushima further increase the political pressure to the point of ‘green’ energy. In contrast to the fossil fuel the renewable energy resources are infinite. Although there are many problems with generating and transporting these energies, the development has proceeded significantly in the recent years. The commercial viability greatly increased as well.

1.1 Research field and motivation

In order to achieve these environmental aims, wind energy is one major factor. In the 1980’s Größte Windanlage (engl.: biggest wind plant) (GROWIAN) was built, a 3 megawatt (MW) research plant, to expand in extreme construction sizes. Despite the fact the GROWIAN was a technical and economical failure, these defects were analyzed so that today, this plant size is manageable. Even 5-6 MW turbines are now ready for mass manufacture.[2] Over a long period of time wind farms are built only within the country. For several years, on sea (offshore) wind farms were built, abroad as well as in Germany´s North and Baltic Sea (e.g. Alpha Ventus, Bart 1/2, further are under construction). Newer offshore farms are technically matured. On the one hand the return is significantly higher. But on the other hand the installation and maintenance costs are higher than on land (onshore). Therefore the investments are arguable. One major disadvantage of offshore wind farms in Germany is the missing infrastructure for electricity. Currently, the energy is mainly produced in the northern Germany but the infrastructure to carry it down south is not available. The decentralized onshore wind power plants do have a significant advantage because

[1] Cf. Landeszentrale für politische Bildung Baden-Wüttemberg (2013).
[2] Cf. ZDF (2013); cf. Agentur für Erneuerbare Energien e. V. (n.d.a).

they are spread all over the country and thus the existing power grid can be used. However, most of the onshore wind farms are out-dated and no longer in the current state of technology. As new locations for wind farms are hardly approvable, the so-called repowering of wind farms is an important phenomenon. Ultramodern and efficient farms with high performance are replacing the existing, old farms. The existing infrastructure of power grids can be used even though they probably have to be modified and because of higher capacities. Due to the increased benefits of repowering, the investments get more interesting for stakeholders such as operators and communities. Therefore, challenges and opportunities for repowering onshore wind farms shall be analyzed in this thesis followed by the development of an approach to solve the problems for investors, operators, economy and environment.

1.2 Research question and methodical approach

The question, which induces the transition change into renewable energies, is about how to enlarge the wind energy. Possibilities are offered by offshore and onshore technology. The onshore wind energy is the focus in this thesis. There are two opportunities of onshore wind energy: To enlarge the wind energy, new wind power plants can be built or out-dated wind power plants can be replaced. Because of the fact that potential areas for onshore wind power plants are already engaged, the repowering is a chance to expand the use of wind energy. By repowering, existing locations can be used. Accordingly, the research question is: How can the adequacy of repowering and its financial implications, especially profitability be evaluated? The basics will be represented relying on theexisting literature to get a brief overview and understanding of the subject. The most important aspects will be named, which concerns among other the approval of the repowering. Based on this, a process model will be developed, the so-called phase model. It illustrates the several key steps of a repowering project which are essential to implement the wind power plants. Referring to the model, different dimensions will be analyzed with the help of interviews with professionals. At last, exemplary calculation of two wind power plants will highlight the financial implications of a repowered farm compared to a continued old farm. An open questionnaire was used. When the professionals got no qualitative answer, the questions are specifically and more closed. The professionals gave intensively answers in addtion to the aked questions. With the questionnaire, four dimensions can be analyzed.

Finally, a calculation of two wind power plants shall mention the usefulness and opportunities for the repowering. In this calculation two main indices are significant, which are calculated by formulas. The essential indices are the Net Present Value (NPV) and the Return On Equity (ROE). To calculate the NPV, several models have to be included into this index to get an expressive value. The model is the discount rate by the weighted average cost of capital (WACC), which is included in the NPV. To calculate this rate, the capital asset pricing model (CAPM) is necessary. The ROE is the most interesting value for investors. All in all, this thesis includes descriptions about the repowering by literature, a qualitative phase model, a qualitative analysis by interviews and a quantative calculation.

1.3 Research design

The research design represents the sequence of the methodical research steps. In the course of this thesis different types of methodical instruments have been applied. An extensive literature research is the basis. A structured summary of the details concerning onshore wind energy are presented. Further examinations have been conducted for the explanatory part of this thesis. An open questionnaire containing several dimensions of the topic has been developed. 10 interviews based on this questionnaire have been conducted with 10 people, practitioners and other experts. Furthermore, a phase model displaying the repowering process in detail has been developed. After conducting the qualitative interviews an example based on the information from the interviews is calculated to further analyze the financial impact of repowering projects. In this context two financial indices are decisive. All in all, four different methods have been applied in a logical sequence. Altogether this allows a profound conclusion on the opportunities and challenges of repowering wind power plants.

to be hard work for the communities as they have to revise the areas of existing wind farms which can be repowered. The communities should regard the opportunities to restructure the locations efficiently.

A further aspect is the acceptance of repowering by the residents or the society in general. Further participation opportunities in repowering projects should be developed. When the acceptance rises, less doubts will exist in the course of the approval procedure. So fewer discussions are necessary and the duration of appoval procedure is shortened. Thereby, the planning securities rise as the risk of political changes during the time of planning is reduced. Also an unique lease system has to be developed, because of preventing envy. Wind power areas are very demanded and therefore the lease costs are high and varying extremely.[234]

Repowering is a modern concept and is not applied for avery long-time yet. The experience with exsting old plants can be used. But for several questions and information lacks, a central consulting and service point would be helpful to inform about repowering and the whole process including the problems, opportunities, opportunities, current regulations and restrictions. By an improved information lost investments could be reduced. Furthermore, conflicts can be reduced by including further stakeholders. So the acceptance increases as well.[235]

7 Conclusion and outlook

The energy transition into renewable energies is a fixed subject. The federal parliament has the goal to generate 80% of the consumed electricity by the renewable energies till 2050. But this is a burden in some way. A majority of the electricity produced by renewable energies comes from wind energy. New offshore wind farms, new onshore wind farms and also the repowering of existing wind power plants are in the focus of the government. These technologies are subsidized and the produced electricity gets a high remuneration. In this thesis, one strategy to reach

[234] Cf. WindComm Schleswig-Holstein (n.d.), p. 8.
[235] Cf. Rehfeldt,K. / Geile, A. (2009), p. 108.

these governmental goals is to repower out-dated wind power plants. To answer the research question the following conclusions can be drawn. The government supports repowering with an incentive for every produced kilowatt hours, if the restrictions are accomplished. The total remuneration for these projects is very interesting for operators of wind power plants. But for the government, the repowering projects are very significant as well. One reason is that the power grids are less strained by modern wind power plants than by out-dated wind power plants due to a more constant electricity production. Because of contemporary overload, old wind power plants cause the erosion of the power grids. So, the new wind power plants are a chance to support the power grids. Further opportunities are the reduction of single old wind power plants in the lanscape. By eliminating them, the location can be restructured. Communities have to restructure the existing locations and therefore improve the renaturation of the lanscape. Furthermore, by repowering the commercial tax will rise. This is a chance for the communities. Finally, the employment market and the independence of the imported resources is supported by repowering.

Despite the opportunities, several challenges are prevalent, too. First, the power grids are supported by the constant electricity production. But for this purpose the power grids have to be modified and expanded in the whole country. In addition, the electricity has to be used efficiently to prevent from transporting the surplus electricity to foreign markets. Furthermore, the planning of repowering projects requires professionals to ensure a quick approval. This is a challenge because many restrictions and regulations influence the approval procedure. A further challenge is the exact planning of the electricity production by the wind power plants. If the electricity demand could be predicted exactly, the need of energy by conventional plants can be planned more precisely. This would prohibits the varying capacities for power grids.

In conclusion, the repowering is a high technology concept and essential for the future. By repowering, several opportunities can be effected. With this technology, the climate aims can be supported. It is indispensable to replace the out-dated plants. Also the location can be used more efficiently by restructuring them. For sure, challenges exist, but it is essential for the future to repower. The storage of electricity is an important aspect for the future. In the short run, the planning are focused, but in the long run, the storage is even more important. If the goals are reached that 80% of the electricity need are satisfied by renewable energies, the energy storage is the next huge challenge. The technologies of the renewable energies such as the wind technolgy are dependent on the weather. The storage of electricity can counteract the volatililty of production due to weather changes. Because of this, the most important opportunities for renewable energies, especially the wind energy is seen in the storage of energy in the future. The storage has to be a parallel point with the repowering for the expansion of the energy transition.