Risk Management for Offshore Wind Energy Projects: A Key Figure Analysis

Bachelorarbeit

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vorgelegt von

Name: Lange Vorname: Stefan

[redacted] [redacted] [redacted] [redacted]

Prüfer: Prof. Dr. M. H. Breitner

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1 Introduction

The awareness of climate change in the public and the policy area has grown over the past few years. Therefore, the change in the energy landscape from burning fossil fuels to renewable energy is one of the key targets of the German government. In this context, the importance of Offshore Wind Energy (OWE) is going to increase: it is expected to reach 10 GW by 2020.[1] However, the current capacity is only 268 MW.[2]

This increased importance of OWE raises questions about the financing. In order to reach the 10 GW capacity goal by 2020, a total investment volume of EUR 30 bn is required. With EUR 130 bn, the global investment volume over this time horizon is even bigger.[3] But after the global financial crisis of 2008/2009, financing conditions from banks deteriorated. Traditional investors in energy plants, i. e. utility companies such as RWE or E.ON, seek to share the risk and equity requirements that come from offshore wind parks.[4] Therefore, alternative financing forms in which financial or strategic investors take a share or even develop the project as a joint venture are projected to become more important.[5] This means that projects are conducted in the realm of project finance, in which the risk factors for all involved parties are accounted for.[6] Previous research has identified the amount of energy that is produced as one of the key risk factors.[7] Because of the high upfront costs of investing in OWP, they can only be profitable if significantly more energy is produced than at onshore wind parks, which have lower upfront costs.[8]

[1] Cp. KPMG (2010, p. 3)
[2] Cp. Burger and Bruno (2013)
[3] Cp. Roland Berger Strategy Consultants (2013, p. 5)
[4] Cp. *Ibid.,* p. 17
[5] Cp. *Ibid.*, pp. 17–18
[6] Cp. Uken (2011)
[7] Cp. Madlener, Siegers, and Bendig (2009, p. 141)
[8] Cp. Koukal and Breitner (2012, p. 8)

1.1 Central Research Question and Methodical Approach

This leads us to the central research question. In other previous research[9], the key figure "full load hours" (FLH) has been used as a proxy for energy production. But this key figure is an aggregate key figure, as it incorporates both the possible energy production from the wind and the technical availability of the wind turbines. Thus, it becomes difficult to assess the adequate probability distribution, the distribution parameter and the site-specific conditions.

A different approach is suggested in this work which involves splitting up this key figure in two parts: The theoretical maximum amount of energy that the turbine can generate from the wind, which depends mainly on the distribution of the wind at the site, and the limitation of this amount by several factors such as technical availability or the positioning of the wind turbines at the offshore wind park.

The first part of this work will lay out the theoretical foundations of project and risk management as well as the distribution of wind speed. Afterwards, this information is used in a discounted cash-flow model (DCF), which is extended by a Monte Carlo Simulation (MCS). On top of that, the case study of a fiction wind park from Koukal & Breitner (2012) is used and the results from the first chapters are incorporated. The results from this analysis are compared to the classical FLH analysis and advantages and limitations for this presented approach are shown. Finally, the central research question, i. e. whether this approach is more appropriate to use than the standard FLH approach, is answered and discussed.

[9] Cp. Koukal and Breitner (2012)

7 Conclusion and Outlook

An improved way of deriving key figures for the risk management and project value calculation of offshore wind parks is suggested in this work. Instead of using the aggregate key figure of full load hours, the underlying factors are analyzed, which is mainly the wind distribution and the technical availability.

In order to gain an understanding of the wind distribution, the Weibull probability distribution of the wind is introduced and their defining parameters are derived from wind data. Furthermore, analysis of technical availability reveals that it can be separated in three distinct phases: for about five years, it increases and is followed by a time of a constant technical availability. In the last years of a project, TA declines again.

Using this information, a DCF analysis and Monte Carlo Simulation of a fictitious wind is conducted in order to derive the probability distribution of the project value. The results differ greatly from the standard analysis of previous research that use full load hours, as the mean project value and the $CFaR_{95\%}$ become significantly lower. Furthermore, the probability that the project does not break even is increased from approximately 8 percent to 29 percent. A higher Kurtosis of the probability distribution also indicates that extreme events happen more often.

The discussion of the validity of the results remains open. On the one hand, the input parameters are much less artificial than the input parameters from the previous FLH analysis. On the other hand, as there is no probability distribution of the project value that can be observed in reality, the better input parameters alone must serve as a justification for using the proposed approach.

These findings are of significant importance for all the involved parties of project finance. While previous research draws a pretty favorable conclusion with regards to project finance of offshore wind parks, these findings suggest that the projects are more risky than previously anticipated. Whether OWP still offer a favorable risk-reward-ratio is subject to further research.

In addition to this, this work underlines the importance of conducting throughout analysis of the site-specific conditions of key figures. As explained in Section 6.3, differences in the Weibull shape factor have a huge impact on the project value. This factor might also impact the construction time and O&M expenses, which were not part of this analysis. Furthermore, a correlation analysis of the weather conditions and technical availability is yet to be conducted.