Demand for special vessels for the decommissioning of offshore wind turbines in the German North Sea: A simulation study

Thies Beinke¹*, Abderrahim Ait Alla¹, Stephan Oelker² and Michael Freitag¹,²

¹ BIBA – Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Bremen, Germany
² University of Bremen, Faculty of Production Engineering, Bremen, Germany

ABSTRACT

Offshore wind turbines are designed for a lifetime of 20 to 25 years. Therefore, many wind turbines will have to be removed from the German North Sea and Baltic Sea in the next few years without leaving any residue. With alpha ventus and BARD Offshore 1, two wind farms have already reached about half of their useful lifetime. On the one hand, this process is complex and, on the other hand, requires high efforts of resources within a harsh maritime environment. Due to the high costs of the required installation vessel, the decommissioning must be as efficient as possible. Moreover, the installation vessels could be a limiting factor. They might be requested by other industries and are also required for the installation of new offshore wind turbines. Besides, weather windows with special weather conditions will also be needed for decommissioning. Based on this motivation, a simulation study was carried out which considers the decommissioning of wind turbines in the German North Sea. Real wind farms as well as weather restrictions and process times are taken into account. The results of the simulation show how many additional resources will be needed for the decommissioning of offshore wind turbines in the coming years.

KEYWORDS: Offshore Wind Energy, Decommissioning, Simulation Study.

INTRODUCTION

The German government has the aim that renewable energies should cover 80 percent of the electricity supply by 2050 (Deutsche WindGuard, 2019). Offshore wind energy plays a key role here, with 6.5 GW to be installed at sea by 2020 and 15 GW by 2050. These targets have already been met or exceeded, with 1,407 turbines or around 7 GW having been installed by June 2019 (Deutsche WindGuard, 2019). However, the lifetime of the plants is only 20-25 years. Afterwards, the plants must be dismantled without any residues according to the guideline of the Federal Maritime and Hydrographic Agency (BSH, 2019). Assuming a lifetime of 20 years, more than 1,000 turbines have to be decommissioned between 2030 and 2040, alone in the German North Sea and the German Baltic Sea.

So far, virtually no turbines have been decommissioned in the deep sea. Therefore, there are no valid concepts for the decommissioning of offshore wind turbines. It is also not known what unexpected challenges will arise. It is also possible to extend the term, repower or decommission the turbines. No matter which variant is chosen, the decommissioning of the turbines always takes place at the end. Special vessels are required for the decommissioning of the turbines. It can be assumed that the decommissioning will be similar to the installation of the plants and that an installation ship will be needed for the decommissioning of the plants. These installation vessels have a very high charter rate, which is between 70,000 – 145,000 EUR per day (Haselsteiner et al., 2018). In addition, these vessels are also used in other industries like oil and gas. Therefore, there is a limited availability on the market.

Based on this motivation a simulation was developed in this paper, which simulates the decommissioning of wind turbines in the German North Sea. In particular, it considers how many installation vessels are needed for the decommissioning and how high the workload of these vessels is.

METHODOLOGIE

In this paper, an agent-based discrete event simulation model is proposed. This research considers the decommissioning process as a reverse process of the installation process. As empirical values for the decommissioning process are not available yet, the processing times and operation restrictions are derived from the installation process as given in Beinke et al. (2017). It can be assumed that certain processes in decommissioning will in reality take more time and others less. Therefore, the times for the erection of a plant are a first assumption for the simulation.

The purpose of this study is to analyse the impact of tactical decisions on the number of used vessels depending of the weather conditions during the decommissioning phase in order to reduce the costs of decommissioning. For the simulation study, a 50-year weather data set is used.

Compared to Beinke et al. 2018, the focus of this paper is not on the differences within an offshore wind farm (OWF) but on the deconstruction of an entire sea area. The German North Sea is considered as an application example.

STATE OF THE ART – DECOMMISSIONING

In the North and Baltic Seas, only one wind turbine was decommissioned so far. It was a 5-MW test turbine, which was located near Hooksiel. The turbine was located in shallow waters and was only 500 meters away from the dike (Weinhold, 2018). Accordingly, it was a near-shore turbine, which means that the knowledge gained could not be easily transferred.