IOP Conf. Series: Journal of Physics: Conf. Series **1222** (2019) 012033 doi:10.1088/1742-6596/1222/1/012033

Lifetime Extension, Repowering or Decommissioning? Decision Support for Operators of Ageing Wind Turbines

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Abstract. In Germany, more than one third of the installed wind energy capacity will leave the feed-in tariff funding between 2021 and 2025. Operators of affected turbines are therefore increasingly concerned with the design of profitable end-of-funding strategies. This requires feasibility analyses of both lifetime extension and repowering options and entails the subsequent challenge to determine the optimal lifetime extension and corresponding repowering timing. To support operators and other stakeholders dealing with wind turbines' end-of-life issues, this study presents a geographic information system that permits evaluating optimal end-of-funding strategies at different spatial scales reaching down to detailed analyses on individual turbine level. The decision support system processes topographic, wind, turbine, and finance data in an integrated system of resource simulations, spatial planning analyses and economic viability assessments. Case-study results show that a uniform end-of-funding strategy cannot be applied to all ageing turbines. Conducted sensitivity analyses rather indicate that the best strategy highly depends on various turbine-specific aspects, especially the location, type and maintenance costs as well as exogenous factors, including the developments of electricity spot market prices and tendered feed-in premiums. In light of latest trends regarding the exogenous factors, lifetime extension and repowering potentials increase. However, the results also indicate that dismantling, disposal and recycling of numerous ageing turbines will become a major challenge for the wind energy sector in the next decade.

1. Introduction

At the end of 2020, more than 5,000 wind turbines ($\approx$ 3.9GW) will reach the end of the feed-in tariff funding period according to the German Renewable Energy Sources Act (EEG). More than 8,000 turbines ($\approx$ 12.5GW) will follow by the end of 2025. If a lifetime extension beyond the funding period is technically viable, operators of affected turbines need to find alternative sales models for the generated electricity once the feed-in tariff expires. The most popular sales model is trading the generated electricity directly or via contracts with trading companies on the