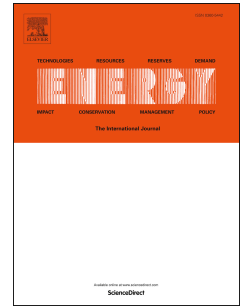


Accepted Manuscript

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PII: S0360-5442(17)30706-5

DOI: [10.1016/j.energy.2017.04.138](https://doi.org/10.1016/j.energy.2017.04.138)

Reference: EGY 10779

To appear in: *Energy*

Received Date: 15 October 2016

Revised Date: 17 April 2017

Accepted Date: 25 April 2017

Please cite this article as: Kopiske J, Spieker S, Tsatsaronis G, Value of power plant flexibility in power systems with high shares of variable renewables: A scenario outlook for Germany 2035, *Energy* (2017), doi: 10.1016/j.energy.2017.04.138.

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Value of power plant flexibility in power systems with high shares of variable renewables: a scenario outlook for Germany 2035

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Abstract

As part of the German transition towards a low-carbon economy, renewable energies are set to account for more than half of the gross electricity consumption by 2035, resulting in a rising flexibility demand. Flexibility is required to balance fluctuations in the residual load. In addition, uncertainties in the wind and solar power generation cause an increased demand for control reserve. A unit commitment model of the German power system is used to analyze the value of power plant flexibility in systems with high shares of variable renewables. To investigate the value of power plant flexibility, the additional revenue that can be generated by flexibility improvements is calculated. The results indicate, that power plant flexibility has a small positive impact on the power plant's contribution margin in 2014. A future power system configuration according to the German Grid Development Plan would provide sufficient flexibility to integrate high shares of renewables without power plant flexibility being very valuable. However, integrating variable renewables into a system relying on coal-fired and nuclear power stations results in power plants being able to significantly increase their revenue with improved flexibility. Under these circumstances, power plant flexibility has a considerable value.

Keywords: power plant flexibility, unit commitment model, electricity market, control reserve, renewable energies, equilibrium pricing, non-convexities

1. Introduction

The German energy system has begun to undergo a substantial transition aiming to reduce greenhouse gas emissions. As a result, renewable energies accounted for roughly 30% of the German electricity generation in 2015 [1]. With ambitious goals regarding the reduction of CO₂ emissions, the installed renewable generation capacity is expected to rise even further. The target set in the German Renewable Energy Sources Act (EEG, see [2]) is to increase the share of renewables to at least 55–60% of gross electricity consumption by 2035.

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Preprint submitted to Energy Special Issue ECOS 2016

April 26, 2017

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