HOW DOES RENEWABLE CURTAILMENT INFLUENCE THE NEED OF TRANSMISSION AND STORAGE CAPACITIES IN EUROPE?

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(1) Overview

One of the main targets of the prospective European energy system is a share of 34% renewable energy sources (RES) on the coverage of the electricity demand in 2020 and is supposed to increase further until 2050 (European Commission, 2006). Hence, the European power sector will face a drastic change from conventional power generation to an energy system with a high share of intermittent renewable generation. Therefore, the current discussion focuses on the extension of RES and their impacts on the existing energy system with regard to power plant dispatch, investments in storage facilities and grid expansion (dena, 2010a, 2010b; European Commission, 2011; Fürsch et al., 2013). Schaber et al. (2012) analyzed the benefit of grid expansion, while the penetration of RES will increase in Europe in 2020. However, these studies consider an obligatory feed-in of RES into the electricity system. Assuming that every produced unit of RES has to be integrated into the electricity system, a high amount of additional grid and storage capacities is required. The question is obvious, whether the cost of the investments needed to integrate every unit of RES feed-in is reasonable. For example Jacobsen and Schröder (2012) consider the possible effects of voluntary and involuntary curtailment from a regulation point of view. However, the latter analysis is not model based and the trade-off between grid and storage enforcements is neglected. Thus, the aim of this paper is to investigate the impact of various feed-in mechanisms on grid and storage investments.

(2) Methods

The analyses of this paper are performed with ELTRAMOD, which is a European electricity transshipment market model. It represents the electricity market of the EU-27 states, Norway, Switzerland and Balkan region connected by net transfer capacities (NTC) between these countries. Based on this linear optimization model, the cost-minimal generation dispatch and investments in storage and transmission capacities are identified. In order to adequately consider the intermittency of RES, the temporal resolution is determined by 8760 h per year. The wind and PV feed-in time series are derived from public data base. Two main scenarios are investigated: Within the first one ("*RES feed-in obligation"*) the total feed-in of RES is integrated into the energy system. The scenario "*RES curtailment"* has the possibility to curtail RES. Both scenarios are complemented by sub scenarios like different investment options for storage and transmission capacities.

(3) Results

First results show regardless of the presence of RES feed-in obligation, significant investments in additional transmission capacities are needed in Europe up to 2050. In both scenarios, the periphery regions of Europe are stronger connected to central Europe. Even though, the total RES supply has to be taken up in the scenario *"RES feed-in obligation"*, curtailment occurs. Due to the lower costs of curtailment of this exceeded feed-in the installation of adequate scaled storage facilities is not reasonable in an economic point of view. Furthermore, the investments in the scenario "RES feed-in obligation" are much higher than in the scenario "*RES curtailment"*, whereas the amount of curtailed RES feed-in does not significantly differs. Hence the chosen feed-in scheme has got a strong impact on the required NTC and storage capacities. Additionally, in the middle to long-term it has to be discussed whether RES feed-in should be curtailed.

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