

IMPACTS OF RENEWABLE ENERGY SOURCES ON WELL-INTERCONNECTED ELECTRICITY MARKETS: A REGIONAL CASE STUDY

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Overview

European electricity markets are marked by large-scale development of renewable energy sources and stepwise integration along with increasing cross-border trade today. In the Central-Eastern European region, most power systems are dominated by thermal generation; the exploitation of renewable energy sources varies widely from country to country, reflecting different phases of development. As a well-interconnected region, cross-border exchanges have an important role in the regional electricity market.

The case study presented here was aimed at a comprehensive assessment of regional and cross-country impacts of renewable electricity generation, involving a number of countries from the Central-Eastern European region. Considering the structural differences in the generation mix of the individual countries, the analysis focuses on day-ahead market prices, exchanges, and network congestions in the context of renewable electricity generation. Also aspects related to security of supply are addressed.

Methods

An empirical analysis was conducted to assess the regional impacts and cross-country-effects related to renewable electricity generation on the basis of coherent market transparency data from 2015. The empirical analysis focused on the actual availability of renewable electricity generation capacity, on regional simultaneities, and on the ramp rates that can be observed from the available market transparency data.

Statistical methods were applied to the parallel time series of system demand, wind, solar and hydro production and day-ahead market prices in order to highlight the influence of renewable electricity generation and identify the extent of observable interdependence.

The underlying datasets have been made available by Regulation (EU) No 543/2013 recently. Data publication coordinated by the European Network of Transmission Operators for Electricity (ENTSO-E) started early January 2015. System demand, electricity generation, day-ahead electricity market price time series were collected for each country, in addition to further data on transfer capacities and scheduled commercial electricity exchanges at each interconnection.

Based on the information on generation capacity per production type, estimated merit order curves were calculated for each involved country in order to evaluate the possible impacts of the merit order effect depending on the variable supply of renewable electricity. The concept of residual load (considering renewable electricity generation from hydro, wind and solar resources as a negative load) was applied in order to identify the country level and cross-border impacts of renewable electricity supply on day-ahead market prices. In addition to the analysis of the merit order effect on market prices, aspects related to security of supply were analysed, as well. The availability of solar and wind resources for each country has been evaluated along with a cross-country assessment that was aimed at identifying the cross-country impacts and observing simultaneities in production. Also the impact on exchanges and network congestions has been highlighted by analysing parallel time series.

Results

Despite the limited time period for which coherent market transparency data are available, some clear tendencies can be identified. An observable correlation shown by the coefficients of determination exists between the residual load and the spot market prices; also important cross-country effects are present in the region. Due to its higher variable renewable energy exploitation and larger size, the German market has a considerable impact on the markets of the regions. Cross-border congestions and over-supply of renewable electricity generation are also partially interrelated.

When analysing aspects related to security of supply, weather-related simultaneity of regional renewable electricity generation was identified as a key factor, as well. The limitation in the set of input data (shorter time period) enabled only a very indicative assessment of issues related to security of supply.

Conclusions

Already at the present exploitation of renewable energy sources in the Central-Eastern European Region, the merit order effect has a large impact on electricity market prices. As storage capabilities are limited in the region at present, the availability of back-up generation and control reserves is of key importance. The proper consideration of the observed cross-border impacts and simultaneities is a pre-requisite for an electricity market framework that can deliver sustainability, security of supply and competitiveness for the Europe, along with a harmonized renewable energy development framework.

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