COST-MINIMAL INVESTMENTS INTO GENERATION CAPACITIES IN EUROPE GIVEN A EUROPE-WIDE RENEWABLES POLICY

Clemens Gerbaulet, TU Berlin and DIW Berlin, cfg@wip.tu-berlin.de
Casimir Lorenz, TU Berlin and DIW Berlin, cl@wip.tu-berlin.de
Friedrich Kunz, DIW Berlin, fkunz@diw.de
Christian von Hirschhausen, TU Berlin and DIW Berlin, cvh@wip.tu-berlin.de
Benjamin Reinhard, TU Berlin, br@wip.tu-berlin.de

Overview

The future development of the European power system is intensively discussed with respect to the electricity network as well as generation technologies. Renewable generation is assigned a dominant role with the underlying aim to reduce the carbon intensity of the entire electricity sector. This has direct implications for conventional generation capacities and their future development. Thus, a closer investigation of the investments in generation technologies is aimed taking into account the variability of an increasing share of renewable generation. Given Europe-wide scenario assumptions regarding the development of renewable policies and prices for relevant input factors like fuel prices and power plant construction, the investments in storage and the power plant portfolio are an important indicator for future policy developments.

Methods

In our paper, we develop a dynamic electricity model which endogenously determines cost-minimizing investment in generation capacities in ten year steps and model their dispatch for the entire European electricity system. Interactions between countries are modeled using a country-sharp power transfer distribution factor aggregation based on the actual underlying high-voltage transmission grid, which allows for a representation of loop-flows while reducing computational complexity. Taking the current generation portfolio and the expected decommissioning of power plants into account, certain investments in different forms of dispatchable generation and storage capacities are required at every ten-year step. This is necessary to compensate fluctuations in renewable generation while incorporating power plant ramping constraints and thus to ensure that load is met at every instant of time. The dispatch of generation is modeled for a series of typical days over the course of one year in order to reflect the temporal and regional variations of renewable generation capacities, with an emphasis on wind generation. This methodology arrives at a cost-optimal power plant portfolio for every European country and provides an estimate for the costs associated with each scenario regarding investments into the electricity system.

Results

Our model results indicate no capacity expansion for nuclear and carbon capture and storage technologies before 2050. This stands in contrast to the results indicated in the EC's scenarios which are based on calculations by the PRIMES model and influence the current European policy developments. Thus, cost assumptions are shown to be a crucial influence factor. Hence, underlying sensitivities should be analyzed carefully. The same holds true for the CO_2 price which has a great influence on the profitability of generation technologies.

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