European Electricity Grid Infrastructure Expansion in a 2050 Context

Jonas Egerer[*], *Clemens Gerbaulet*[†], *and Casimir Lorenz*[‡]

Executive summary

The low-carbon transformation will change the spatial distribution and the shares of conventional and renewable technologies of electricity generation in the European electricity sector, a process which will require continuous adjustments of the transmission network. In this paper, an electricity sector model calculates the investment in individual high-voltage power lines for three different scenarios, which describe the national power plant portfolio development from 2020 to 2050. The results provide insights in the relation between the transformation process and the timing, location, and extend of transmission investment.

We apply a techno-economic electricity sector of the European electricity market, including both generation and the physical transmission network, on infrastructure investments into the European high-voltage transmission system up to 2050. We assume perfect competition and a European central planner expanding the transmission network with the aim of minimizing total system costs which include annualized fixed costs of network investments (voltage upgrades and additional HVAC lines and investment in HVDC lines) and variable generation costs of electricity generation. The model is a mixed-integer linear problem to account for the lumpy nature of transmission investments and approximates electricity flows in the network with a DC load flow linearization. The applied methodology does not include combined investments in generation and transmission, as the generation capacities are exogenous parameters.

In the analysis the results of three scenarios (national generation capacities by technology, fuel costs, and CO_2 price) provided by the results of an energy system model (PRIMES) serve as input for the transmission investment model. The three scenarios are distinguished by the two dimensions policy and technology and have different developments in the power plant portfolio.

We find that network requirements are lower than generally assumed. The largest share of investment is in domestic upgrades, rather than cross-border interconnectors. Most investments (20bn EUR) occur in the near future, by 2030 the latest. Only the high-mitigation scenarios require large additional network investments. The timing and location of investments differ, depending on generation scenarios and cost assumptions for interconnectors. The results indicate

[*] Technische Universität Berlin, Workgroup for Infrastructure Policy (WIP), Straße des 17. Juni 135, 10623 Berlin. je@wip.tu-berlin.de; and DIW Berlin, Department of Energy, Transportation, Environment, Mohrenstraße 58, 10117 Berlin.
[†] Technische Universität Berlin, Workgroup for Infrastructure Policy (WIP), Straße des 17. Juni 135, 10623 Berlin. cfg@wip.tu-berlin.de; and DIW Berlin, Department of Energy, Transportation, Environment, Mohrenstre 58, 10117 Berlin.
[‡] Technische Universität Berlin, Workgroup for Infrastructure Policy (WIP), Straße des 17. Juni 135, 10623 Berlin. cl@wip.tu-berlin.de; and DIW Berlin, Department of Energy, Transportation, Environment, Mohrenstraße 58, 10117 Berlin.

Executive summary of the article: Egerer, Gerbaulet, and Lorenz, 2016. The Energy Journal, Vol. 37 SI3.
https://doi.org/10.5547/01956574.37.SI3.jege

that carbon emission reduction targets alone provide insufficient information for long-term network planning

Executive summary of the article: Egerer, Gerbaulet, and Lorenz, 2016. The Energy Journal, Vol. 37 SI3.
https://doi.org/10.5547/01956574.37.SI3.jege