Modeling transmission investment under different regulatory regimes

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Overview

We address how differences in regulatory evaluation of major transmission expansion projects affect the development of the transmission grid on a European scale, and, consequently, how to improve the regulatory framework governing network investment. In order to cope with increasing amounts of renewable generation capacity, the European transmission system is in need of additional network capacity (e.g., Buijs et al., 2011; Schaber et al., 2012; Teusch et al., 2012; Steinke et al., 2013). At the same time, however, there is a tension between the increasing cross-border nature of power flows that must be facilitated by the infrastructure, and the predominantly national perspective of regulators who approve major transmission investments. The risk exists that infrastructure development is hampered by national interests, as is argued by Supponen (2011), as a result of which insufficient new transmission capacity is realized, which would lead to RES curtailment and sub-optimal generation dispatch. We developed a model of the North West European transmission grid with endogenous transmission investment, to which we can apply different regulatory investment evaluation criteria.

Methods

We apply an agent-based model to simulate investments in the European transmission grid over the period 2015–2050 and simulate the development of the North West European transmission grid as a series of yearly investment decisions by individual TSOs, and calculate the resulting effects on system costs (power plant dispatch and network investment), market prices, network use, and renewables curtailment. The model consists of an integrated market and network model, which we use to simulate the processes of market clearing and load flow calculations. It is capable of performing market and dispatch simulations, load flow calculations, grid security assessments to determine safe Available Transfer Capacity (ATC) values, and grid investment decisions by TSOs as well as investment evaluation by regulators (also see Van Blijswijk & De Vries, 2013). We represent the physical Central Western European electricity system through 13 interconnected nodes. Generation capacities and loads are located in one specific node, but several nodes may be part of the same price zone for market clearing purposes. Thus, the model distinguishes between cross-border and internal lines. Trades between the price zones take place through a market coupling algorithm. On the basis of power plant dispatch and nodal loads, which are obtained by running the market coupling algorithm we use a load flow model to calculate the physical flows in the (simplified) network. The development of generation capacity and demand, which form the basis for any such calculation, are represented through scenarios and are thus not modeled endogenously.

Results

Determining the net benefits of transmission expansions requires one to evaluate projects in conjunction with all other developments that take place during its lifetime. This precludes the application of a static model to compute the costs and benefits of a single investment, but instead requires a modeling approach that endogenously considers grid development in the simulation. We seek to determine what differences arise in terms of network development (and, as a consequence, welfare) when (potential) transmission expansion projects are assessed on the basis of different regulatory evaluation criteria. These effects change over time as TSO investment affects available cross-border capacities, which affect market prices, which affect power plant dispatch. Using our model we can show what happens in terms of consumer and producer welfare as well as transmission costs (tariffs) when different criteria are applied when potential grid investments are evaluated, varying from purely national to system-wide approaches, and what effects different (generation and load) scenarios have under these criteria.

We apply our model to compare the long-term effects on network capacity of three different regulatory regimes: we compare the current regulatory framework with a purely national investment criterion on the one hand and a purely European perspective in the other extreme. We must take caution in interpreting our model results, as the model has not yet been conclusively validated. Our first results nonetheless seem to suggest that a system-wide approach leads to the realization of significantly more cross-border transmission capacity than under the nationally-oriented mechanisms, resulting in a more efficient dispatch and less diverging market prices. However, it is uncertain whether the cost of realizing this additional interconnection capacity weighs up against the savings in dispatch costs, according to our preliminary model results.

Conclusions

In this paper we show how different regulatory assessment criteria affect transmission grid investment by TSOs in North West Europe. Using an integrated market and network model of the CWE region with endogenous investment in transmission capacity, we show the consequences for network development (and associated costs for society) between different regulatory regimes for evaluating potential major transmission expansions. We simulate transmission investment under 1) a purely national focus, as would result from the current national regulatory frameworks, 2) with the effects of an inter-TSO compensation mechanism, which is intended to alleviate the shortcomings of the nationally focused framework, and 3) a `system wide' (regional welfare optimizing) investment criterion. This approach allows us to show where there is room for improvement in the regulatory framework, in order to better align the effectiveness of currently existing national regulatory structures to a reality where TSOs must build capacity to accommodate increasing volumes of power transfers that of a cross-border (or even cross multiple borders) nature. While we must take caution when interpreting our model results, preliminary results appear to suggest that a system-wide approach leads to a higher degree of interconnection capacity and causes lower dispatch costs, lower RES curtailment, and lower market prices in all price zones. However, the higher investment costs (i.e., more capacity is realized) may not fully weigh up against these benefits.

References

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