Interaction between Security of Supply and Investment into Renewable Energy in the Netherlands and Germany

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Overview

We study the potential effects of introducing a capacity market in a European country in response to the deteriorating market position of many (mainly gas) generators due to the growing share of renewable energy. We pay specific attention to cross-border effects of capacity markets, because security of supply in Europe is an issue of subsidiarity and is therefore tackled at the national level. The support of RES is directly linked to this issue of security of supply, since the promotion of RES displaces conventional technologies in the merit order (Finon and Roques, 2013). This has significant consequences on the investment behaviour of conventional energy generators. The displacement of the hourly merit order implies a lower load factor, lower average revenues, and lower predictability of their revenue due to intermittency of RES.

Germany has introduced a small strategic reserve to handle the consequences of the nuclear phase out. Other European countries such as France and the UK are in various statges of implementing a form of the capacity market(DECC, 2011). A capacity market ensures generation adequacy by addressing the 'missing-money' problem through a separate market for tradable capacity credits(Cramton and Stoft, 2006).

While the issue of security of supply is being addressed at the national level, the European Commission has set highly ambitious goals for generation from renewable energy resources at a pan European level. It is legally binding on each of the member states through their respective National Renewable Energy Action Plans (NREAPs) which impose targets for electricity generation from renewable sources per member state (Beurskens et al., 2011). Given such a setting, it is pertinent that the long term interactions between such aforementioned policies are analysed. In this study we limit our scope to the Netherlands and Germany.

Method

EMLab: We model the German and Dutch markets in EMLab Generation, an agent-based wholesale electricity market model which is a part of the Energy Modeling Laboratory (EMLab) of TU Delft (de Vries and Chappin, 2012). The model contains two electricity markets with an interconnector between them. In case of congestion of the interconnector, market coupling is applied. The main agents in the model, generation companies, are modeled as autonomous agents, each with their own set of objectives, that take decisions based on inputs from their environment and other agents. Fuel prices and demand growth are exogenously determined scenario.
Targeted Investment into Renewable Energy: Investment into renewable energy is simulated to meet the member states' respective NREAPs. If private energy producing agents in EMLab fail to meet the national targets for a particular year, the RE producing agent simply invests exactly the missing capacity regardless of budget constraints.
Capacity Market: The capacity market model is designed as an extension to the EMLAB-Generation model, and is based primarily on the New York ISO ICAP market (New York Independent System Operator, 2013). The capacity market is based on a uniform price auction where at the beginning of every time step (which is one year), the consumers submit their demand for capacity credits. Consumer demand for capacity credits is mandated by the regulator, who bases it on measured peak demand plus a reserve margin, here 15.6%. In a two node system, only generators who are located in the market with the capacity mechanism are allowed to participate in the capacity market. The price cap is set at the value of 1.5 times the cost of new energy (CONE).
Experiment design: The model is run for a duration of 50 ticks, every tick representing a year. The base case (BC) scenarios are those without the capacity market, while the capacity market scenarios (CM) have it implemented. We perform two main experiments, we first study the effect of the NREAP on the capacity market for the Netherlands, where the Netherlands is an isolated country. We secondly study the same effect in a two country case, with both the Netherlands and Germany; the capacity market being implemented only in Germany, while the Netherlands remains and energy only market. Refer Iychettira (2013) for a detailed description.

Results

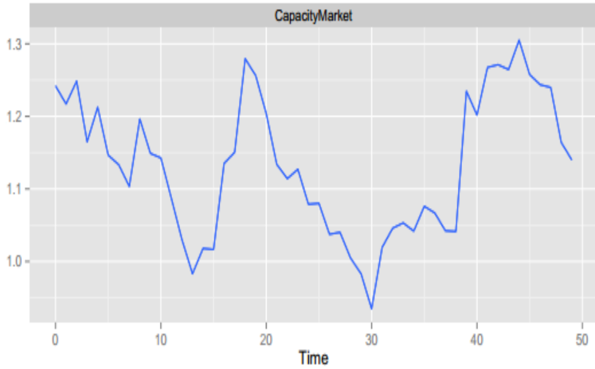

Figure 1: Supply Ratio in Experiment 1, CM

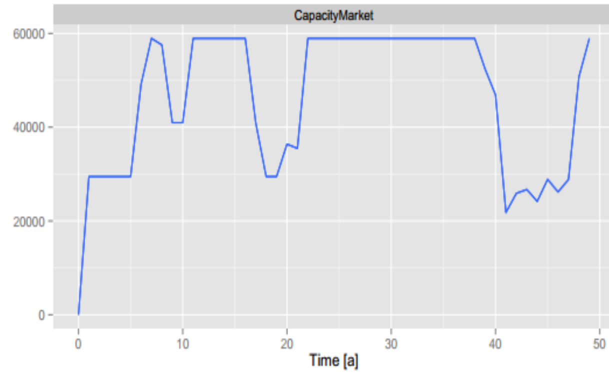

Figure 2: Capacity Market Price in Experiment 1

The key performance indicators that were used were *supply ratio*, a ratio of total operational capacity to total peak demand, *average electricity price*, *LOLE*, the loss of load expectation. At the outset, the scenarios with targeted investment into renewable energy showed an average increase of 30% LOLE, as compared to the case without targeted RE. In the single country experiment (based on the Netherlands), the capacity market (CM) improved the supply ratio as compared to the base case (BC) by 15%. The LOLE with the capacity market decreases to 2 hours per year, as compared to 27 hours per year without. the average LOLE, even with the capacity market, in the presence of targeted RE generation is about 2 hours per year, still higher than the LOLE 0.8 hours of corresponding scenario without targeted RE generation. In the two country experiment, apart from the effects of increased intermittency observed in the single country experiment, several cross border effects were observed. One such effect is that the investment cycles in the energy only market (the Netherlands) are exacerbated when a capacity market is introduced in a neigbhoring country (Germany), as compared to the BC. Also, LOLE in the Netherlands increases in the presence of a capacity market in Germany, as compared to the BC.

Conclusions

The main conclusion is that if the renewable energy targets of the member states were to be met, then the intermittency in the system would significantly increase, exacerbating the security of supply concerns.A capacity market then can help in maintaining generation adequacy. However, there would be several adverse effects (dampened investment, increased LOLE) on neigbouring energy only markets. These adverse effects are only worsened due to the intermittency of renewable energy generation. Therefore it is recommended that a single capacity market may be implemented across both countries, or that export restrictions are imposed, if one country has a capacity market and the other does not. Additionally, as RES change the market dynamics and make the business case for thermal plant more difficult, the design of a CM needs to be adjusted when the share of RES increases. One possible change in design is to increase the reserve margin of the capacity market. Another possibility is to lower the slope of the demand curve in the capacity market design.

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