A MODELING APPROACH TO ANALYZE THE IMPLEMENTATION OF CAPACITY MARKETS IN GERMANY

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(1) Overview

The substantial increase in renewable energy in the supply mix of the EU has increased investment risk in the electricity market. The presence of intermittent generation with low variable operating costs makes the window of opportunity for the thermal power plants to recover their cost smaller. There is concern that investment in these power plants will become too unattractive. Therefore France and the UK are implementing different types of capacity mechanisms; other countries are considering similar policy measures for ensuring generation adequacy.

Currently, Germany is deploying a small strategic reserve in order to handle the consequences of the nuclear phase out. As France and the UK are implementing capacity markets, this is a possible alternative for Germany as well. A capacity market ensures generation adequacy by addressing the 'missing-money' problem through a separate market for tradable capacity credits (Cramton, 2006; DECC, 2012). The sale of these credits provides an earlier investment signal to generation companies and also dampens investment cycles.

Security of supply policy is a matter of subsidiarity in Europe. Consequently, there is a risk that individual countries implement policies that have unintended cross-border effects. In order to assess the potential cross-border effects of one country implementing a capacity market while its neighbor continues with an energy-only market design, we evaluate the long-term effectiveness of a capacity market in (a model of a market that is loosely based on) Germany, which is connected to a market that is representative of the Dutch electricity market. We evaluate the effects of a capacity market in isolation as well as cross-border effects on prices, investment and reliability.

(2) Methods

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 (Richstein, 2012). The model contains two electricity markets with an interconnector between them. In case of congestion of the interconnector, market coupling is applied. The model also contains a CO_2 market. The 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 parameters (De Vries, 2013).

The capacity market model is designed as an extension to the EMLAB-Generation model, which is a part of the energy modeling laboratory (EMLab) of TU Delft. EMLab is an open source platform that consists of multiple interconnected projects. (De Vries, 2013). The main purpose of the EMlab Generation model is to explore the long-term effects of interaction between energy and climate policies.

The main agents in the capacity market are the energy producers, the regulator and the consumer. The capacity market is based on a uniform price clearing 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 determined by the regulator, who bases it on measured peak demand plus a forward reserve margin. The generation companies offer their available generation capacity to the capacity the market. On clearing of the capacity market, all the generating units in the merit order are paid the clearing price for the capacity made available by them.

The determination of the quantity of forward reserve is based on a downward sloping demand curve (Stoft, 2002). The forward planning period of the capacity market is assumed to be three years akin to the PJM market. (PJM Capacity Market Operations, 2012). The function of the regulator is to ensure that the consumers purchase the required capacity on the market. In case of a failure to do so, the regulator imposes a fine on the consumers. The magnitude of the fine is defined by the modeler. 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 modeler can choose whether generation companies in the market with the capacity mechanism are allowed to export their electricity during shortages or not. (When there is ample capacity, they are always allowed to export).

The baseline scenario is a two-node interconnected energy only market, modeled on the German and Dutch electricity markets. The modeled scenarios are Germany as a single node with a capacity market and, secondly, a two-node interconnected system with an energy-only market in the Netherlands and a capacity market in Germany. The results from these scenarios are analyzed using the baseline scenarios.

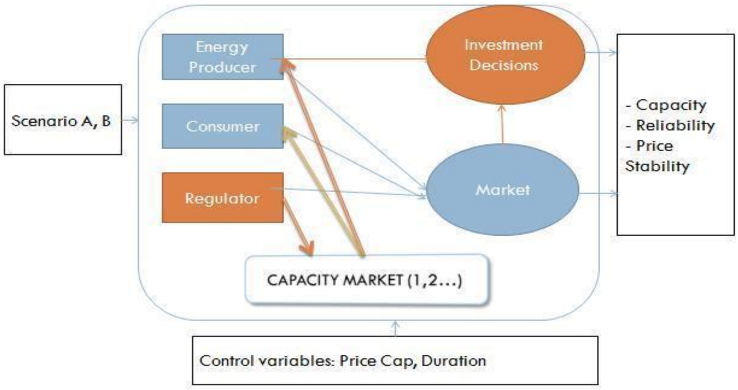

Fig 1: Conceptual model of the capacity market

(3) Results

In a closed market, a capacity market leads to maintenance of a robust reserve margin capacity and stabilization of electricity prices. The price volatility in the capacity market increases with increasing slope of the capacity market demand curve. The investment incentive is a function of the value of the penalty and capacity requirement (set by the regulator). An important design variable is how far ahead in time the capacity requirement is implemented. A reserve requirement for the current year only does not allow sufficient lead time new investment, which may cause the capacity market to become cyclical. On the other hand, a forward reserve requirement that has a very long (above 5 years) planning period will reduce market liquidity.

In the two-node scenario, the capacity market reduces average wholesale prices in the entire system, except during shortages. If the capacity market limits exports during regional shortages (on the grounds that the consumers who paid for capacity credits should also reap the benefits during shortages), high prices develop in the energy-only market during these shortages. Combined with the lower prices during all other hours, this causes price volatility to increase. On the average, however, prices may remain the same in both markets, but the higher volatility in the energy-only market increases investment risk and causes a risk of investment cycles. If the capacity market does not restrict exports during shortages, its beneficial effect for generation adequacy extends to both markets to the extent that there is sufficient interconnector capacity. In this case, investment shifts to the capacity market and the consumers in the capacity market pay more than in the energy-only market, which can be considered to be free riding.

(4) Conclusions

Capacity markets can be an effective policy intervention for achieving long term supply adequacy. The investment incentive and market prices are sensitive to the planning period and demand slope. In an interconnected system, a unilateral deployment of a capacity market will increase price volatility in neighboring energy-only markets. The presence of a capacity market may also deter investment in a neighboring country with an energy only market, depending on the regulation of exports from the capacity market to the energy-only market.

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