[*ECONOMIC CONSEQUENCES OF THE CAPACITY MARKET IMPLEMENTATION: THE CASE OF POLAND*]

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Overview

The capacity market is a remuneration mechanism aimed to provide better investment incentives in order to ensure generation adequacy that has been recently implemented in Poland. As in the energy-only-market power producers do not receive sufficient incentives, this mechanism aims to encourage investments. Due to the increase in the market share of renewables the economic standing of conventional power units are getting worse. As a result, the missing money problem arises (Cramton and Stoft, 2006; Joskow, 2006; Cramton et al., 2013). Consequently, conventional power plants operating in Poland do not generate sufficient revenues to cover operating and capital costs. This leads to a reduction in the level of installed capacity in the domestic power generation system and, at the same time, causes an increase in the risk of the lack of an appropriate level of reserve margin. Because power units do not have sufficient financial resources, they do not modernize existing or build new units, what can lead to the missing capacity problem. Moreover, this issue is getting more serious due to the withdrawal of subsequent existing units from the domestic power generation system. The missing capacity problem is not a new phenomenon in Europe and in the world. As a result, there are several countries or regions that have introduced such solutions. The most known examples of capacity markets are those operating in the United States: the New York Independent System Operator, the Pennsylvania New Jersey Maryland Interconnection, the Independent System Operator – New England, the Midcontinent Independent System Operator (Bowring, 2013; Spees et al. 2013) and in the UK.

One of the key elements of the capacity market is the capacity auction. In accordance with applicable regulations, the existing, modernizing and new units can participate in the auction. The capacity market is also technological neutral. Accordingly, the implementation of this regulation will cause the changes in electricity production-mix and will affect electricity prices. To the best of our knowledge, there are no studies or publications on the economic consequences of capacity market implementation in Poland. Consequently, this paper contributes to the field of remuneration mechanisms literature.

In this context, the aim of the paper is to analyse economic consequences of the introduction of the capacity market in Poland. This issue is important due to the need to provide reliable information on the potential economic consequences of the implementation of the considered mechanism, especially about electricity prices as they are critical to maintaining economic growth.

Methods

The issue of assessing the economic consequences of the capacity market implementation in Poland is complex and requires the application of appropriate tools. To the best of our knowledge the only recognized approach to solving such problems is the system analysis, of which quantitative tools are mathematical models.

In this paper, the model-based analysis is carried out with the employment of the Polish power generation system model (Kamiński et al., 2014). The objective function (optimization criterion) is formulated as the minimization of power generation costs. The model is implemented in the GAMS (General Algebraic Modelling System) as a Mixed Integer Linear Programming (MILP) problem and solved with the CPLEX solver.

In order to tackle the abovementioned problem, a methodology based on cyclical computation of the model is proposed. The model is solved for each year individually over the entire horizon (2021–2035), separately for each of the considered scenarios. Depending on the scenario, it is possible to analyse and compare: (i) the energy-only market (EOM scenario) and (ii) the capacity market (CM scenario).

In the case of EOM scenario, the procedure is following: The first step is a simulation of the energy-only market in hourly resolution. The results of this stage includes identification of existing power units that do not meet the condition of economic efficiency. Next, the level of missing money is estimated for each unit. Afterwards, the estimated units are withdrawn. In accordance with the assumptions, if they do not cover maintenance costs at the disposal of the existing units, they are allowed to report early withdrawal of inefficient units by 2021, as well as in subsequent years. Finally, the next simulation of the operation of the electricity market with decommissioned

units is carried out. The results of this step are: electricity price level, individual consumer losses, loss of load hours and expected energy not served.

In the case of the CM scenario, the procedure is following: the electricity market is simulated in the same way as in the previous scenario. It is assumed the power generation system is balanced in every hour of operation, and the potential shortages are covered by units of the lowest capital and operation cost – usually OCGT or CCGT. Then, the level of missing money is calculated. In the next step the capacity supply and demand curves are estimated. Subsequently, the capacity market equilibrium price and volume are determined. Therefore, the structure of the power generation system is changed – new power generation units are put into operation, and selected existing units are withdrawn. Ultimately, the simulation of the operation of the resulting configuration of the power market is carried out.

Results

Regardless of considered scenarios, the results indicate an increase in electricity prices in both scenarios. This is due to the increase in both, fuel prices and the European Emission Allowances (EUA) price. Only in 2030 and 2032 the decrease in electricity prices are noticed due to the commissioning of a nuclear power plant. The comparison of electricity prices in both scenarios indicates higher prices in the case of the EOM scenario than in the capacity market scenario. The difference in electricity prices between the analysed scenarios initially exceeds the value of €6.06/MWh, while the maximum value amounts to €11.8/MWh (in 2031). In the EOM, due to the problems with power generation adequacy an increase in electricity prices is observed. It is worth mentioning that the duration of brownouts is usually longer when compared to the actual shortages.

Conclusions

The results of study carried out in this paper show that in the case of Poland, the long-term maintenance of the energy-only market results in higher electricity prices when compared to the capacity market scenario. The limited possibilities of meeting the economic efficiency condition in the case of conventional power generation units and the lack of investment incentives in new capacity or modernization of existing units cause the missing capacity problem. The lower level of reserve margin during unfavourable circumstances (namely the maintenance of units during windless weather, or at high ambient temperature and at low water level in rivers) results in brownouts.

The implementation of the capacity market reduces the imperfections of the energy-only market in the Polish conditions. The results confirm that it was beneficial to the Polish economy to implement the remuneration mechanism that generates adequate investment incentives for construction of new units and allows for the maintenance of existing power plants.

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