

The fuel and energy sector plays a role in the Polish economy. Energy security is necessary both to guarantee welfare for the society and to enable the economic development of the country. Since large-scale storage of electricity is not yet at the commercial stage, demand for power must be constantly balanced by its generation. Due to the significant share of coal used for electricity production in Poland, the electricity market is particularly exposed to new risks in the area of regulations implemented in the power sector. Dynamic changes that take place in the Polish electricity market, both on the regulatory and technological level, induce the research community and scientists to carry out studies on the impact of these changes on the electricity prices and future of Polish power producers. One of the key regulatory changes, in the previous years, was the introduction of a capacity market in Poland. This mechanism was implemented by Act Dz.U. 2018 poz. 9 of the Polish capacity market in 2018. To the best of our knowledge, the most robust method used in research on these changes is mathematical modelling.

The main aim of the research carried out within the project is to develop a mathematical model that mimics the Polish electricity market and to examine the impact of the implementation of the capacity market on the power generation system (energy companies, electricity market, etc.) using the developed research apparatus.

The project assumes **two research hypotheses**: (i) it is assumed that the implementation of the capacity market will reduce electricity prices and (ii) it is assumed that the implementation of the capacity market will enable active participation of demand side response (DSR) providers in the market.

A mathematical model will be developed within the project. For this purpose, the Linear Programming approach will be employed. The model will form a representation of the Polish electricity market. The model will take into account the key elements of this sector on the demand (power consumption) and the supply side (conventional generating units, DSR providers, renewables, import, etc.), as well as the interactions between them and selected sectors of the economy. The energy companies will be characterized by their technical and economic parameters. The following parameters will be implemented in the model: achievable capacity, efficiency, availability factor, fuel, CO₂, NO_x, SO₂ and PM emission factors, fuel costs, CO₂ emission price and the emission charges of pollutants (NO_x, SO₂ and PM). In addition, forecasts of capacity demand, fuel prices and emission allowances will be included. The model will take into account the capacity limits of power generating units and emission limits. The objective function of the developed model is to minimize the total costs of electricity production in the power system.

In order to achieve the aim of the project, two research scenarios will be developed. In the first one, the electricity market will be modelled, in which there is no capacity market (revenues only from the sale of electricity). In the second one, the electricity market and the capacity market will be reflected (revenues from the sale of electricity in the electricity market and capacity in the capacity market). The impact of the implementation of the capacity market on the power generation system (energy companies, electricity prices, etc.) will be assessed. The research results will allow: (i) to quantify the impact of the implementation of the capacity market on electricity prices (ii) to estimate a change in profit of energy companies, (iii) to the impact of capacity market implementation in countries undergoing decarbonisation.

A particular **innovation** in basic research is the **quantitative assessment** of the impact of the implementation of the capacity market on the electricity market.

The **added value** of the research project will be (i) development of a new mathematical model in which not only the electricity market, but also the capacity market is implemented, and (ii) report on the quantitative assessment of the impact of implementation on the capacity market on the Polish electricity market. In addition, the results of the research carried out in this project will provide answers to the following questions: (i) Will the implementation of the capacity market slow down or accelerate the decarbonisation of the Polish power sector? (ii) Will this mechanism reduce electricity prices? The answers will allow to fill the research gap occurring in the discussed research field.