

The use of renewable energy sources (RES) is a predominant trend in research on new technologies for the production of final forms of energy. Despite many advantages, these sources are often characterized by unstable and discontinuous operation, and their production mismatches the instantaneous demand of the power system. It is therefore necessary to develop a technology for electricity storage. Without high-efficiency, reliable and relatively inexpensive energy storage solutions, the power sector, especially in Poland, will face significant problems in the near future. One way of storing energy is producing hydrogen in the electrolysis process, with the use of excess electricity produced in RES. This is the so-called Power to Gas (PtG) technology. Hydrogen can be further processed to produce synthetic natural gas (SNG) and other products that are valuable substrates for chemical synthesis. For this purpose, it is necessary to supply the process with carbon dioxide, which may come, for example, from combustion or gasification of fuels (e.g. coal or biomass). The use of biomass allows to obtain the system entirely based on renewable sources. The primary advantage of storing methane in relation to hydrogen is its ease of storage, further use (e.g., in engines, gas turbines or fuel cells) and transport (natural gas pipelines).

The primary objective of the project will be to analyze the innovative concept of a hydrogen-based electrolysis system using excess electricity generated from renewable sources (wind turbines or photovoltaic cells) and the oxygen gasification process of solid fuels for the production of synthetic natural gas. This system can act as an energy store (in the form of methane) and as electricity (and heat) generator. An important innovation element of the proposed solution is the use of the gasification process to produce the necessary for the methanation (methane production from hydrogen and carbon monoxide or carbon dioxide) CO or CO₂. In addition, the use of oxy-fuel gasification will allow the utilization of oxygen from the electrolysis, which is a by-product in this process. The project will analyze the potential for further use of SNG gas in the cogeneration system and its injection into the gas transmission network. The analyzes and accompanying system optimizations will be carried out both, taking into account thermodynamic (efficiency) and economic (cost of living) criteria. In addition, experimental research (on a test stand) on the methanation process using hydrogen from the electrolysis will be carried out.

Utilization of energy storage and renewable energy sources will increase the reliability of energy supply, which will consequently result in lower emissions (including dust, sulfur and nitrogen oxides and carbon dioxide), improvement of the quality of the generation system and increase the energy security and health of the population. Power to Gas technology is indicated as one of the storage methods that has a great application potential, especially where the dominant renewable energy sources are sources with discontinuous operation characteristics (e.g., wind turbines or photovoltaic cells), and thus also in Poland.