

## **Abstract**

The work presents the theoretical basis for compressed air energy storage systems and reviews structures that could be used as compressed air storage in Poland, as well as a general review of heat storage that could be used to build an adiabatic system. The main objective of the work, which was to develop a concept for an adiabatic compressed air energy storage system that could play an important role in the National Electricity System, has been achieved. The paper presents two basic variants of the system, with isochoric and with isobaric compressed air storage, where the patented invention of a hybrid compressed air and heat storage using a disused post-mining shaft is used. For the concept, a preliminary verification of the feasibility of using the shaft as a pressure vessel was carried out, and design solutions were proposed for the segmented thermal energy storage. For both system configurations, thermodynamic analyses were performed for various combinations of compressed air storage pressures and heat storage charging temperatures, and the possibility of using heat that is not reasonably storable was taken into account. Part of the heat normally lost to rolling during the charging phase is planned to be used to heat water in the district heating main using a heat exchanger. The analysis carried out showed that the most efficient system is the one with isobaric compressed air storage, and this despite the adoption of compressor operation with unfavorable efficiency characteristics. Using the NPV ratio, a simplified economic analysis was performed for the two main configurations of system operation in options with and without the heat exchanger. The heat exchanger used shows the high potential of the proposed concepts. Economic analyses have shown the superiority of the isobaric compressed air energy storage system, particularly with the use of the heat exchanger, while also indicating that with a certain difference in electricity prices, this system can be commercially viable.