Abstract of the dissertation: Use of energy harvesting in increasing the energy efficiency of buildings with a BMS management system and autonomous supply of cooperating remote sensors.

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The global energy consumption for the operation of buildings represents the largest share of the total energy consumption generated by mankind. Nowadays, at a time of strongly increasing effects of global warming and a resource and energy crisis, it is thus particularly important to reduce energy consumption for building operations.

The presented study investigated the impact of thermal energy harvesting installations managed by the BMS CHRONOMATIK™ system on increasing the energy efficiency of buildings. Two energy harvesting installations managed by the BMS CHRONOMATIK™ system and implemented in industrial factories (located in Wrocław and Ruda Śląska) with the participation and under the direction of the dissertation Author were presented and analysed. One of the projects discussed was related to the operation of a waste heat energy harvesting system using two heat pumps installed in an aluminium forge. The system harvests waste heat energy from the air in the production hall, which is then used to operate a boiler room for heating the office part of the facility during the heating season and for year-round domestic hot water preparation. The boiler room automation is part of the BMS CHRONOMATIK™ system. As a result of the project, the use of natural gas for boiler plant operation was completely eliminated (which was the supply of the boiler plant before system implementation). The second project was related to the implementation of an automatic control system for waste heat recovery from the compressor cooling system in one of Wrocław's factories. The installation, which is also part of the BMS CHRONOMATIK™ system, is characterised by high energy efficiency, which resulted in a significant reduction in energy consumption for heating the production hall during the heating period. In this dissertation, the impact of both projects on improving the energy efficiency of buildings with a BMS syetm was assessed with reference to the PN-EN ISO 52120-1:2022-09E standard.

Increasing the energy efficiency of buildings is also very important in case of existing buildings, which due to old construction technology usually have poorer energy characteristics than

buildings currently under construction. These buildings, due to their construction, are often excluded from the possibility of implementing BMS building automation systems in a conventional, hard-wired architecture. One alternative method of installing BMS systems in such buildings can be to use wireless components (currently in most cases battery powered thus still requiring regular servicing). Based on the LoRa sensor platforms, which are developed and manufactured by KMB Grupa (in consortium with Wrocław University of Technology and with the direct participation of the Author), the paper investigates the feasibility of battery-free powering of such remote sensor platforms using thermal and mechanical energy harvesters located inside buildings. During the research, analysis of the energy requirements of the sensor platforms was carried out, and thermal energy harvesters were developed exploiting several sources of waste heat energy inside buildings, such as the window glazing, water meters supplying the building with cold water, the return bar of the central heating distributor or the waste heat duct from the compressor cooling system. Two mechanical energy harvesters installed on the door handle stem and door closer arm were also developed and studied. During the research, suitable low-voltage DC-DC voltage converters were also selected, as well as the necessary electrical energy storage systems. Both types of building energy harvesters were also tested in real industrial conditions. Battery-less LoRa wireless sensor platforms, powered entirely by the discussed energy harvesters successfully transmitted data for several weeks to the CHRONOMATIK™ BMS communication node using the LoRaWAN communication gateway.