Poland's obligation to meet the EU's RES target has resulted in the growing interest in the biogas market in Poland. The state's energy policy introduces solutions to support renewable energy and cogeneration, and the fuel industry, represented by ORLEN, PGNiG and PAK, plans to build its networks of agricultural biogas plants for the production of biomethane, and as a target also green hydrogen. These activities are going to encourage, among others agri-food industry to invest in this direction. Currently, about three hundred biogas plants operate in our country, of which less than one hundred are agricultural installations, and the rest are mainly facilities at landfills and wastewater treatment plants. The management of digestate (sewage sludge) from biogas plants in wastewater treatment plants is a huge technical and social problem faced by wastewater treatment plants not only in Poland. The digestates are usually significantly diluted (usually from 3 to 6% dry mass), have a colloidal structure responsible for significant problems with their mechanical dewaterability, contain inorganic impurities, including alkali and/or heavy metal compounds. They are characterized by a low calorific value of dry matter (organic compounds contained in the substrates for biogas plants have already been mostly converted into biogas in the process of methane fermentation) and they create odour problems.

In the last few years, the treatment of wet biomass by hydrothermal carbonization has been intensively developed. On its basis, various ideas for wet biomass management technologies arise. While the properties of digestate are relatively well known, the knowledge of the properties of their wet torrefaction products is already very limited, because the research so far has focused mainly on the hydrothermal treatment of wood biomass, non-digested sewage sludge and the organic part of municipal waste, i.e. raw materials with a high calorific value of dry matter. Good knowledge of the properties of digestates and their hydrothermal carbonization products (sludge and hydrocarbons, as well as degassing and leachate) is crucial to help engineers and technologists develop technologies for the rational management of these digestates.

Tests of raw materials (digestates) and products of their wet torrefaction will be carried out at temperatures of 200 and 220°C, under equilibrium pressure, for 2 to 4 hours, in a slightly acidic and slightly alkaline environment. Under these conditions, the dry mass of digestate converts to a small degree into the gaseous phase (usually up to 2-3 wt.%) and to a large extent to the liquid phase (usually 15-25 wt.%). Mainly as a result of its dehydration, and a two-phase mixture is formed (called sludge) from which a solid phase with properties similar to carbon (called hydrochars) and a liquid phase (called leachate) are separated. The great advantage of using the hydrothermal carbonization method is the complete hygienization and disinfection of raw materials (here digestates), i.e. complete destruction of all pathogens (bacteria, viruses, etc.) present in them.

The main goal of this research will be to determine the properties of digestate and products of their hydrothermal carbonization, carried out with the use of advanced instrumental techniques. Standard tests are planned for digestate, which will be the source of knowledge about the raw material for the hydrothermal carbonization process. For hydrochars, it is planned to perform standard research analyzes describing their physical and chemical properties, and more advanced techniques e.g. thermal analysis in which the process of their combustion is simulated. The possibility of using the pyrolysis and/or gasification process of the formed hydrochars and the assessment of the chemical composition of the resulting syngas in terms of energy application. Additionally, the possibilities of using hydrochars for the production of biosorbents and CO_2 absorption will be investigated. This type of analysis requires examining the structure of the resulting hydrochars using a method determining the specific surface area of the material and the size and distribution of pores. The morphological analysis of the structure will be supported by microscopes, as well as the study of changes in the structure of chemical bonds and the proportions of polysaccharides (hemicelluloses, celluloses and lignins). For the gaseous phase, standard procedures are planned to be carried out, usually for exhaust gases, in terms of their adsorption on carbon filters. It is planned to perform physical and chemical tests for the leachate, including content of alkali and heavy metals and the ability to gasify in the process of methane fermentation. The products of vacuum distillation of the effluent will also be tested. The research on hydrothermal carbonization products, i.e. the method assessed in the latest scientific literature as the most promising for wet biomass, is primarily intended to broaden our knowledge of their physical, chemical and thermal properties and dependencies between digestates, process parameters and hydrothermal carbonization products. This knowledge is indispensable for the effective search for ways of rational management of these products, especially in the area of biogas plants. The developed research methodologies can be used in the future for testing standard products of wet torrefaction.