



Narodowe Centrum  
Badań i Rozwoju



# New renewable energy technologies

## for sustainable development of rural areas and low-carbon agriculture

Baltic Bioeconomy Days  
10th–12th March 2020,  
Rostock, Germany

BIOSTRATEG3/344128/12/NCBR/2017  
Project co-financed by the National Centre for Research and Development as part of  
the strategic program of scientific research and development  
works „Natural environment, agriculture and forestry” BIOSTRATEG

# TechRol

The main aim of the project is to develop technologies benefiting from natural resources in the agricultural and forest areas for the production of electrical and heat energy.



- New eco-energy technologies.
- R&D in the field environment, agriculture and forestry.
- The consortium of scientific and industrial partners.
- The practical and innovative solutions in rural areas.







# THE CONSORTIUM

- Institute of Fluid-flow Machinery Polish Academy of Sciences - IMPPAN
- Warsaw University of Life Sciences - SGGW,
- Insitute of Soil Science and Plant Cultivation State Research Institute - IUNG
- University of Warmia and Mazury in Olsztyn - UWM





# THE CONSORTIUM

- BLUETOMATION
- EcoSolar
- Ekotechlab
- ENKI Sp. z o.o.
- ForéF
- IMPLASER Innovative Technologies Sp. z o.o.
- Instytut Energii Sp. z o.o.
- QUERCUS Sp. z o.o.



# WP 1

## Prosumer model for rural communes

- The analysis of actual energy consumption and need for different types of energy in rural areas, including heat and electricity demand.
- The evaluation of the existing RES potential.



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## WP 2

### Biomass production from low quality land and its conversion processes

- Thermal and biochemical processes for pretreatment of lignocellulosic agricultural biowastes leading to increased production of biofuels (biogas and bioliquids) and good quality digestate to be used for improvement of soil quality.
- Biomass and pellet production (in lab scale), their characterization and assessment of economical affectivity.
- The organic waste conversion (by biodrying) into solid fuel, or a product fulfilling the legal quality criteria of organic fertilizers.
- Construction of the installation for tar-free straw gasification combined with the gas cleaning system and cogeneration unit.
- Development of a comprehensive system of solid and tar particles removal from the syngas.



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# WP 3

## Renewable technologies for agriculture, environment and rural production

- Small-scale cogenerative systems for emission free electric energy generation based on heat recovery from different processes.
- Complex hybrid heat supply systems, consisting of heat pump powered from micro wind turbine and PV installation integrated with energy storage.
- Popularization of new technologies for producing heat and electricity in agricultural areas.



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## WP 4

### Smart energy management

- Development of commune energy model based on real and virtual models of energy infrastructure, including the municipal waste stream management constituting the basis to produce biogas and alternative fuels, allowing for balancing energy, planning and forecasting energy demand municipality.
- Creation of basic algorithms for the management of waste streams and producing energy in a distributed environment generators and receivers occurring in the community.
- Evaluation of the degree of sustainability of both food and energy production, with a special attention paid to the aspects of the security of the food supply in the overall balance of communes in Poland.
- Creation of an important decision support tool, with respect to local investments as well as the general policy supporting the development of local energy systems and distribution of resources with respect to supporting programs.



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# WP 5

## Environmental impact assessment of implementing renewable technologies in rural areas

- The assessment of landscape values and the impact of changes, related both to the agriculture as well as to the works on the appearance of small distributed energy sources.
- The innovative monitoring system to control the pollution levels, primarily from solid particles, in the community.



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# WP6

## Experimental development of RES installations for agriculture and rural areas

- The development of power supply and control system for GlidArc unit.
- The construction of an electrode array system for the GlidArc. An important parameter of the proposed arrangement of electrodes is the long operating time.
- The development of the micro ORC technology for pre-commercial phase and conducting tests of a pilot plant in simulated real conditions will be done.
- The long-term verification and investigation of complex hybrid heat supply system consisting of heat pump powered from micro wind turbine and PV installation.

# The most important technologies developed under the project



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# Turbogenerator for the CHP ORC system powered by waste heat

- Designing and building of a turbogenerator tailored to the needs of the company along with the entire ORC system (Fig. 1).

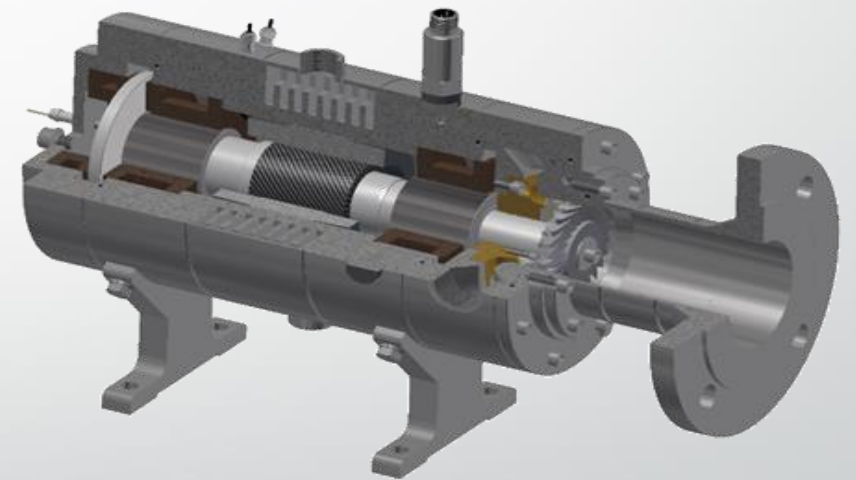


Fig.1. CHP turbogenerator with ORC system (fed with waste heat from the technological process) (source: IMP PAN)



# Turbogenerator for the CHP ORC system powered by waste heat

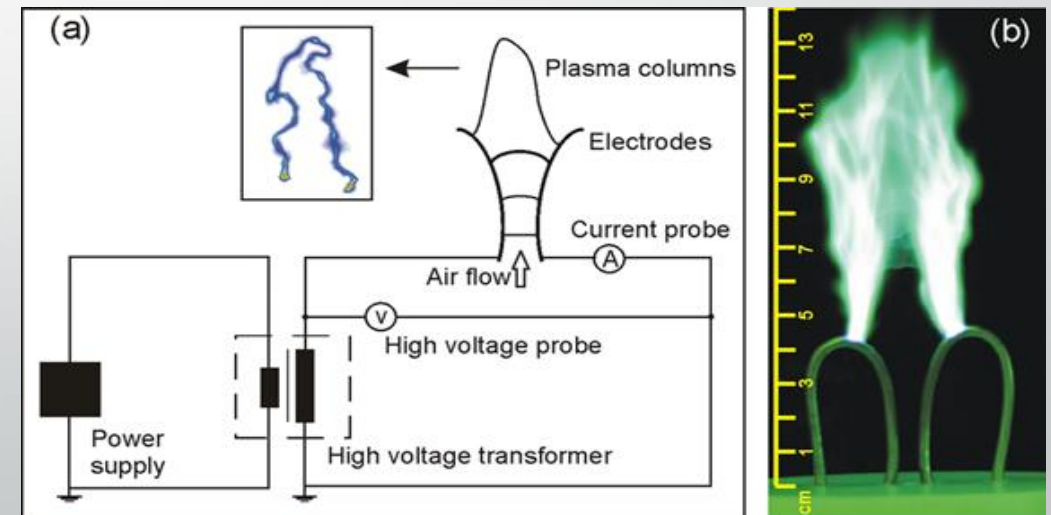
- As part of the design work, an analysis of ORC medium selection and flows will be carried out; analysis of own and commercially available ORC subsystems; and a turbogenerator prototype will be built.
- For ORC installations, own needs and technical restrictions will be determined, and based on these results, input data for design work in the ORC system will be obtained; works will be carried out on the integration of the turbogenerator with the technological process and the power grid (at the location indicated by the industry partner). In addition, assumptions will be made to implement the ORC unit in the production process of the model. The project also includes testing of expanders that can be used in ORC systems as devices converting heat energy into electricity.



# Concepts of the synthesis gas purification device

- Conduction of the synthesis gas cleaning technology using electrostatic and plasma methods.
  - The project will develop a power supply system for the synthesis gas cleaning system based on the GlidArc application (Fig. 2).
  - The GlidArc system also requires the construction of electrodes operating in difficult discharge conditions.
  - Pilot studies of ORC installations will be conducted in realistic conditions.
- The planned tests include correct operation, efficiency and durability of the newly designed and constructed energy system. Test results will help prepare a commercial version of this type of cogeneration system.

Fig.2. Synthesis gas purification device concepts (Glid Arc Discharge) (source: IMP PAN)



# Experimental research on a heat pump compressor

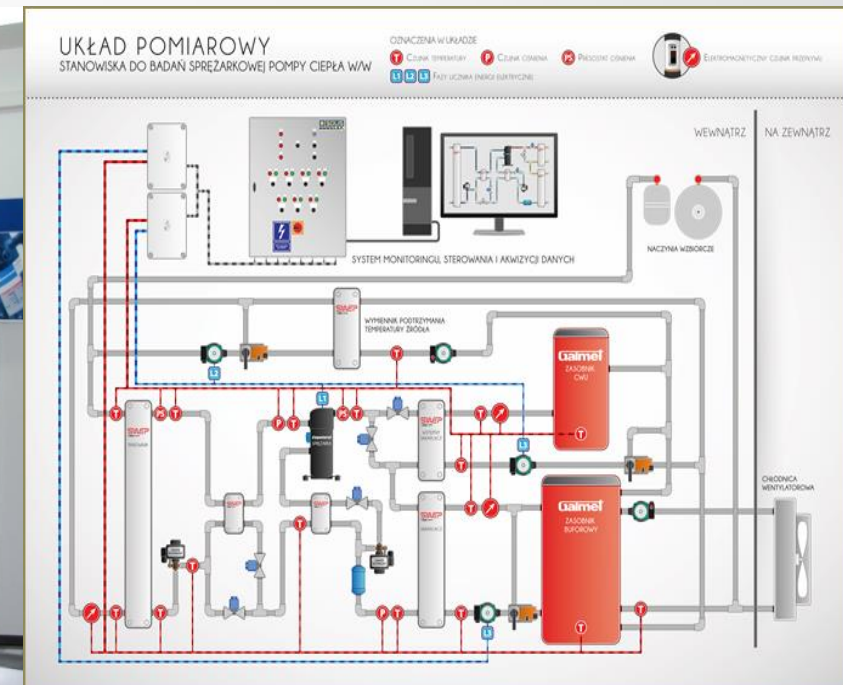
- The project will carry out research in the aspect of island / autonomous power supply for the heat pump. For this purpose, different design options and the relative proportions of different micro energy sources will be analyzed.
- A long-term test of the hybrid heat supply system will be carried out to verify and assess the energy, economic and environmental efficiency and the level of autonomous operation.
- The assessment of effectiveness will consider the possibility of selling surplus electricity generated in micro energy sources to the grid (wind turbine and photovoltaic installation) and the option of using the surplus energy accumulated in lithium batteries for own consumption.



# Experimental research on a heat pump compressor

The whole system will be designed based on tests of the system elements and analysis of the heating needs of the object (Fig. 3) as well as a time analysis of energy production from a renewable micro energy source and the development of a method for scaling the share of individual elements of the hybrid system.

Fig. 3. Concept of compressor systems with heat pump  
(source: IMP PAN)



# Conclusions

- It is assumed that the main recipients of products created as a result of the research performed by this project will be the rural communes.
- The ability to monitor the streams of biomass and other energetically useful wastes translates directly into economic benefits, which - depending on the business models - can be useful for:
  - communes (municipal waste management companies, municipal power companies),
  - prosumers producing their own energy from biomass (eg. agricultural and forestry holdings),
  - energy companies dealing with distribution and trade of electricity.



# Thank you for your attention

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