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BIOCOM

Farm and biogas plant: cooperation experience in Finland

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Introduction

Biogas production is one of the most popular areas of renewable energy development. According to the Annual report 2019 published by European Biogas Association, in the end of year 2018 the amount of Biogas plants in Europe was about 18 200 with annual growth of 2% (Annual report 2019, 10).

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Biogas contains mainly methane CH_4 (45-85%) and carbon dioxide CO_2 (25-50%). During the cleaning process, carbon dioxide and minor impurities such as H_2S (hydrogen sulfide) and silicon oxides are removed. As a result, pure methane remains, equal in properties to natural gas.

In biogas plants, biogas is produced in fermentation tanks or reactors, where biogas is formed in aerobic process from different organic feedstock materials. Commonly used feedstock materials are organic fractions of municipal solid waste, agricultural manure and energy crops, food industry side-streams, sewage from wastewater treatment, slaughterhouse and fish processing waste. (Biovoima 2019.)

Thus, compared to other sources of renewable energy, biogas has a number of advantages that explains it's growing popularity in agricultural areas.

Firstly, biogas plants are more compact and less dependent on natural conditions than wind and solar power plants, not to mention hydropower plants. Individual biogas units can occupy an area of several square meters and can be located on the territory of a small farm or garden plot.

Secondly, biogas offers a comprehensive solution to three important tasks: economic, environmental and social. In addition to the production of thermal and electrical energy, the biogas plant efficiently processes almost any agricultural waste into organic fertilizer. This is of great importance for farmers and foodstuff producers, who are disburden from both waste recycling and wood/coal heating. Besides that, biogas successfully replaces gasoline and solar oil as fuel for cars and agricultural machinery.

Bioenergetics development in Finland

Finland is one of the leaders among the countries choosing a course toward environmental protection and climate conservation. Opinion polls show that the country's population puts environmental issues above the economic problems and fight against terrorism.

As a part of the EU's long-term environmental programmes, Finland is committed to reduce greenhouse gas emissions by 80–95% by the year 2050. The share of transport biofuels will be increased to 30%, and the minimum aim is to have 250,000 electric and 50,000 gas-powered vehicles on the roads.

Equally ambitious goals are set for a closer perspective. Under a plan approved by the Finnish government, coal-fired heat/power plants all over the country must be closed or repurposed by 2029. The decision is connected with the fact that in the production of 1 MWh of electricity coal-powered CHP unit emits into the atmosphere about 0.8 tons of CO_2 - twice as much as a natural gas (or biogas) CHP. In turn, the City Hall of Helsinki plans to reduce carbon dioxide emissions to zero by 2035 to counter global warming. It is implied that the «zero emission» will be achieved by switching to thermal energy from renewable sources.

As far as natural gas is not a renewable resource, and also requires considerable import costs, Finland is actively developing the production of biogas. There are two types of digestion methods, wet and dry. The difference between them is in the total solids (TS) content of the feedstock material. In wet process the TS is max 15% and in dry process 20-40% accordingly. The most common type of reactor for the wet fermentation process is compeletely/countinously stirred tank reactor.

As for the dry fermentation process, both batch and continuous type of reactors are used. Batch reactor means, that the reactor is fed with the organic material and then closed and feedstock is digested a certain period. After the digestion process is completed, the reactor is emptied. The continuous type of reactor means, that the feedstock is regularly added to the reactor and the digested material removed from the other end of the reactor. In continuous reactor, the biogas production rate and the methane content constantly remain approximately at the same level. (Kymäläinen & Pakarinen, 2016, 83.)

Photo 1, 2. Juvan Bioson OY Production Buildings. Photo: Hanne Soininen

Industrial cooperation: turning waste into resource

As mentioned, biogas plant in farm could bring several benefits; it could provide energy and help to manage the organic side flows, such as manure. The reasons for scarcity of the farm-scale biogas plants in Finland is high cost of investment and capricious support policy. Although farms get income from energy sales and also can reduce their own energy costs, it does not cover the annual investment and maintenance costs of the plant. Therefore, the profitability of the plant investment is highly dependable from various forms of financial support and gate fees from the organic waste materials. Refinement of biogas to transport fuel (biomethane) is also significant tool to increase the profitability of biogas plant.

In such conditions, the most profitable and successful way is industrial cooperation, based on the principle «Your waste is our resource.» An example is the Juvan Bioson OY plant located in Juva area, South Savo region.

Currently there are three centralised biogas plants in the South Savo region, and the fourth one will be completed in 2020. Juvan Bioson OY is one of them. It is a centralised farm-scale biogas plant that started its operations at the end of 2011 in Juva, Finland. Biogas is produced by a continuous wet method based on the reactor, which operates in mesophilic conditions. Organic raw materials, including liquid manure, dry chicken droppings and plant waste, are constantly supplied by the plant's co-owners.

Juvan Bioson OY is jointly owned by 11 farms and a greenhouse-farm company Turakkalan puutarha OY. Accordingly, all waste of these farms is delivered to the plant and processed into biogas, and then - to electrical and

thermal energy. A special output of production is digestate, a neutralized and decontaminated organic substance that farmers get back to farms for use as fertilizer.

Transportation of raw materials and final product is handled by a private transport entrepreneur, whose services are paid by the co-owners of the company. As transport in Finland is expensive, the minimal distance between farms and the biogas plant is of great importance. The main advantage of the plant in Juva is its proximity to suppliers of row materials and consumers of electricity, heat and digestate.

What are the main revenue items of this enterprise?

At the moment, all thermal energy and the bulk of electricity are used in the greenhouse farm Turakkalan Puutarha OY, which is located next to the plant. This significantly reduces the cost of the farm's production and makes its work more profitable. Some of the energy is used for the in-house load of the biogas plant, and all the extra energy is sold to the local energy company. Usually in Finland, so-called eco-electricity, or "green electricity", is a little bit more expensive, but the difference is not significant (at least for the private consumer). The biogas plant receives separate fees for the processing of organic waste by local food companies. Recycling waste from canteens and restaurants is also for a fee.

The use of digestate is an important element of cost savings. This product widely reduces the need of co-owner farmers to buy fertilizers. Digestate is distributed to farmers free of charge, depending on the amount of raw materials supplied and the actual fertilizer needs of the farm. The transport company also cares about its delivery.

The annual sale of energy by South Savo plants is about 2,300 MWh (about 60% of all energy produced), in which the share of electricity is 1,190 MWh, thermal energy - about 1,120 MWh. The digestate is used as a fertilizer and soil amendment. The nutrient potential of the liquid manure increases because of the co-digestion of the manure with chicken litter and also because of the hydrolysis of the nutrients.

As long-term observation of Finnish experts shows, a well-organized cooperation in biogas production supports the local circulation of organic materials and also reduces the negative impact of farming on waterways, soil and air. The joint biogas plant intensifies the initiatives and aims of local farmers to take account the sustainable development in farming and in food production chain. This is a very important change in the traditional scheme "resources - energy - production - products - waste". Waste is converted into resources, the chain is transformed into closed circuit, a process of recycling nutrients is started.

BioCom Project: Spreading European Experience in Russia

Russia does not stay away from the world trends of bioenergy development. In 2018, the overall load capacity of renewable energy facilities in Russia was 54.7 GW. According to the International Renewable Energy Agency (IRENA), at the end of 2015, 20% of electricity capacity in Russia was produced by renewable energy facilities, mainly by large hydroelectric power plants. Between 2015 and 2020, more than 30 wind and solar power plants were commissioned in various regions of the country.

The main tools for promoting biotechnology in Russia are state targeted programs, business investments, national and international projects. One such tool is the two-year BioCom project, developed under the Russia-Southeast Finland 2014-2020 Border Cooperation Programme and launched in May 2019.

Three organizations - two Russian and one Finnish - became partners of the project:

1) Institute of Engineering and Environmental Problems of Agricultural Production (IEEP) - a branch of Federal State Budgetary Scientific Institution FNAC VIM (St. Petersburg, Russia)

2) State Government Institution "Center for Energy Conservation and Energy Efficiency of the Leningrad Region" (Leningrad Region, Russia)

3) University of Applied Sciences of South-East Finland – XAMK (Finland)

South-East Finland and the Leningrad Region are intensively developing areas with a significant share of the agricultural sector. Promoting bioeconomic approach and developing cooperation in border rural areas will assist to covering the growing need for energy while reducing the anthropogenic load on the environment.

It should be noted that today in the Leningrad region only single farms have own biogas plants, and their use is not always stable and cost-effective. At the same time, the raw material base for biogas production is huge if to manage properly the waste of large livestock farms, wood processing and food production. The idea of industrial cooperation based on the principle "Your waste is our resources" with the proper support system could significantly accelerate the solution of the extremely urgent problem of waste management in the Leningrad Region.

The Bioeconomy Competence Centre, organised on the basis of the project Lead Partner (IEEP), performs a wide range of biotechnology promotion tasks that help on the sustainable development of pilot areas. First of all, it is informing and training of target groups (schoolchildren, students, farmers, rural specialists, researchers, entrepreneurs) on innovative educational programs developed by project experts. In addition, the Centre organises regular meetings of experts involved in the introduction of biotechnology in agribusiness.

Photo 3. Russian project experts at the biogas plant in Haukivuori, Finland

Another important activity of the BioCom project is to help farms to reduce production energy costs. The project experts conduct an energy survey (energy audit) on pilot livestock farms: identify the potential for energy saving and make recommendations to improve the energy efficiency of enterprise.

Russian and Finnish experts plan to develop a model of the demonstration zone of energy efficiency for the agricultural sector. This task demands to create a common system of environmental and energy survey of agro-industrial enterprises on both sides of the border. Particular attention will be paid to adapting successful Finnish experience to Russian conditions, taking into account objectively existing differences in the inclusive working environment of farms.

Successful implementation of project objectives leads to the formation of a new information / education space, which promotes the active cooperation in the field of energy efficiency and environmental security. Promising expectations from the project are to accelerate the process of innovation, increase the stability of pilot areas and reduce the environmental impact in the Baltic Sea Region.

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