

Economic analysis of operation parameters of the biogas plant in Rozhanovce

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The use of renewable sources in the production of electricity and heat is currently rather common practice than something unusual. Nevertheless, while projecting such a source of energy, it is necessary to take into account certain particularities, risks as well as possibilities. With the production and usage of biogas it is the use of local energy and working sources, which has a positive impact on the development of the region. In this article, technical and economic operation parameters of the biogas plant in Rozhanovce are analysed.

Key words: *biogas, cogeneration, renewable energy sources, economy*

Introduction

Reducing the energy dependence and the production of electricity using renewable sources is not a fashion trend, but the essential course on the way to energy independence. One of the forms is biogas plants, processing agricultural products both of vegetable and livestock production, and, by means of cogeneration units, producing electricity and heat. In Germany, there are currently more than 4,000 biogas plants, locally contributing to partial independence from the supply of electricity or heat. Since, in their nature, biogas plants make use of the local potential (raw material and working potential), it is necessary to realize that also in Slovakia biogas plants should have a solid position in energy mix.

Partnership – the foundation stone of the biogas plant in rozhanovce project

The company Bioplyn Rozhanovce, s.r.o. came into being as a joint venture company in order to build and operate a biogas plant in Rozhanovce. The companies Východoslovenská energetika a.s. and AGROTRADE GROUP, spol. s r.o., which, through their subsidiaries, established the company Bioplyn Rozhanovce, s.r.o., participated in this mutual project.

The project of building and operating a biogas plant resulted from an analysis of business options arisen after the adoption of Act No. 309/2009 Coll. on the promotion of renewable energy sources and high-efficiency cogeneration in the year 2009. This Act guarantees 15-year purchase period for electricity produced by means of renewable sources. The preliminary economic analyses of income and expenses with regard to the construction and, subsequently, the operation of the biogas plant, determined the parameters and price options of investment and operation costs while keeping the expected project payback.

Since the purchase price for electricity produced by means of burning biogas produced by anaerobic fermentation technology is guaranteed for the period of 15 years, the main idea was the maximization of the production of electricity, i.e. the choice of such a biogas plant and such cogeneration units which would fulfil this idea.

The choice of the biogas plant technology was based on the production possibilities of the input raw material being at the project partner, the company AT ABOV, spol. s r.o.'s disposal, and the individual price levels of purchased electricity. From the viewpoint of the purchase price, the most effective was to build a biogas plant with the installed capacity of 1MW. From the viewpoint of eliminating the risk with the anaerobic fermentation process, the input raw material was selected to be corn silage and for the starting process together with corn silage also CCM (Corn Cob Mix).

The company AT ABOV, spol. s r.o. deals with both vegetable and livestock production, while farming approx. 0 ha of arable land. With its idea, the project of a biogas plant suitably fitted in the conception of the diversification of the company's entrepreneurial activity. With the planned construction in the year 2010 and the completion of the biogas plant in the year 2011, the company AT ABOV, spol. s r.o. adjusted the sowing plan and provided for sufficient amount of the raw material (corn silage, CCM) for the starting-off and proper operation of the biogas plant. The official connection of the biogas plant to the distribution system took place on 9 June 2011.

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The choice of the biogas plant technology

The original project documentation counted on using waste heat mainly in order to provide for optimum fermentation process of the creation of biogas and the farmyard of the company AT ABOV spol. s r.o. However, the needs of the farmyard are minimal, thus the choice of cogeneration units focused on higher efficiency in favour of the production of electricity.

In order to provide for optimum running of the biogas plant from the viewpoint of continuous process of biogas production and from the economic viewpoint of the size of the installed capacity, this being 1MW, 2 cogeneration units with the installed electrical capacity of 400 kW and 600 kW were defined into the project. Together with them, appertaining fermentation tanks with the fermentation technology circle in circle, and the final storage of the output digestate were included in the project.

The choice of the cogeneration units and, also, the technology itself, was connected with the possibility of modularity which this system enables. It also applies to carrying out small serviced repairs to the cogeneration units, as well as general repairs, or not planned service interventions which, with suitable setting and managing of the processes, will provide for continuous biogas production without the need to stop the fermentation process in the fermentors. With regard to the need of biogas, the effective production will be influenced by the change of feed rations, thus providing for optimum regulation of the operation costs in comparison with the maximization of the yields at that moment.

Cogeneration units at the biogas plant in rozhanovce

When choosing the cogeneration units, one of the reviewed factors was the efficiency of the cogeneration units as far as the production of electricity and heat is concerned. The projected cogeneration units of the company MWM GmbH meet the required parameters. The cogeneration units TCG 2016 V08 C and TCG 2016 V12 C are installed.

Tab. 1. Basic parameters of the cogeneration units.

Type of cogeneration unit		TCG 2016 V08 C	TCG 2016 V12 C
Installed capacity			
• heat	kW	415	620
• electric	kW	400	600
Working speed	min ⁻¹	1500	1500
Temperature of exhaust gases	°C	442	447
Amount of gases	kg/h	2147	3224
Amount of combustion air	kg/h	1979	2972
Amount of ventilation air	kg/h	11978	15968
Efficiency			
• electric	%	42,5	42,5
• heat (with exhaust gases cooled to 150 °C)	%	42,3	43
Total efficiency	%	84,8	85,5
Number of cylinders			
		8	12
Length	mm	3070	3700
Width	mm	1480	1450
Height	mm	2280	2200
Weight	kg	4500	5700

The economics of the biogas plant

The underlying documents for the economic analysis of the biogas plant are based on both the contracted investment costs of the construction of the biogas plant complex and the planned operation costs. The payback period of such defined biogas plant is expected to be 11 years.

Tab. 2. Planned financial indicators of the biogas plant.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Investície/CAPEX	-3 194	0	0	0	0	0	-365	0	0	0	0	0	0	0	0
Úver/Instalment credit - principal	2 662	-295	-296	-296	-296	-296	33	-332	-332	-332	-37	-37	-37	-37	-37
Prevádzkové náklady/OPEX	-429	-687	-690	-693	-696	-700	-703	-707	-711	-714	-718	-722	-727	-731	-736
Výnosy, úspory/Revenues	584	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168	1 168
EBITDA	155	482	479	475	472	469	465	461	458	454	450	446	442	437	433
Odpisy/Depreciation															
- daňové/tax	328	328	328	328	346	346	89	89	89	89	89	89	89	89	89
- účtovné/accounting	191	328	328	328	339	346	196	89	89	89	89	89	89	89	89
EBIT	-36	154	151	147	133	122	269	372	369	365	361	357	353	348	344
Úroky/Instalment credit - interest	-143	-133	-118	-104	-89	-74	-77	-61	-44	-28	-11	-9	-7	-5	-4
Úroky/Overdraft loan - interest	-3	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11
EBT	-182	10	21	33	34	38	181	301	314	326	339	337	334	332	329
Základ dane	-318	10	21	33	26	38	288	301	314	326	339	337	334	332	329
Strata na rozpustenie (ostávajúca)	-318	-308	-287	-254	-228	-190	0	0	0	0	0	0	0	0	0
Upravený základ dane	-318	-308	-287	-254	-228	-190	98	301	314	326	339	337	334	332	329
Daň/Tax	0	0	0	0	0	0	-19	-57	-60	-62	-64	-64	-64	-63	-63
PAT	-182	10	21	33	34	38	162	244	254	264	275	273	271	269	267
CF	-522	43	54	65	77	88	26	0	11	21	327	325	323	321	319
DCF	-522	41	48	55	61	66	18	0	7	12	183	171	161	151	141
ČSH/NPV	592														
Vnútomé výnosové percento/IRR	15,42%														
Doba návratnosti/Payback period	11	2022													

Heat – a challenge still existing

The heat from the cogeneration units is distributed to a heat exchanger which will supply part of the heat to the system for the needs of the fermentation process, part for winter heating of the technological rooms of the biogas plant, and the remaining part to the system for cooling. The amount of the heat for the fermentation process depends on the outside temperature conditions influencing the interior temperature of the fermentor. [6] During winter months the maximum capacity is expected to be approx. 215-270 kW_e, the annual average should be approx. 145 kW_t.

As it is clear from the previous paragraph, the use of heat at the biogas plant is not the most suitable. However, with the economic analysis of the payback and the time pressure put on the construction and, mainly, on the starting off the biogas plant resulting from the notified change of the purchase price during the year 2011 (the price applicable until 30 June 2011 was 148,72 EUR/MWh), it was not possible, during the preliminary phase of the project, to look for other economic utilization of waste heat. At present, the company Bioplyn Rozhanovce, s.r.o., is reviewing other possibilities of the utilization of waste heat. The negotiations with the representatives of the village of Rozhanovce on supplying the school and the school buildings complex, which passed into the property of the village after the delimitation, have not been successful yet from the economic viewpoint. The school is approx. 800 m away from the technological preparation of leading the waste heat from the biogas plant for external use, and based on the analysis of the recent years, the year-round consumption of heat for heating of supply water is approx. 300 MWh.

The investment costs of building hot water connection were estimated to be approx. EUR 200 thousand, which in reality means that with keeping the year-round payment for heat as in the previous years, the payback would be 28 years. Together with the village we are therefore looking for other possibilities of funding this connection (financing infrastructure by means of structural funds), or further use of waste heat.

Another possibility of using heat is drying digestate, which is suitable fuel after having been processed, for instance, for pellets. The need to dry dregs for its energy use is also shown in the diagram. The need of heat to dry the digestate is considerable, which is also indicated by the dependence of water and dreg weight per 1 ton of dry dregs, shown in the Fig. 1.

With maximum dregs dampness suitable for compacting for the energy process, 15 % represents the weight of water per 1 t of dry substance only 176 kg, while with common dregs dampness approx. 66 % this value is already approx. 1,950 kg! [5]

Within the half-year operation of the biogas plant, the cogeneration units did not record any significant failures. During the regular inspections, determined by the producer of the cogeneration units, motor oil was taken away and analyzed. Based also on these analyses, the replacement of a turbo-blower on one of the cogeneration units was planned and carried out at the beginning of December 2011 within the warranty

period. Other service activities (the replacement of spark plugs, filters, ...) were carried out according to the Schedule set by the producer of the cogeneration units.

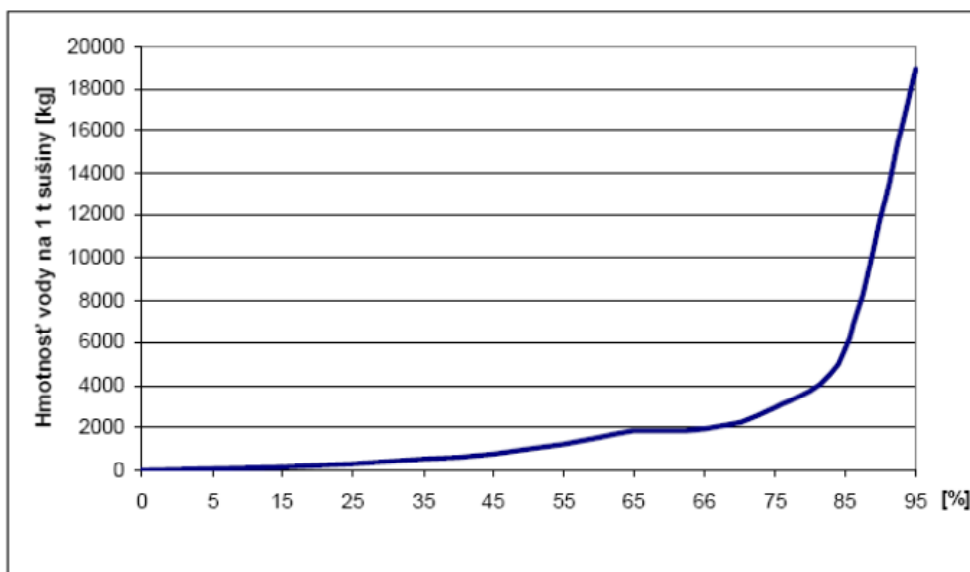


Fig. 1. Dependence of water and dregs weight to the dregs dampness to 1 tone of dry dregs.

Electricity – review of production

The current operational capacity of the cogeneration units is set to be 96 % of their installed electrical capacity. The production of electricity from the starting off the biogas plant is shown in the graph in Fig. 2.

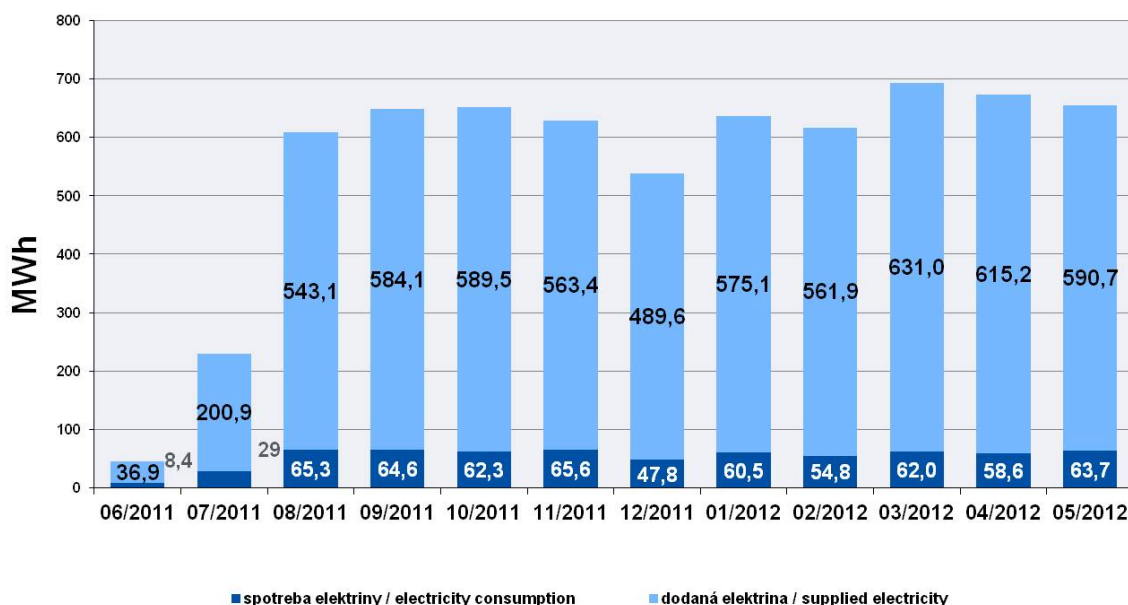


Fig. 2. Production of electricity.

Conclusion

It is possible to conclude that the current operation and the production of electricity are going according to the plan. If we manage to find and implement an economic solution to the use of waste heat, it will have, as a consequence, more effective use of the biogas plant and the improvement of the economic parameters.

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