ECONOMIC EVALUATION OF BIOGAS PLANT

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ABSTRACT

This paper deals with problematic of biogas plants. Economical evaluation of biogas plant will be described.

1. INTRODUCTION

Exploitable potential of biomass in Slovakia is 11,237 GWh per year, which would cover nearly 40% of annual electricity consumption in Slovakia. The big advantage of biomass is, that biomass don't leave "carbon footprint", because biomass during its growth through photosynthesis consumes carbon dioxide, which is released into the atmosphere in its energy use. In conditions of Slovak Republic biomass energy can be utilized as:

- forest biomass - fuel wood, energy crops,
- agricultural biomass - waste of growing and processing crops, garden biomass from orchards and vineyards, production of liquid biofuels (bioethanol), livestock manure, waste from the food industry,
- waste - waste wood processing industry, municipal waste, sludge from sewage treatment plants.

In this paper economic evaluation of biogas plant construction will be described. [1]

2. LOCATON OF BIOGAS PLANT

The location of the biogas plant is considered in Kechnec, Slovakia, industrial zone. This industrial zone is located in the area focused on agricultural production which means that it would ensure adequate supply of materials.

Table 1 Amount of input feedstock

Feedstock	Quantity t/y	Yield m^3/t	Production m^3/y
Corn Silage	17 000	200	3 400 000
Cuttings of sugar beet	1675	90	150 750
The total amount of biogas production			3 550 750

Table 2 The basic technological parameters of waste heat total amount of biogas production

Basic parameters of BGS			
Installed capacity	electric	1 000	kW
	heat	1 376	kW
Biogas production		10 080	m^3/day
Using of equipment		8 250	h/y
		94,17	%

Own consumption of BGS	4	%
Supply of electric energy	7 933	MWh
Sales price of electricity	107,53	€/MWh
Technological heat supply	15	%
Heat supply	35 536	GJ
	9 872	MWh
The price of heat	15	€/GJ
	54	€/MWh

3. BALANCE OF ELECTRIC AND HEAT ENERGY

Produced thermal energy will be used for own fermentation process. According to law No. 309/2009 on RES has been put condition to obtain the full amount of the redemption price of electric energy. Producer of electricity in the BGS combustion of biogas produced from the anaerobic fermentation for this electricity gets 100% of the redemption price if the technological consumption is measured - share the use of technological heat consumption shall be 25% of the total heat production. If technological consumption is not measured - share the use of technological heat consumption should be 15% of the total heat production. [2], [3].

Electric power KGJ:	1 MW
Exploitation of maximum power:	8 250 h
Amount of electric energy at the generator terminals:	8 250 MWh
Losses + own consumption of electricity (4%):	8 250 x 0,04 = 330 MWh
Quantity of supplied electric energy:	7 920 MWh
Price paid for electricity:	107,53 €/MWh
Annual revenues from sale of electric energy:	7 920 x 107,53 = 851 637,6 €
CHP thermal power:	1,376 MW_t
Amount of produced heat:	11 352 MWh_t
Heat consumption (15%):	11 352 x 0,15 = 1 703 MWh
Heat delivered to the customer:	11 352 - 1703 = 9 649 MWh
Price paid of heat:	49 €/MWh
Annual revenues from sale of electric energy:	9 649 x 49 = 472 811 €
Annual sales total:	851 637,6 + 472 811 = 1 324 448 €

4. CAPEX (CAPITAL EXPENDITURES)

The amount of investment costs and their distribution for the proposed solution lies in the following tables:

Table 3 Distribution of capital costs

Capital expenditure	%	EUR
Total investments	100	3 980 000
Building part	45	1 791 000
Technological part	35	1 393 000
Engineering (design documentation, authorization)	5	199 000
Earth works	15	597 000

For the mentioned variant is proposed financing rate of 40% own capital and 60% foreign sources, which represents a loan from the bank. Financing through a bank loan is justified on the basis of determining the amount of return on equity. The higher ratio of foreign sources the higher profit on equity capital at the same interest rate.

Table 4 Method of funding

Total investment cost	3 980 000
Investor's own resources 40%	1 592 000
External funding (loan) 60%	2 388 000
interest rate	5% p. a.
Time of repayment	10 years

For redemption at a constant height annuity the amount of interest at the rate of 5% p.a. represents 704 458 €. On Figure 1 is shown the redemption plan for presented variant. The amount of interest rate for constant amortization at an interest rate of 5% p.a. represents 656 700 €.

Table 5 Redemption plan

Interest Rate Period	The residue of debts	paid		
		interest	amortization	paid
0	2 388 000	-	-	0
1	2 149 200	119 400	238 800	238 800
2	1 910 400	107 460	238 800	477 600
3	1 671 600	95 520	238 800	716 400
4	1 432 800	83 580	238 800	955 200
5	1 194 000	71 640	238 800	1 194 000
6	955 200	59 700	238 800	1 432 800
7	716 400	47 760	238 800	1 671 600
8	477 600	35 820	238 800	1 910 400
9	238 800	23 880	238 800	2 149 200
10	0	11 940	238 800	2 388 000

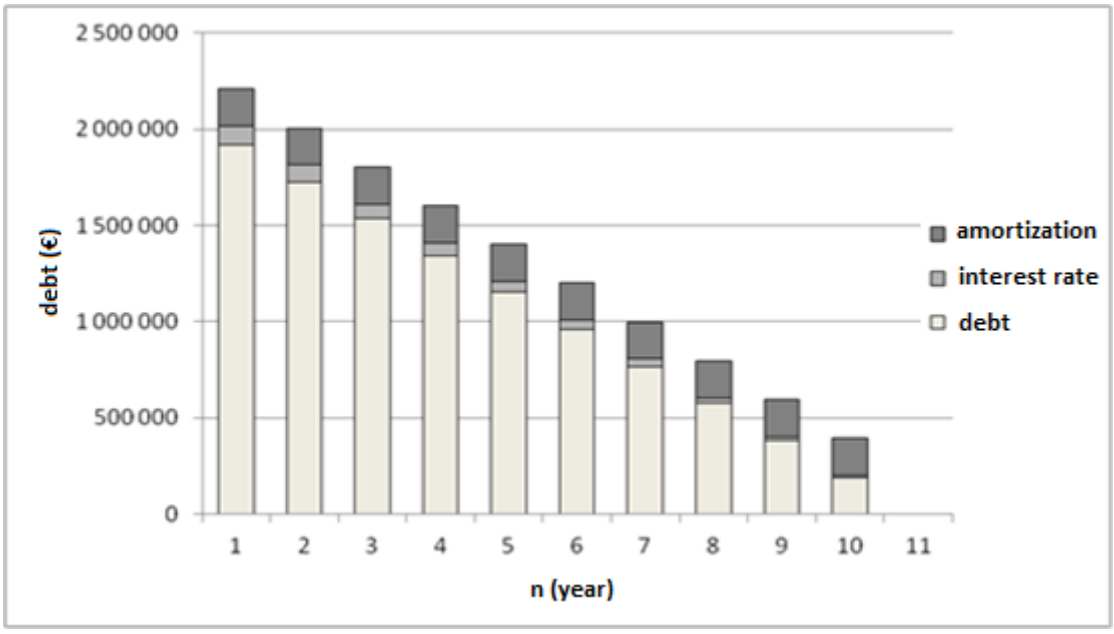

Figure 1 – Redemption plan

5. SENSITIVITY ANALYSIS

Sensitivity analysis gives an overview of which factor in the preparation, construction and operation of the project should be given greater attention. It is necessary to transfer part of the risk to suppliers of technology, raw material supplier or other suppliers to incorporate the requirements into individual contract relations. Such example can be, e.g. the dependence of the electricity produced from biogas quality parameters. Amount of biogas produced from the input of the substrate depends on its quality.

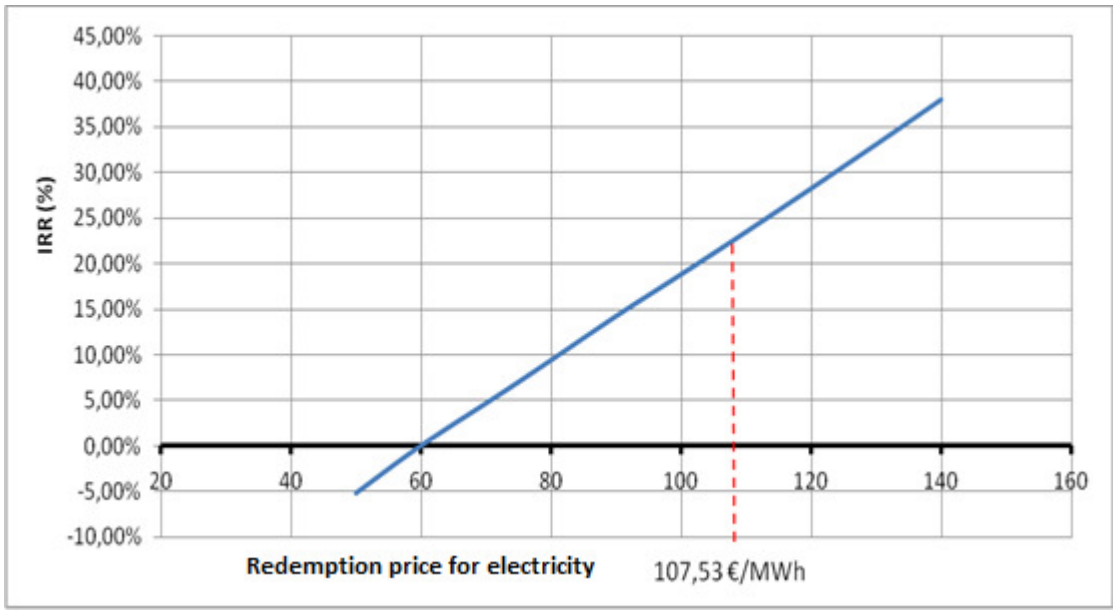

Figure 2 – Dependence IRR from the redemption price for electricity

On figure 2 is dependence of the internal rate of return from the from the redemption price for electricity. At the current redemption price at 107, 53 €/MWh. IRR is at 22, 35%.

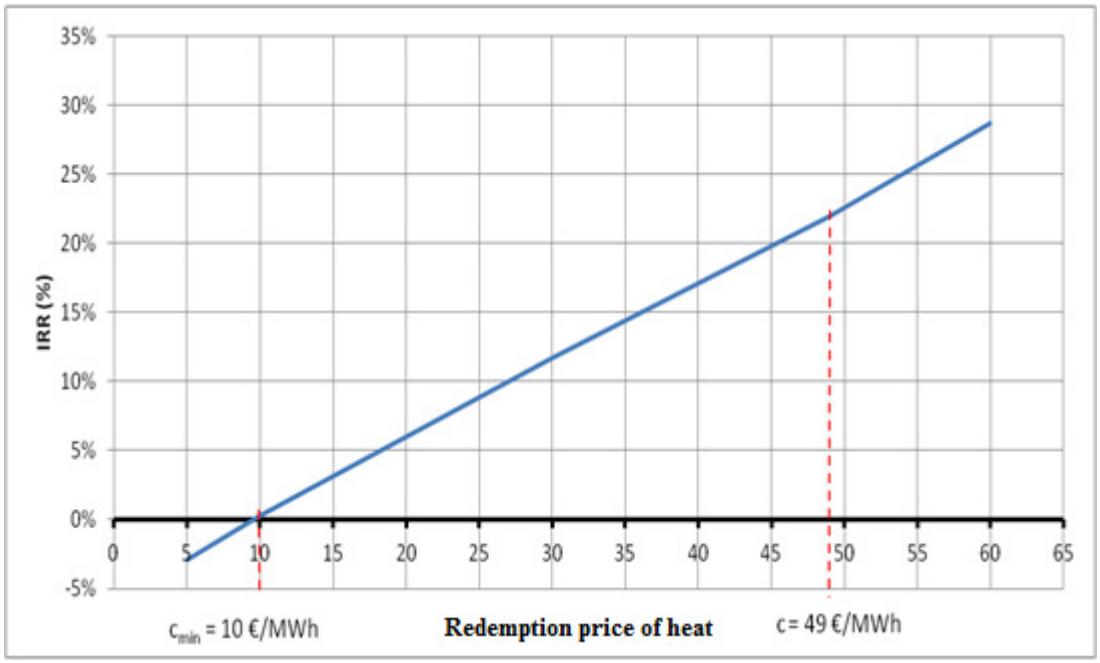

Figure 3 Dependence of IRR from redemption price of heat

To make the project profitable minimum price of heat should not decrease below 10 € / MWh.

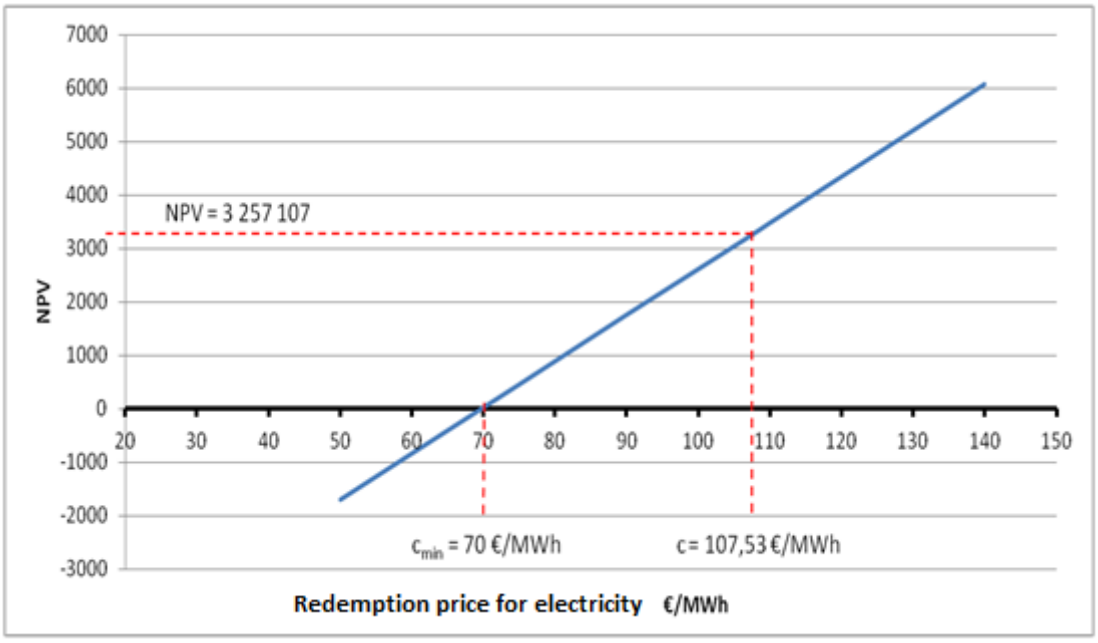

Figure 4 - Dependence of NPV from the redemption price

On figure 4 is NPV sensitivity analysis during the change of redemption price at 5% of discount rate. Based on NPV analysis can determine the amount of the redemption price impact on the profitability of the project. That the proposed variant should by profitable, the redemption price of electricity should not decrease below 70 € / MWh.

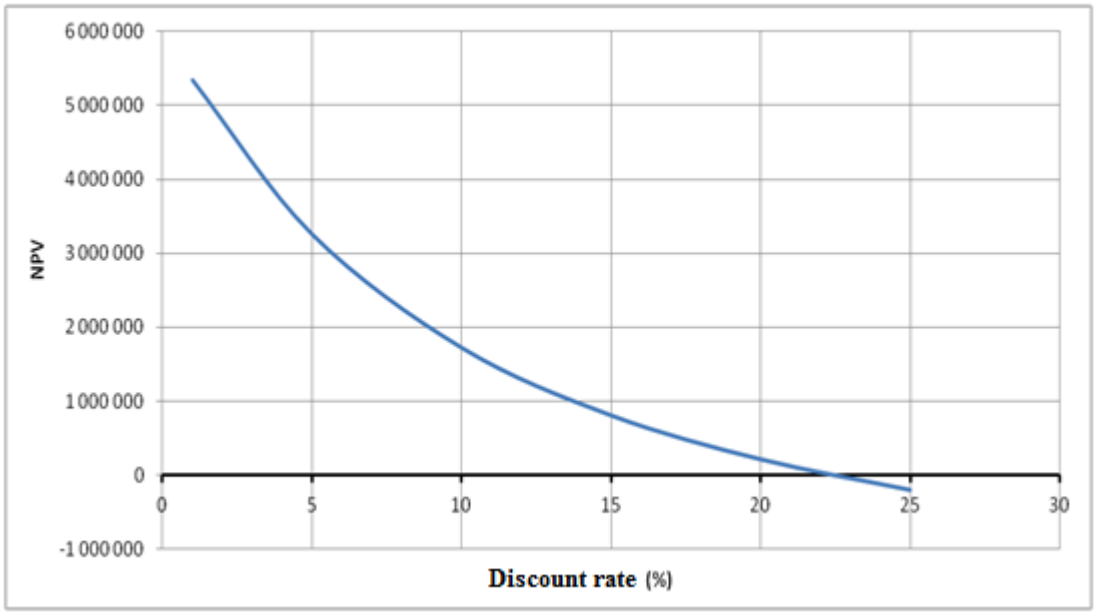

Figure 5 - Dependence of NPV from the change of discount rate

From dependence on the NPV discount rate in Figure 5 shows that the project would not be profitable at a discount rate greater than 22%.

6. CONCLUSIONS

Biogas plants are an appropriate way to diversify energy sources and thus contribute to reducing dependence on imported fossil fuels. They also contribute to the improvement of the regional economy and increase employment. However, with the development of biogas plants must also take the development of electricity supply system, because biogas plants represent decentralized resource which operates certain retroactive effects on the system, which was primarily designed for centralized electricity generation.
The advantage of the variant for combined heat and power production may be less sensitivity to changes in the redemption price of electricity, which is guaranteed for a shorter period than the life of the equipment.

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