BIOGAS PLANT INVESTMENT ANALYSIS, COST BENEFIT AND MAIN FACTORS

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Abstract. The establishment of a biogas station is possible only with a large investment and a good answer to these main questions. 1. Would it be profitable? 2. What are the risks? 3. Is the current support for the establishment of a biogas station sufficient? 4. What are the main factors, which the funding depends on? 5. Is the current buying price for renewable energy sufficient to make the biogas station a profitable venture? These are some of the questions which this work strives to answer through model calculations. Also the graphed payback periods of the main factors and prices are included in the event where the used discount rate is 13 %. By using the model calculation, the quick changing of the variable factors, and finding the most important components, profitability is proved to be possible.

Keywords: investment analysis, remuneration, subsidiaries, sensitivity.

Introduction, materials and methods

All parameters and characterizing values are put into the corresponding mathematical model in EXCEL which are related to the example with the current article (see Normak, etc.). The quantity of liquid manure which is used in the model calculation corresponds to about 400 head milk cow complex. Also an optimum quantity of silage in the calculations is applied, as additional substrate. Obviously, there are also other biodegradable wastes (municipal, agricultural) attached to the process, which are usually possible to use in all potential sites of the biogas plant. This helps to contribute significantly to the waste management organizing. The investment into technology is based on one particular offer of Host Engineering in Energy. The size of the investment between the different equipment providers does not differ much by size, so the resulting impact on the study is not significant. In this case the discount rate for benefit-cost analysis is 13, the investors holding 60.9 % and it uses all the main potential resources of subsidy for livestock, for heat utilization as well as support for established bio-gas plants, which is 4.7 million EEK (about 213 640 LAT). Total cost of the project is 20 975 438 EEK, and investors participation of it is 12 775 438 EEK. The rate of the share capital is 11 %. The excess part of the investment is planned to be covered with a bank loan (49.9 %).

The elements of the model which enable the input of raw data and to make changes in it, have been excluded from the article, and are reported in the last table: “a project cash flow”, which also reflects all the essential elements of this project numerically over the lifetime of the project. Length of the loan period is accounted for 10 years, and the investment lifetime has been calculated for 15 years.

It is important to note that the model calculations have been made by the price of silo being 300 EEK t^{-1}. The subsequent graphs of sensitivity show the impact of the silo price as a significant increaser of the payback period. In this example, the expected discounted payback time is planned for 5 to 6 years.

Prices going up are index-linked for both purchase and sales prices, and it is possible to change the amount of the index variable, this enables to count automatically the analysis of price changes (increase) year by year, and it reflects the projected annual growth in the input prices (substrates and heat selling price). The selling tariff of electricity is taken to account as 1.25 EEK kWh^{-1}, which is 10 cents higher than the fixed purchase price of electricity.

Results and discussion

1. Simple and discounted payback time dependence of silo price

On the following Figure 1 the payback time sensitivity to the price of silo is shown. It appears that there is not much room for the silo price to rise, so the simple and discounted payback time is shifting rapidly over the desired payback period.

Table 1

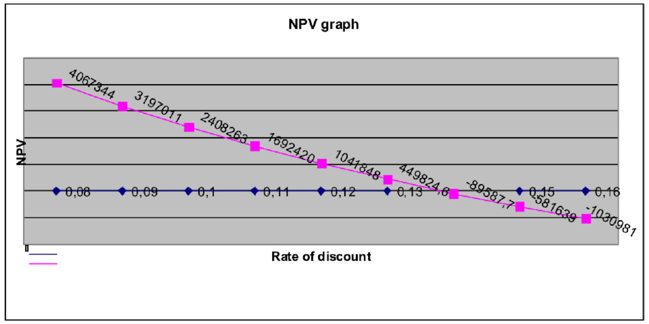
Cash flow from investing activities (MS EXCEL)

Table 1. Cash flows from investing activities

Cash flows from investing activities								
Reduced yield		50%	80%					
Year		2008	2009	2010	2011	2012	2013	2014
Period		1	2	3	4	5	6	7
Annual income								
Income from electricity sale		2 315 625,00	3 705 000,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00
Income from heat sale		1 008 600,00	1 710 585,60	2 138 232,00	2 266 525,92	2 402 517,48	2 546 668,52	2 699 468,64
Income from interest* on liquidity reserve								
Total annual income		3 324 225,00	5 415 585,60	6 769 482,00	6 897 775,92	7 033 767,48	7 177 918,52	7 330 718,64
Expenses		1 830 783,33	3 335 526,65	4 017 682,65	4 258 743,61	4 514 268,23	4 785 124,32	5 072 231,78
Insurances		52 438,60	104 877,19	111 169,82	117 840,01	124 910,41	132 405,04	140 349,34
Maintenance CHP		274 597,83	549 195,66	582 147,40	617 076,24	654 100,82	693 346,87	734 947,68
Maintenance Plant		150 777,90	301 555,80	319 649,15	338 828,10	359 157,78	380 707,25	403 549,68
Analysis, certificates		50 000,00	100 000,00	106 000,00	112 360,00	119 101,60	126 247,70	133 822,56
Rent		0,00	0,00	0,00	0,00	0,00	0,00	0,00
Substrate costs per year		1 072 500,00	1 818 960,00	2 410 122,00	2 554 729,32	2 708 013,08	2 870 493,86	3 042 723,50
Operational management		132 969,00	265 938,00	281 894,28	298 807,94	316 736,41	335 740,60	355 885,03
Electricity costs		97 500,00	195 000,00	206 700,00	219 102,00	232 248,12	246 183,01	260 953,99
Other costs		0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cash flow (net income)		1 493 441,67	2 080 058,95	2 751 799,35	2 639 032,31	2 519 499,25	2 392 794,20	2 258 486,86
Discounted cash flow analysis								
Investment	-12775438	1493441,67	2080058,95	2751799,35	2639032,31	2519499,25	2392794,20	2258486,86
	2408263,23	0,93	0,86	0,79	0,74	0,68	0,63	0,58
		1382926,99	1782610,52	2184928,68	1939688,75	1715778,99	1507460,35	1316697,84

Cash flows from investing activities								
Reduced yield								
Year	2015	2016	2017	2018	2019	2020	2021	2
Period	8	9	10	11	12	13	14	
Annual income								
Income from electricity sale	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 250,00	4 631 25
Income from heat sale	2 861 436,75	3 033 122,96	3 215 110,34	3 408 016,96	3 612 497,97	3 829 247,85	4 059 002,72	4 302 54
Income from interest* on liquidity reserve								
Total annual income	7 492 686,75	7 664 372,96	7 846 360,34	8 039 266,96	8 243 747,97	8 460 497,85	8 690 252,72	8 933 79
Expenses	5 376 565,69	5 699 159,63	6 041 109,21	6 403 575,76	6 787 790,30	7 195 057,72	7 626 761,18	8 084 36
Insurances	148 770,30	157 696,52	167 158,31	177 187,81	187 819,08	199 088,22	211 033,52	223 69
Maintenance CHP	779 044,54	825 787,21	875 334,45	927 854,51	983 525,78	1 042 537,33	1 105 089,57	1 171 39
Maintenance Plant	427 762,67	453 428,43	480 634,13	509 472,18	540 040,51	572 442,94	606 789,52	643 19
Analysis, certificates	141 851,91	150 363,03	159 384,81	168 947,90	179 084,77	189 829,86	201 219,65	213 29
Rent	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Substrate costs per year	3 225 286,91	3 418 804,12	3 623 932,37	3 841 368,31	4 071 850,41	4 316 161,43	4 575 131,12	4 849 63
Operational management	377 238,14	399 872,42	423 864,77	449 296,66	476 254,45	504 829,72	535 119,51	567 22
Electricity costs	276 611,23	293 207,90	310 800,37	329 448,40	349 215,30	370 168,22	392 378,31	415 92
Other costs	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Cash flow (net income)	2 116 121,07	1 965 213,33	1 805 251,13	1 635 691,20	1 455 957,67	1 265 440,13	1 063 491,54	849 42
Discounted cash flow analysis								
Investment	2116121,07	1965213,33	1805251,13	1635691,20	1455957,67	1265440,13	1063491,54	849426
	0,54	0,50	0,46	0,43	0,40	0,37	0,34	
	1142705,38	982606,67	835831,27	701711,52	578015,20	465681,97	361587,12	267569

NPV (13%)	**449824,55**	
IRR (%)	**0,14**	
	e 14%	
Investment	**12775438,40**	
Simple payback time		
Expected payback time 5 Year		
Simple payback time	**11483831,53**	Simple payback time (~5,5)
Discounted payback time	**12972797,49**	Discounted payback time (~8)
	NPV	Rate of discount
NPV(8)	4067344	8
NPV(9)	3197011	9
NPV(10)	2408263	10
NPV(11)	1692420	11
NPV(12)	1041848	12
NPV(13)	449825	13
NPV(14)	-89588	14
NPV(15)	-581639	15
NPV(16)	-1030981	16



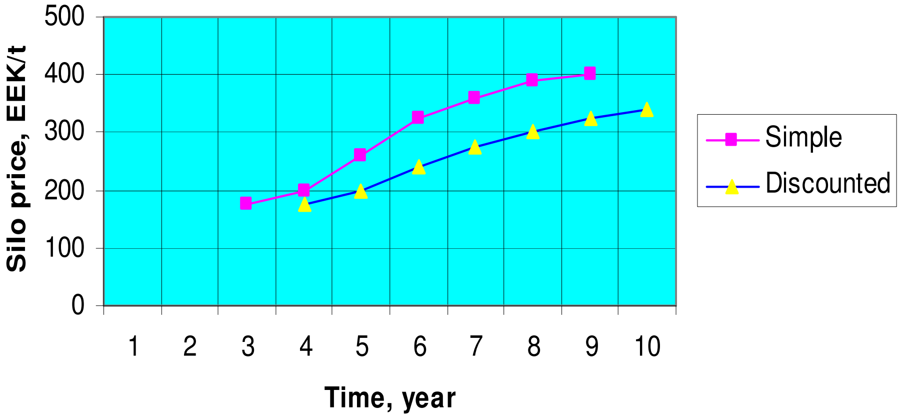


Fig. 1. **Simple and discounted payback time depending on the silo price (electric sales tariff 1.25 EEK kWh^{-1})**

2. Simple and discounted payback time dependence on various electric sales tariffs

On the following Figures 2-4 the silo price and electric sales tariff impact on the biogas plant, on simple as well to discounted payback time at different prices of silo is shown. It appears that even small changes in the silo price and electric sales tariff significantly inflect the payback period.

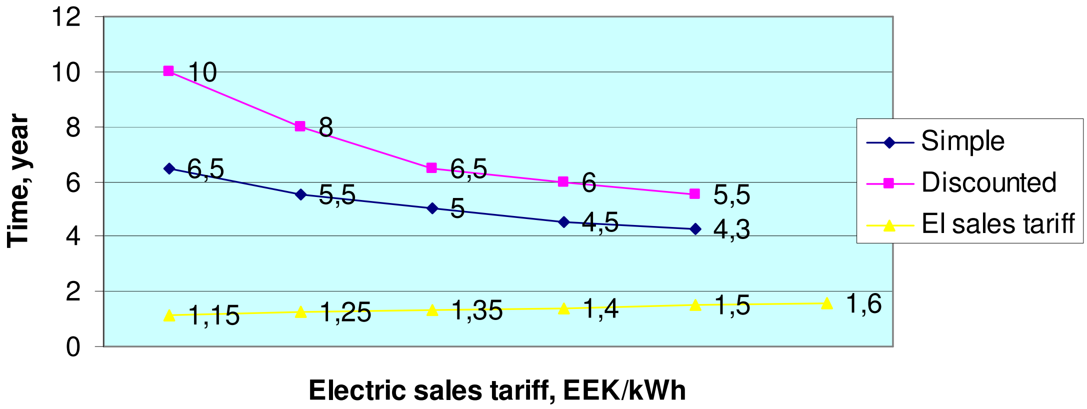


Fig. 2. **Payback time dependence on electric sales tariff (on silo price 300 EEK t^{-1})**

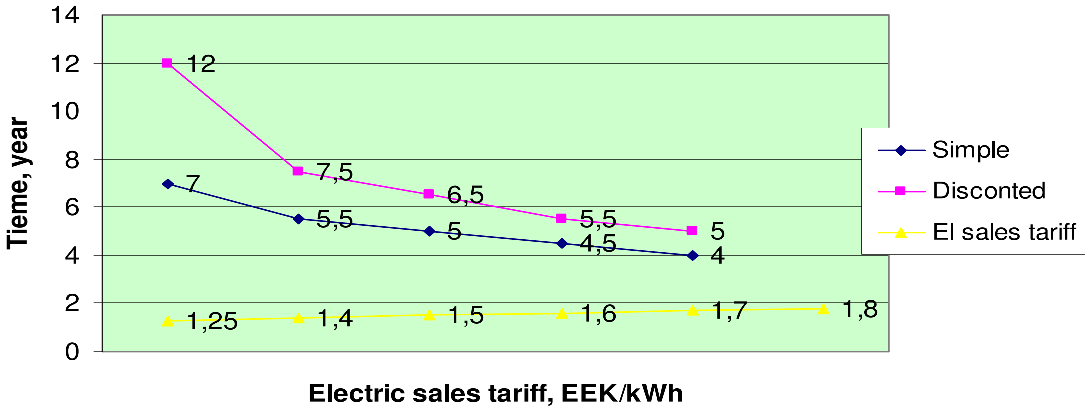


Fig. 3. **Payback time dependence on electric sales tariff (on silo price 350 EEK t^{-1})**

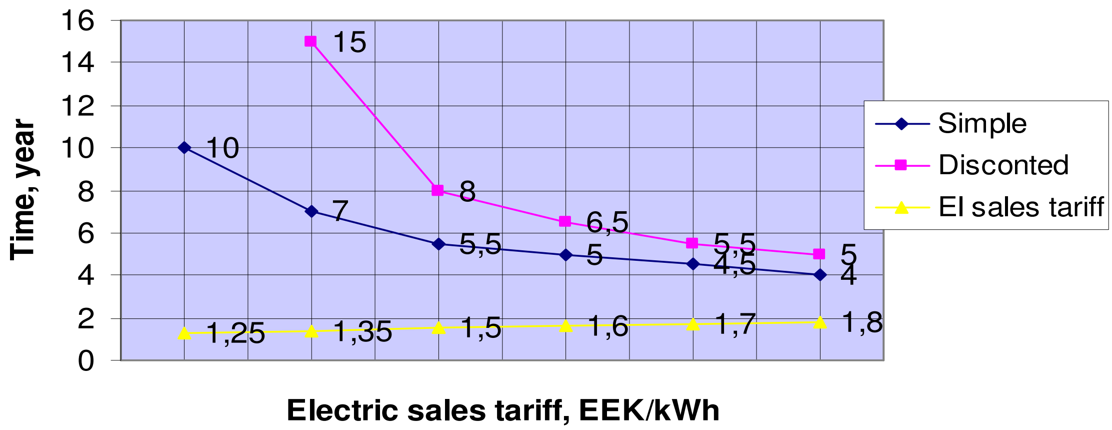


Fig. 4. **Payback time dependence on electric sales tariff (on silo price 400 EEK t^{-1})**

3. Profitability and Policy

The baseline calculation of this project has been done with a discount rate of 13 %. In this case, the payback time is approximately 8 years. Simple payback time is being 5.5 years. Using the 13 % discount rate, the internal rate of return (IRR) is 14 %, so it is also close to the limit on the discounting, which means that the project is still cost-effective. The discount rate of 13 % is a result of the relatively large risk of investment in this area. Based on the project baseline data, current prices, and available financial support, it is not possible for the project to achieve the needed discounted payback time by the 5th to 6th year of operation. Since in the model calculation we use the subsidy for the development of livestock manure management and as well for heat transfer, which is not always possible, hence the real payoff may be much longer. This would require higher subsidies to the establishment of the biogas plant or we need to presume to increase the electricity tariff. Table 1 on NPV (Net Present Value) graph is shown as NPV dependence on a discounted rate of return.

The government politics are also skeptical of the bio-energy industry. Consequently, as a result of such skepticism the bio energy sector is out of attention. The government has show its initiative and desire to increase the share of renewable energies in national energy production, but it may be implemented in other ways, such as wind power supporting.

The analysis carried out by "Ernst & Young Baltic AS" found that the most critical risks, which pose a threat to the bio-energy field in Estonia are related to the raw materials, land low exploitation, and governmental policy and behavior in developing this industry (http://www.bioenergybaltic.ee/?id=1307 summary).

Conclusion

1. When the manufacturing methods of biogas are competently selected there are additional benefit factors to saving nature and costs of testing and other means. To reap additional benefits, as energy yield, these methods need to be applied at the standard recycling and utilisation processes.
2. From the result estimations, according to the current example, the 13 % discounted price payoff period is 8 years. This is a period, which is not attractive to the investor, and it would make getting bank loans difficult if not questionable.
3. Also, here we have used for the price of silo (300 EEK t^{-1}), which is close to the cost price and is not sufficient without the support of the energy-crop growing fund and may not be even enough with that to evoke the interest in silo production.
4. When investigating the changes of investment analysis about electricity sale tariffs also during a small rise (0.25 EEK kWh^{-1}) we see major changes in shortening the payoff period (- 2.5 years), which would make the project feasible. At the same time the rising price of silo (+50 EEK t^{-1}) would cause a noticeably longer recoupment period on investment. It is also certain that the biogas production facility grant of 4.7 m EEK per one described functioning factory is exceptionally modest and accrues from the whole relatively small biogas station only 22.4 %.

5. Currently the sale of renewable energy is also calculated for the consumer separately and therefore there is no problem to calculate it with any justified price. Consequently, profitability is therefore dependent on politics and on the changes in the law of energy marketing.
6. The effectiveness to use the fund depends on the enforcement of the Estonia's agrarian development plan 2007-2013 bio-energy production investment aid measure 1.4.3. When the objective is to support as many projects as possible the obstacle can become the curtailing of these projects for economic reasons, and the fund may become unused, or its means will not be used for establishing biogas factories. Similarly, if to support establishing a smaller number of biogas-factories in a range that would be sufficient to attain an optimal investment payoff period these factories would fulfil their objective answering the environmental and energy problems.
7. Biogas factories would be possible and profitable in Estonia after few small changes in the legislation, support schemes, and in the politics of energy-economy. The minimal sufficient price for electricity in this situation would be 1.5 EEK kWh^{-1}.

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