Energy supply of a landfill site in the after care period by LFG, sun, oil, natural gas etc

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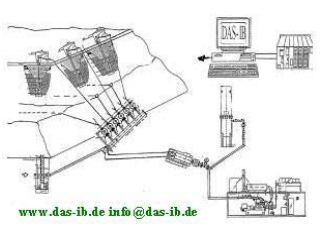

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1. **Task** / interfaces / initial situation and data base of the concept

- Self-sufficient (self-sustaining) energy supply of the existing installations in operation
- Economic comparison of the different plant technologies
- Covering of the electrical and thermal base loads through:
  - microgas turbine / dual fuel engines / gas - engines / heating boilers (two-media burners with landfill gas) in connection with a photovoltaic solar power plant (SPP)
- Measured values landfill gas quality and quantity for the individual gas wells, lines and the entire gas system
- Operational evaluations / technical data of the existing machine technology / ground plan gas collection system / landfill gas prognosis on the basis of the current operational evaluation

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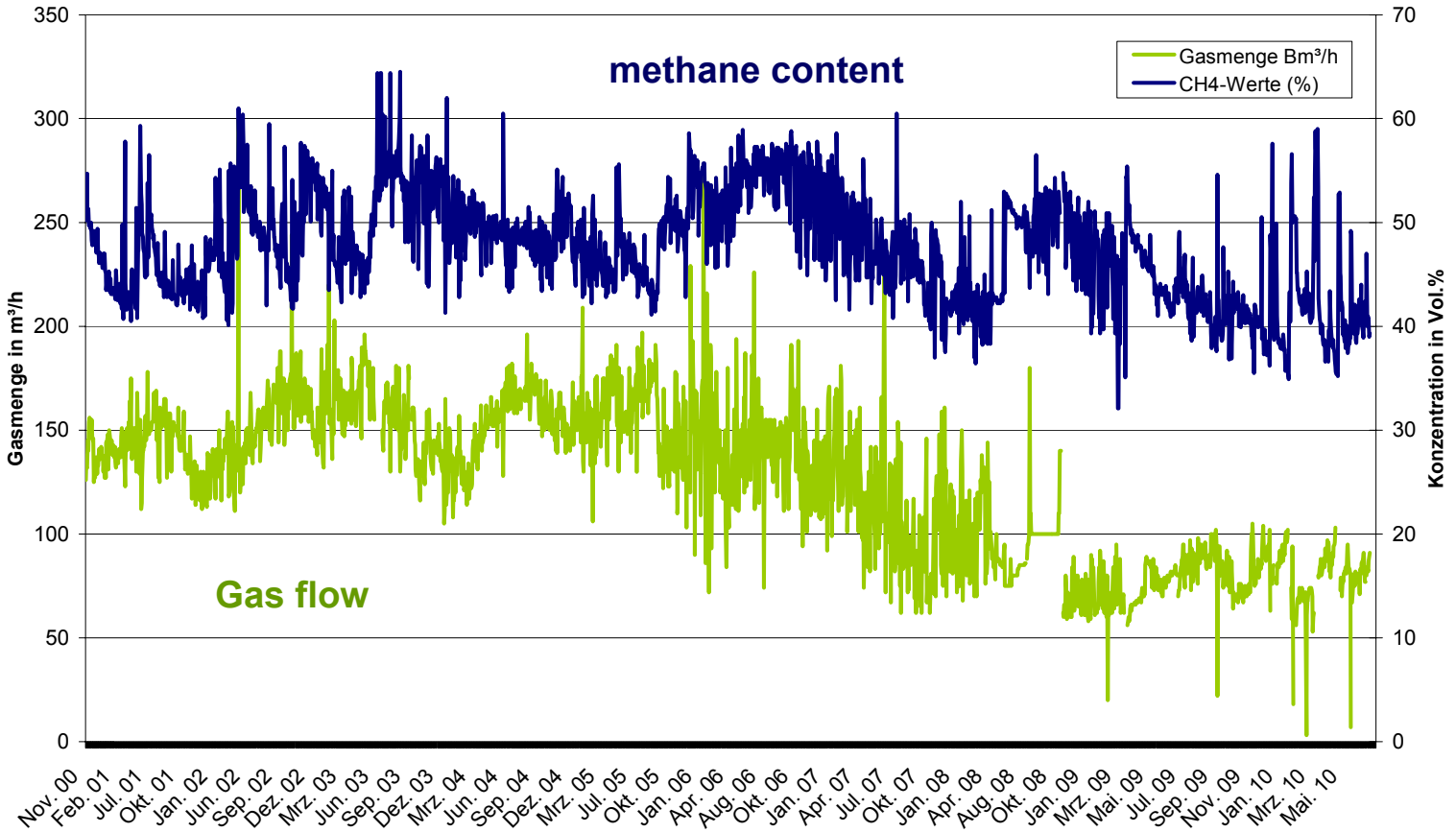
Development of the collected gas quantity and quality on the basis of monthly mean values

W1
W2



1 Windows-Benutzer; 03.09.2011

2 Windows-Benutzer; 03.09.2011

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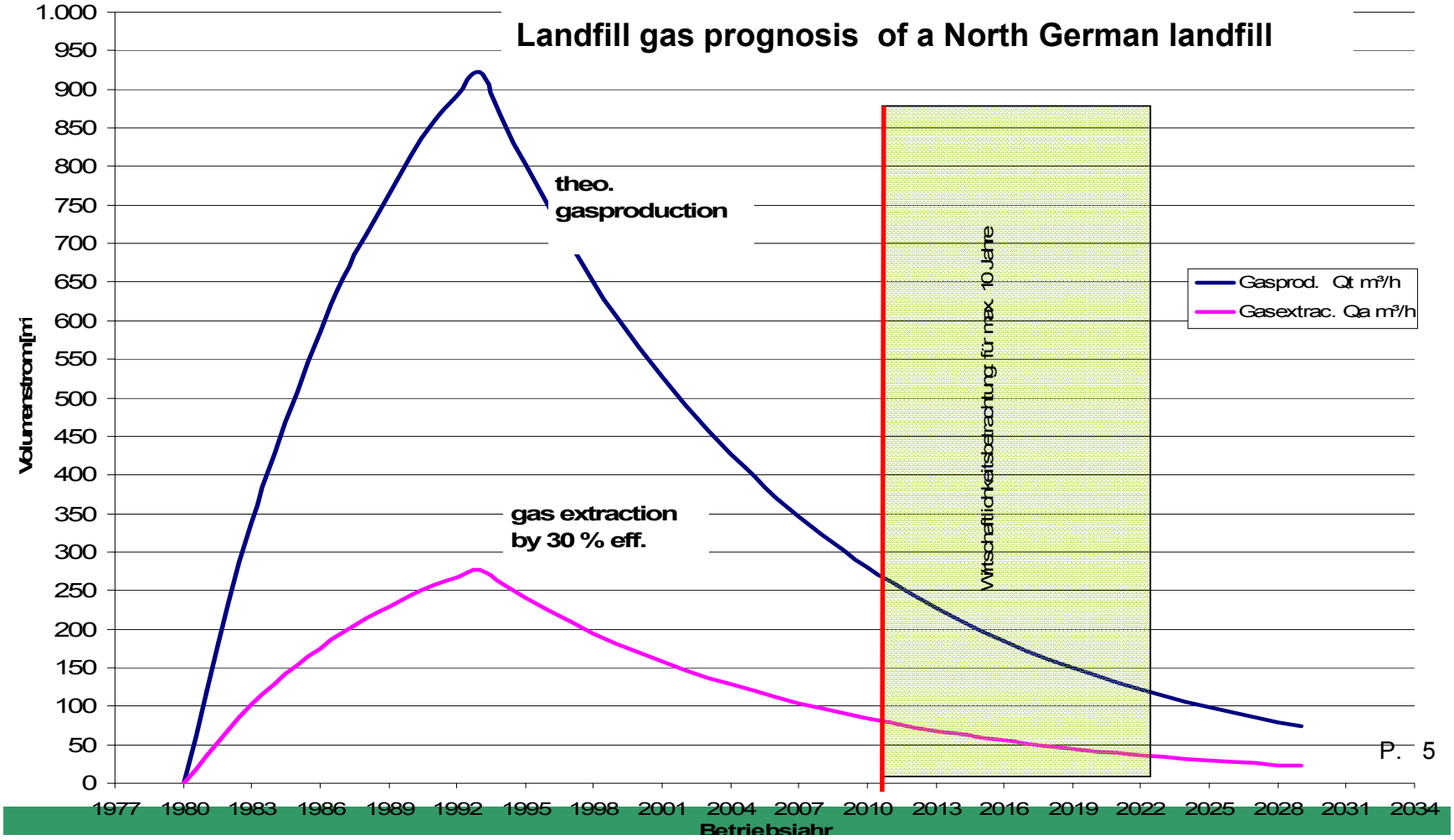
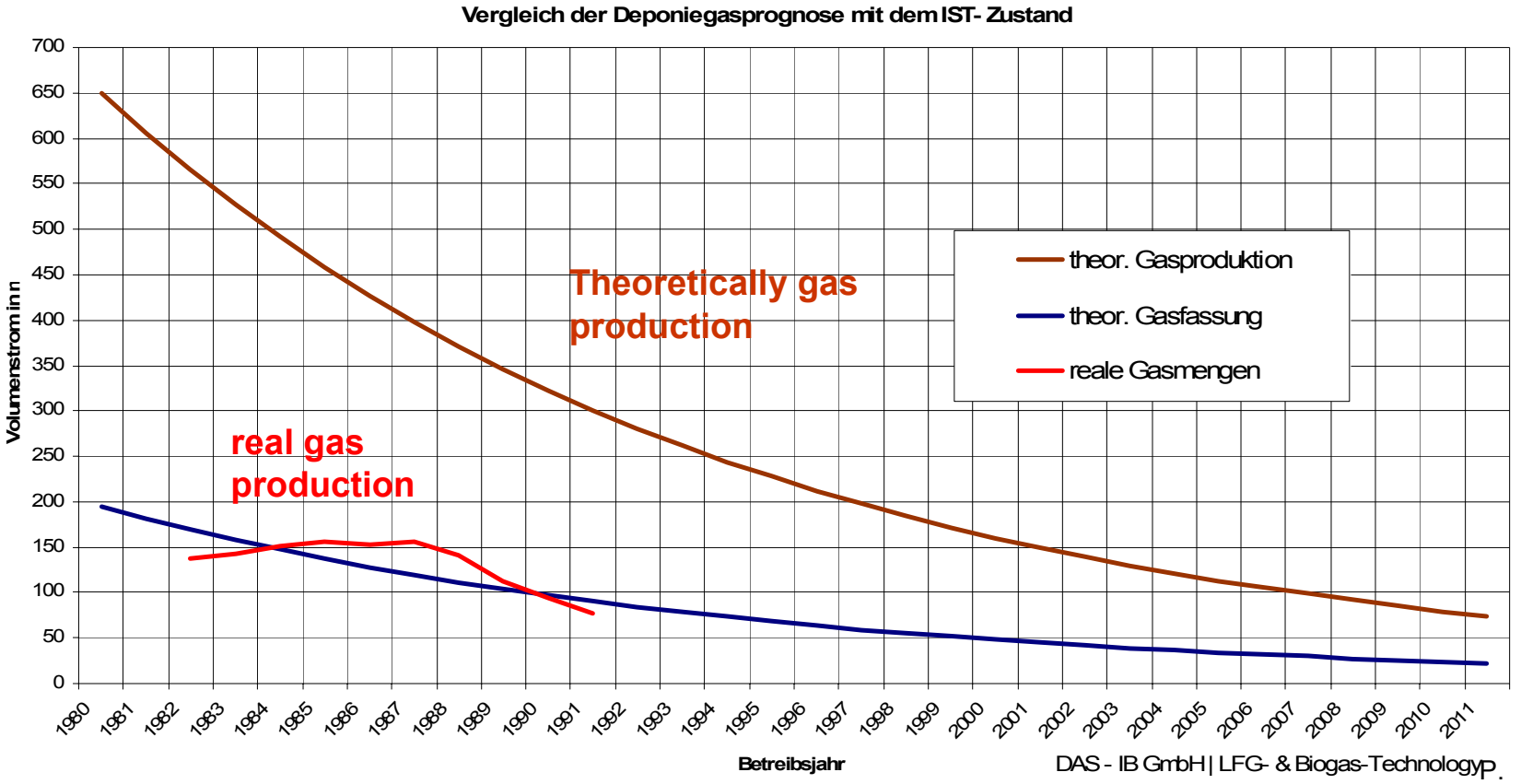


Assumed efficiency of the gas collection system 30 % and a CH_4 content of 50 vol.-%



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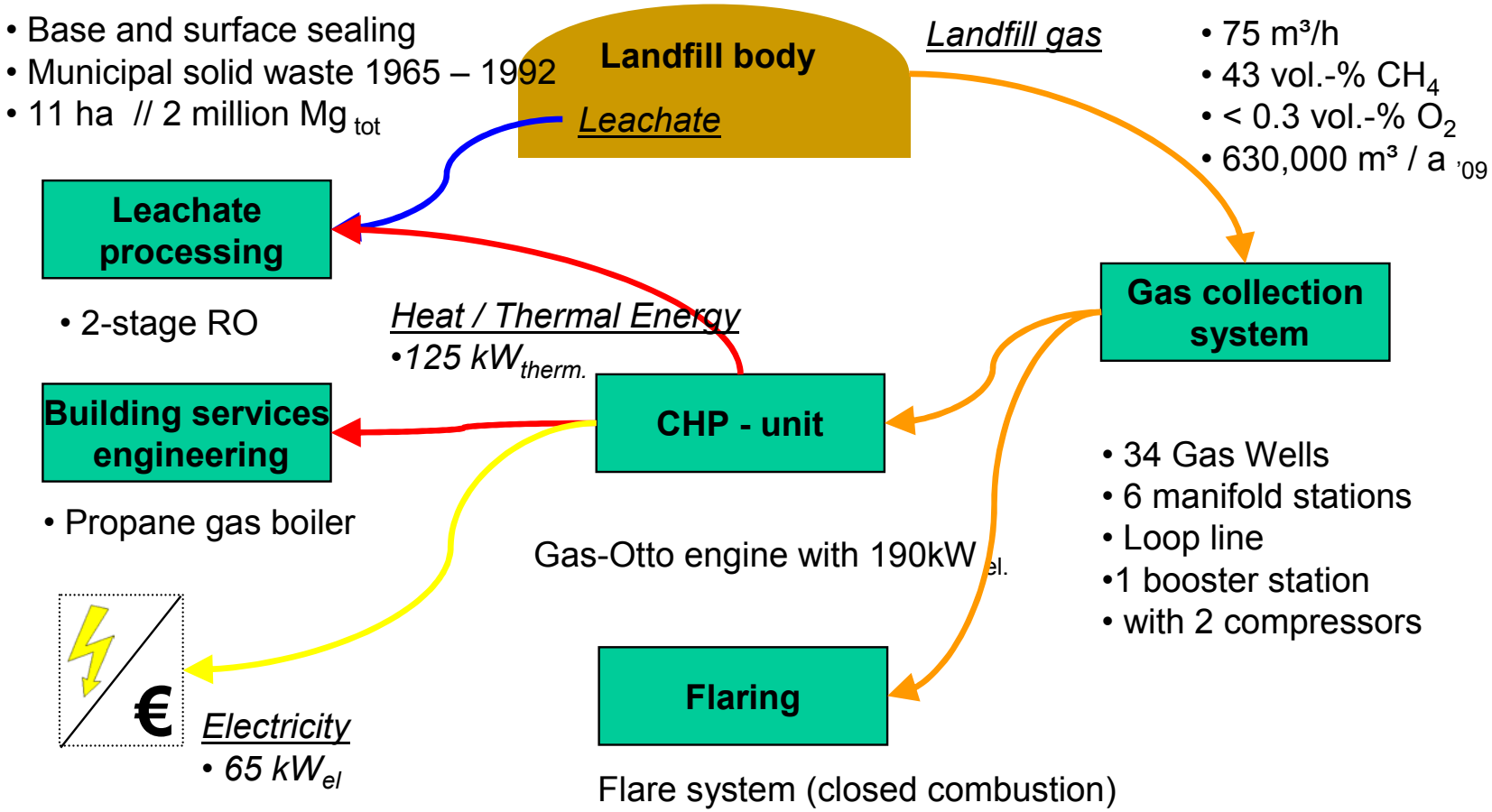

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Determination of the current state

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Producers and consumers

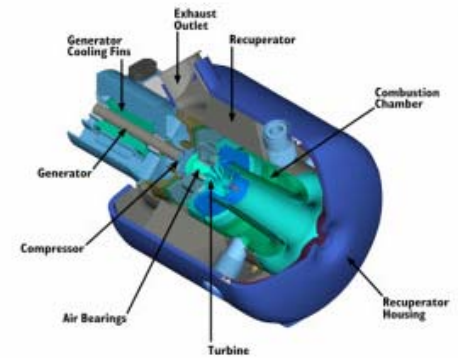
2. **Possible landfill gas utilisations /** basics of the profitability analysis

- Landfill gas prognosis and raw gas analyses
- Internal power demand with 65 kW_{el} and a heat demand with approx. 125 kW_{th}, each as an annual mean value of the existing plant technology
- The installation in the existing CHP room
- **The service life of all aggregates is 10 years and 7,500 operating hours per annum**
- Utilisation of the existing plant technology such as the emergency cooler, flare, gas booster and raw gas analysis as far as this is possible
- Combustible: landfill gas with a calorific value of 5 kWh / m³
- The maintenance costs were considered on the basis of the operating hours and offers / price indications
- The fixed costs amount to € 0.15 per kWh for the electric energy plus the provisioning costs of € 2,000 / a, and the thermal energy costs of € 0.09 per kWh
- Allowance in acc. with EEC 2009 / as regards the turbine, possibly plus the technology bonus

3. Possible landfill gas utilisations / Microgas turbines

Degree of utilisation	η therm. [%]	η electr. [%]
100 %	46.2 to 52.7	*29 to 33*

118 to 280 kW therm. or 65 to 200 kW el.



Advantages: low maintenance costs, lower exhaust gas emissions as in gas engines, higher thermal use than in gas engines, operation with lower methane contents than in dual fuel and gas engines possible, longer service life than gas engines, REL remuneration (the German EEG-payment) plus technology bonus

Disadvantages: high investment costs, lower electrical efficiency than gas engines, gas processing is usually required – compared to engines, a significantly higher primary pressure is required (5 bar instead of 80 mbar pressure IN)

3. **Possible landfill gas utilisations /** gas engines / dual fuel engines

Gas engines:

Advantages: more robust than dual fuel engines, tried and tested

Disadvantages: economic operation optimal at methane values of approx. 50 vol.-%

Degree of utilisation	η therm. [%]	η electr. [%]
100 %	45.4 to 50.8	*32.5 to 38.4*
75 %	45,2 to 49.9	*30.0 to 37.1*
50 %	45.3 to 50.3	27.5 to 31.8
Mean value	*47.8 %*	*33.8 %*

125 to 171 kW th or 80 to 124 kW el.

Dual fuel engines

Advantages: operation with lower methane contents than required for gas engines, low cost

Disadvantages: operation only possible with pilot fuel, reduced life time compared to gas engines

Degree of utilisation	η therm. [%]	η electr. [%]
100 %	39	40.5 to 41.5

107 to 160 kW th or 110 to 170 kW el.

3. Further possibilities to cover the energy demand

Grid-connected photovoltaic solar power plants

require between 7 and 10 square metres per installed kWp (kilowatt peak, defined as performance at a radiant exposure of 1,000 W / m²). In Central Europe, with an optimum south orientation and an inclination of the modules of approximately 30°, an annual yield between 800 and 1,000 kWh can be expected per kW_p nominal plant performance, depending on the position and on the local conditions.

Heating boilers with a two-media burner

are standard heating boilers with specifically-developed burner systems in which landfill gas, biogas, propane, natural gas or fuel oil as combustible gases are converted into thermal energy.

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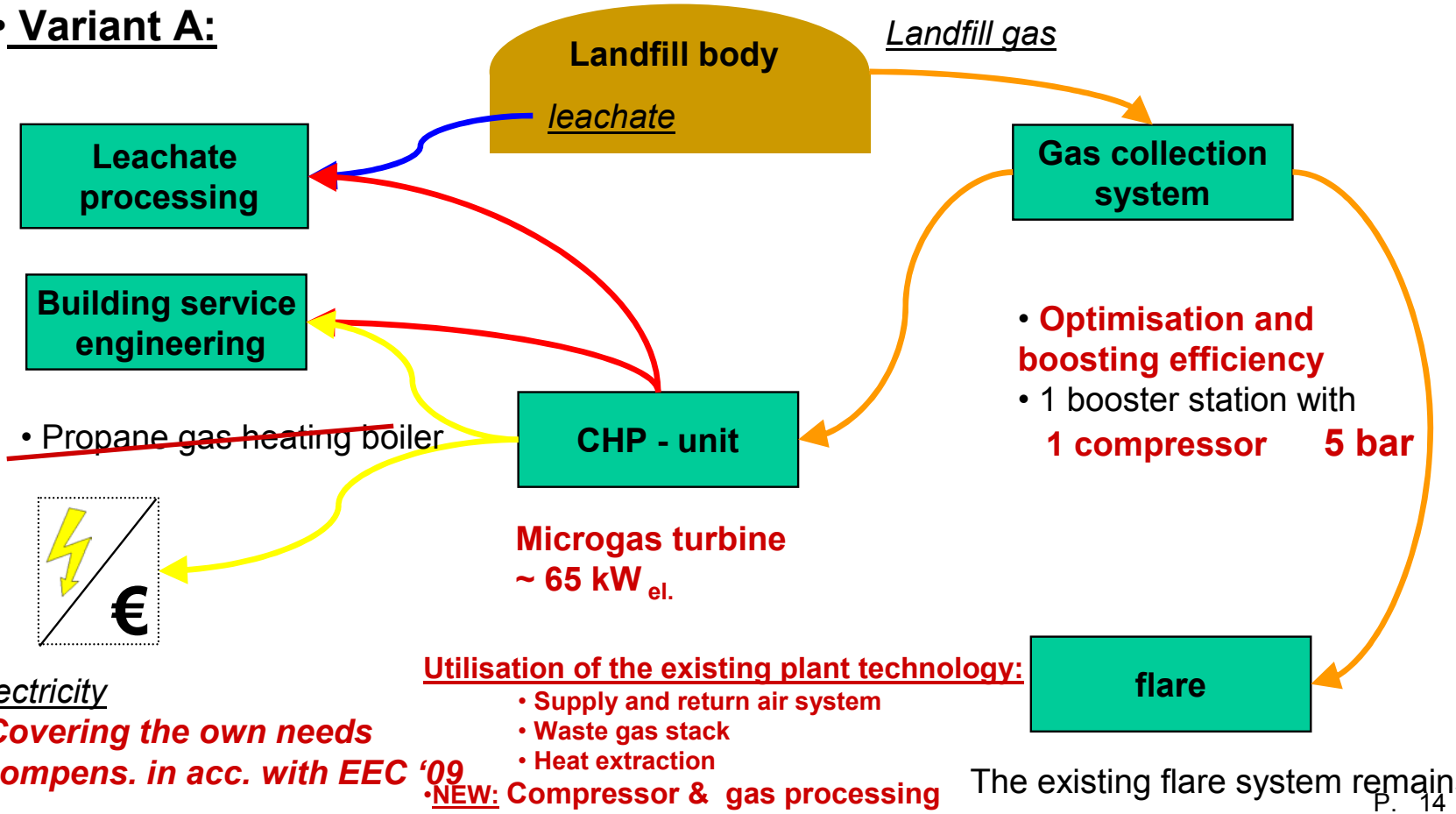
• Variant A:



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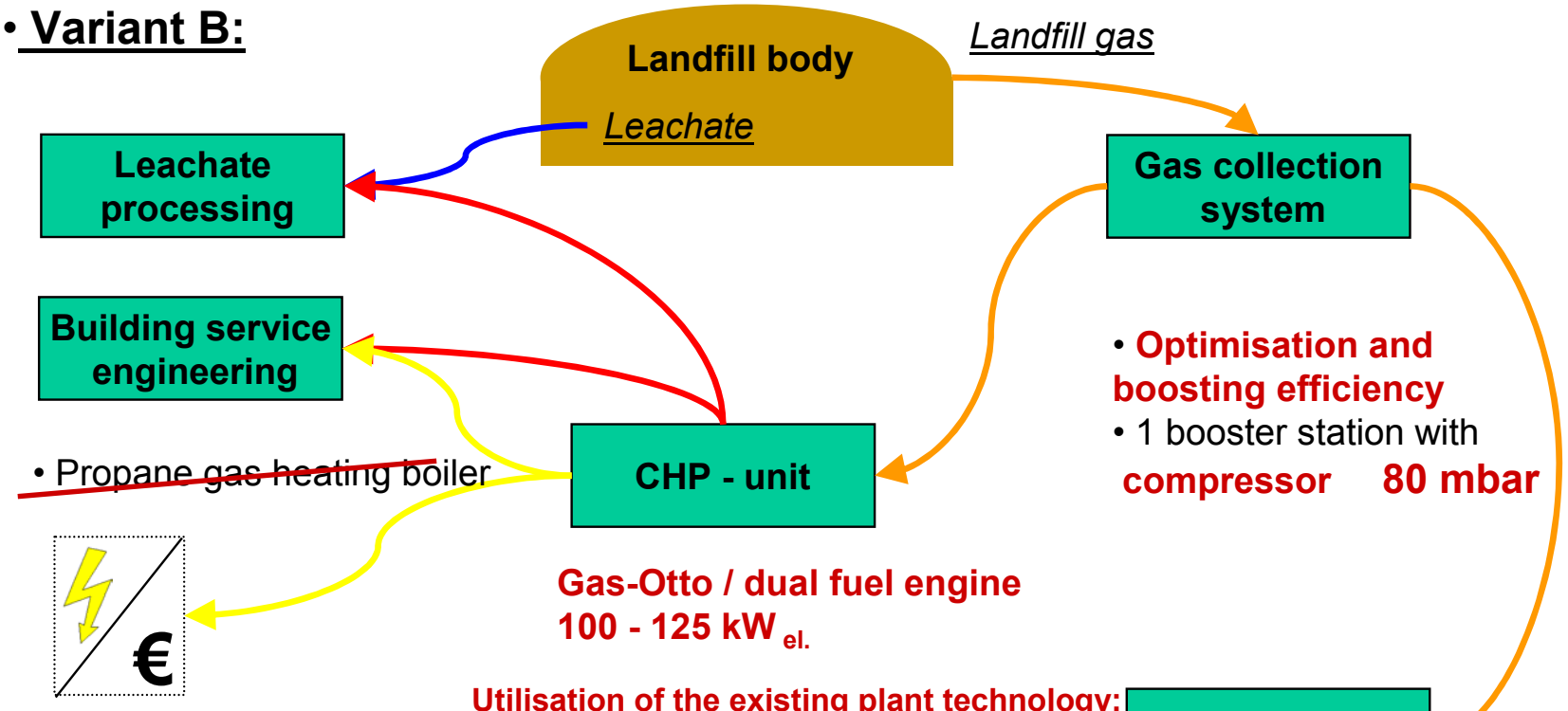
• Variant B:



Electricity

- ***Covering the own needs***
- ***Comp. in acc. with EEC '09***

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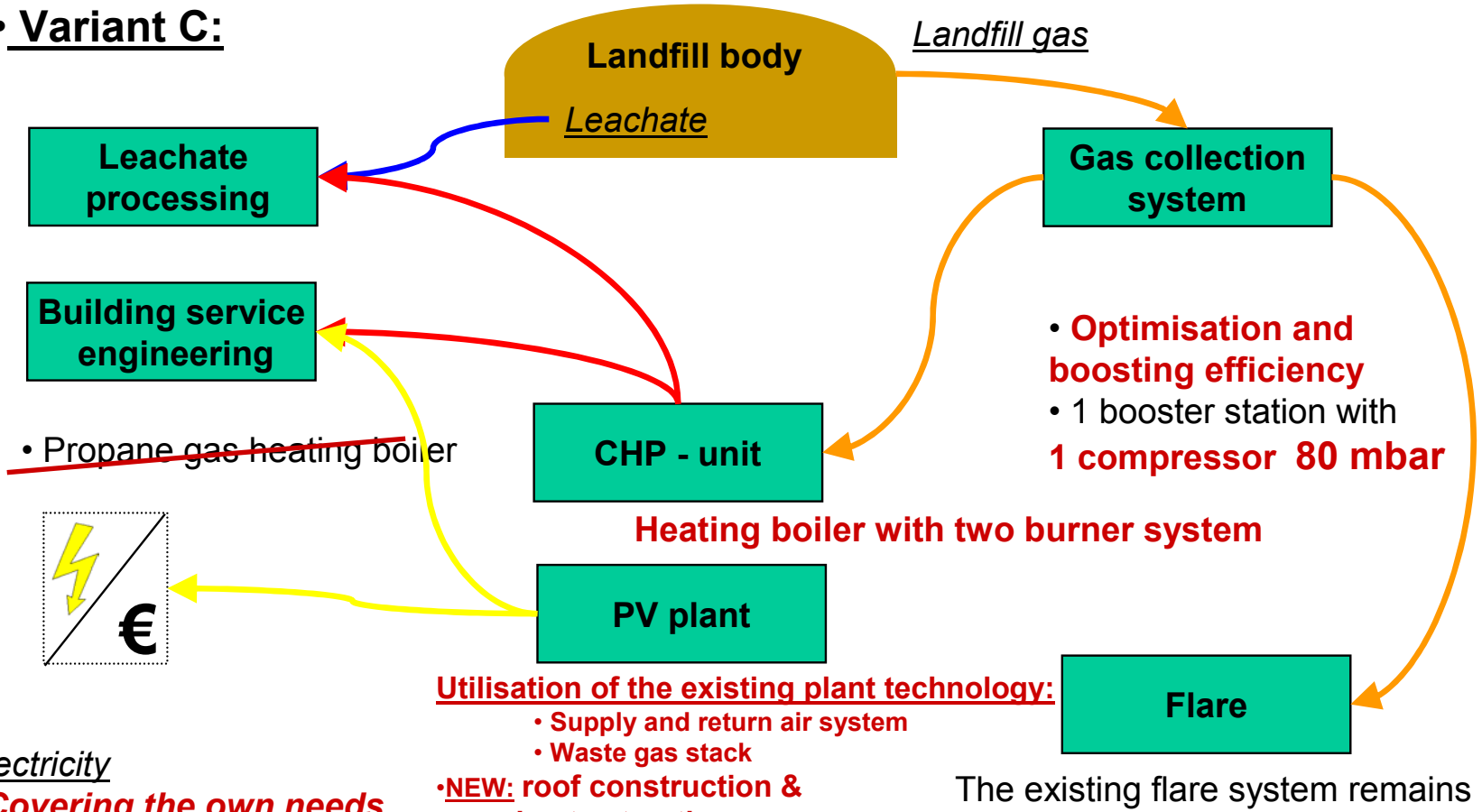
• Variant C:



Electricity

- ***Covering the own needs***
- ***Comp. in accordance with EEC '09***

PV plant // basics // evaluation

- The roof surface area usable for the installation of the PV plant is approximately 700 m²
- There is an optimum roof orientation which is adjusted with support frames
- The carrying capacity of the roof construction is guaranteed
- From 2011 onwards, the remuneration amounts to 27,31 Cent / kW on average for the total output.
- Therefore, the output-related and graduated remuneration is neglected
- Degression of 13 % in accordance with the Renewable Energy Law
- The annual output of a similar plant at the location

- According to the suggested pricing offers, a 128 kWp (approx.) plant can be installed
- Annual yield approximately 104,000 kWh (IBN 2011, last update XII 2010)
- Total investment of approx. € 365,000 (last update XII 2010)
- Average remuneration of approx. € 20,500 per annum (operating period of 20 years)
- Annuities approx. € 18,000 per annum (operating period of 20 years)

Besides the utilisation variant presented here, there is also the possibility to let the roof surface area to a leasing company and, in this manner to only provide the roof surface area to third parties. This variant was not examined here.

Heating boiler with two-media burner // basics // evaluation

The investment costs for an appropriate landfill gas burner with boiler and secondary equipment amount to approximately € 34,000, with average maintenance costs of € 1,500 per annum.

Due to the following factors, the combination of a SPP and a landfill gas boiler was not further considered for the comprehensive profitability analysis of the methods:

- The aforementioned examination is based on a SPP utilisation period of 20 years
- Price development of the acquisition costs of the SPP plant difficult to evaluate as a result of the dynamic market situation
- High dependence of the profitability analysis of SPP plants on the currently rather dynamic, politically-induced power remuneration (in accordance with the EEG) which is difficult to evaluate
- Operating costs for the auxiliary firing of the landfill gas boiler tied to the oil price

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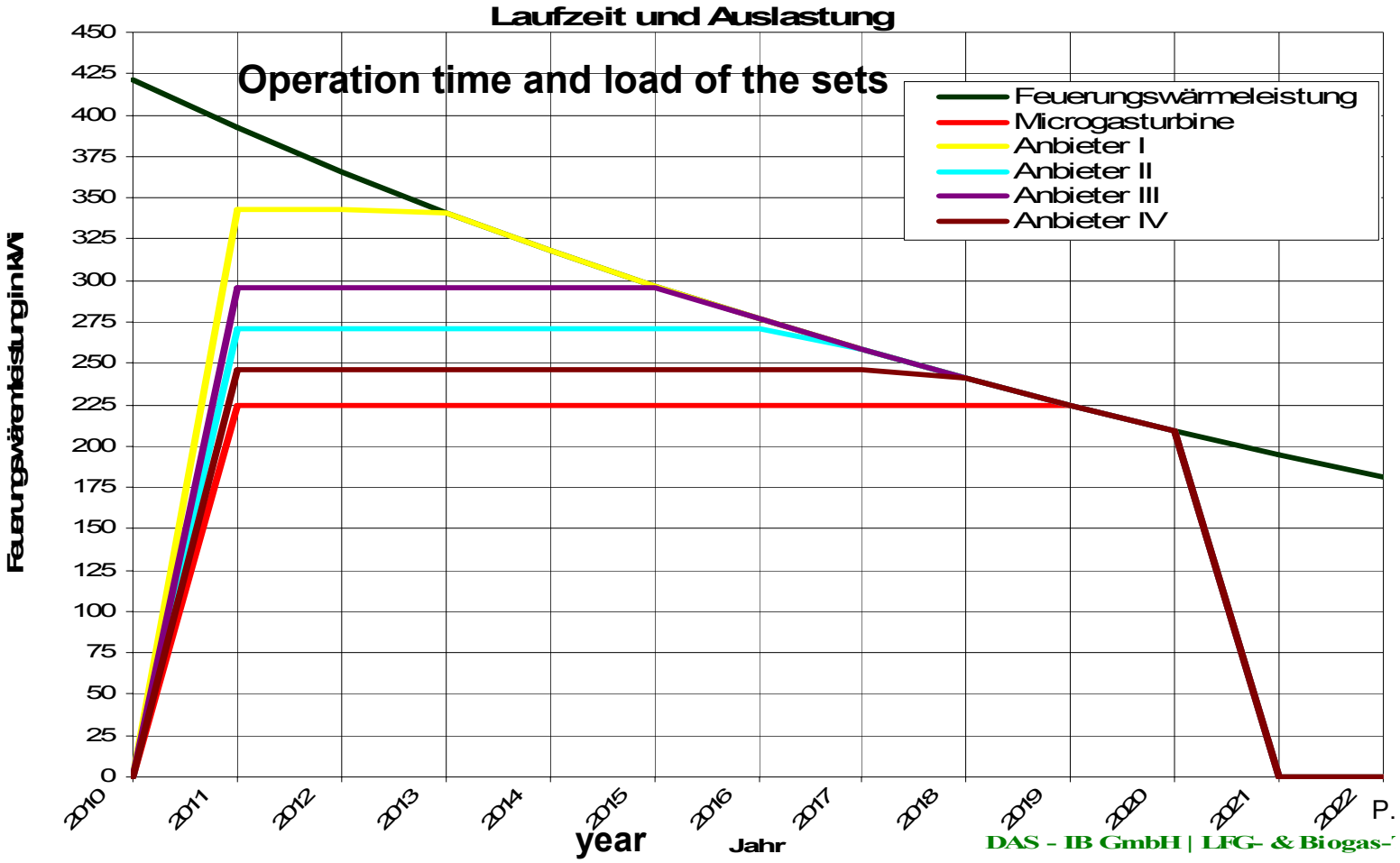

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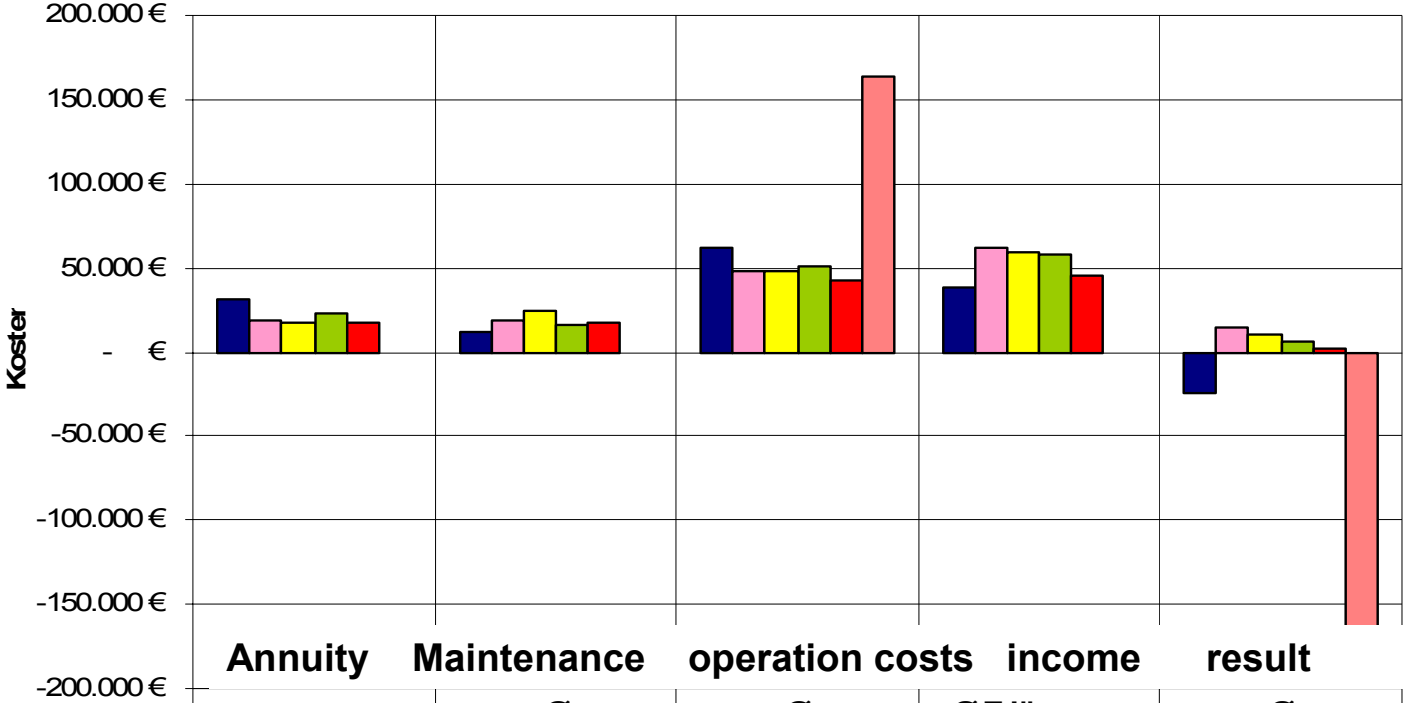
Economic comparison



	Annuität p.a.:	Ø Wartungskosten p.a.:	Ø Betriebskosten p.a.:	Ø Erlöse aus Stromverkauf p.a.:	Ø Betriebsergebnis p.a.:
Turbine	31.858,42 €	11.250,00 €	62.209,72 €	37.721,94 €	-24.487,77 €
Anbieter I	19.143,62 €	19.252,92 €	47.495,38 €	62.624,81 €	15.129,43 €
Anbieter II	17.993,58 €	24.225,00 €	48.746,62 €	59.678,38 €	10.931,76 €
Anbieter III	23.286,65 €	15.375,00 €	51.249,75 €	57.832,56 €	6.582,81 €
Anbieter IV	17.372,12 €	18.000,00 €	43.152,74 €	45.455,45 €	2.302,71 €
Fixkosten			163.912,42 €		-163.912,42 €

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Economic comparison

	Turbine	Provider I	Provider II	Provider III	Provider IV	Fixed expenses
Invest. aggregate:	€ 208,000	€ 116,200	€ 100,950	€ 140,000	€ 111,600	0
Delivery, installation and start-up on location:	€ 5,000	€ 7,800	€ 15,000	€ 13,000	incl. invest	0
Adaptation on location:	€ 10,000	€ 10,000	€ 10,000	€ 10,000	€ 10,000	0
Total investmentcosts:	€ 223,000	€ 134,000	€ 125,950	€ 163,000	€ 121,600	0
Annuity p.a.:	€ 31,858	€ 19,144	€ 17,994	€ 23,287	€ 17,372	- €
Maintenance costs per operating hour:	€ 1.50	€ 2.57	€ 3.23	€ 2.05	€ 2.40	€ / Bh
Ø Maintenance costs p.a.:	€ 11,250	€ 19,253	€ 24,225	€ 15,375	€ 18,000	- €
Ø Additional electricity costs p.a.:	€ 13,596	€ -	€ -	€ -	€ -	€ 75,125
Ø Additional heat costs p.a.:	€ 5,506	€ 9,099	€ 6,528	€ 12,588	€ 7,781	€ 88,787
Ø Operating costs p.a.:	**€ 62,210**	**€ 47,495**	**€ 48,747**	**€ 51,250**	**€ 43,153**	**€ 163,912**

Summary:

	Turbine	Provider I	Provider II	Provider III	Provider IV	Fixed expenses
Ø Revenues from the sale of electricity p.a.:	**€ 37,722**	**€ 62,625**	**€ 59,678**	**€ 57,833**	**€ 45,455**	
Ø Operating profits p.a.:	**- € 24,488**	**€ 15,129**	**€ 10,932**	**€ 6,583**	**€ 2,303**	**- € 163,912**
Operating profits after 10 years:	**- € 244,878**	**€ 151,294**	**€ 109,318**	**€ 65,828**	**€ 23,027**	**- € 1,639,124**

As can be seen from the comparison of the annual operating profits of all variants, gas-Otto engines can be recommended as the most profitable variant for employment on the "concept" landfills, taking into account the **indicated boundary conditions** (in particular for the requested period under consideration of 10 years).

As far as all possibilities of utilisation are concerned, it is striking that, at the latest during the last three years of operation, the heat requirements cannot completely be covered which involves additional costs.

Real after bidding

At the end of the year all bidders go to BIOGAS plants in Germany
and we got only one bidder for these LFG – project - >

These company was approx. 100 % expensive than first budget price.

At the end of day we wait for better prices in 2012

Any questions left?

Knowledge is key and is available when you know where to find it:

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Or we see us at your site or here e.g. next break