

Economic aspects of biogas plants



Calculation for biogas plants:

- **Substrates**
 - Properties of input substrates
 - Gas- and energy yields
- **Plant design**
 - Design & dimensioning of digester and feed-stock storage
 - Electric power installed
- **Economic appraisal**
 - Investment cost of different performance classes
 - Current costs
 - Income, benefits

Design scenarios

Design/ Calculation basis:

Investment CHP	1.000	€/kW
Investment biogas plant	3.600	€/kW
Maintenacnce CHP	1,5	ct/kWh
Workload CHP	7.500	h/a
Maintenance biogas plant	2%	of Investment
Depreciation period:	12	years
Interest rate:	4%	
Feed-in tariff:	16,5	ct/kWh

➔ Calculate a **pessimistic**, a **normal** and an **optimistic** scenario

Cost scenarios for input substrates

Substrate: **Cattle manure (liquid)**

	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	20	30	40
Methane content:		55%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,76	1,98	2,20
Electricity yield	[kWh/t _{Sub}]	35	59	88
Process energy (required)	10%	4	6	9
Electricity for sale	[kWh/t _{Sub}]	32	53	79
Income from electr. sales	[€/t_{Sub}]	5,23	8,82	13,07
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	0,4	0,7	1,0
Maintenance costs	[€/t _{Sub}]	0,5	0,9	1,3
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	1,2	2,1	3,1
Maintenance costs	[€/t _{Sub}]	0,2	0,4	0,5
Total costs	[€/t_{Sub}]	2,37	4,01	5,93
Maximum substrate costs	[€/t_{Sub}]	2,85	4,82	7,13

Cost scenarios for input substrates

Substrate: **Corn silage**

	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	180	200	220
Methane content:		53%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,70	1,91	2,12
Electricity yield	[kWh/t _{Sub}]	305	382	466
Process energy (required)	10%	31	38	47
Electricity for sale	[kWh/t _{Sub}]	275	343	420
Income from electr. sales	[€/t_{Sub}]	45,33	56,67	69,26
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	3,5	4,3	5,3
Maintenance costs	[€/t _{Sub}]	4,6	5,7	7,0
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	10,7	13,3	16,3
Maintenance costs	[€/t _{Sub}]	1,9	2,4	2,9
Total costs	[€/t_{Sub}]	20,58	25,73	31,45
Maximum substrate costs	[€/t_{Sub}]	24,75	30,94	37,81

Cost scenarios for input substrates

Substrate: **Cereal grains**

	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	560	600	640
Methane content:		53%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,70	1,91	2,12
Electricity yield	[kWh/t _{Sub}]	950	1145	1357
Process energy (required)	10%	95	114	136
Electricity for sale	[kWh/t _{Sub}]	855	1030	1221
Income from electr. sales	[€/t_{Sub}]	141,04	170,00	201,48
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	10,8	13,0	15,4
Maintenance costs	[€/t _{Sub}]	14,2	17,2	20,4
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	33,2	40,0	47,4
Maintenance costs	[€/t _{Sub}]	5,9	7,1	8,4
Total costs	[€/t_{Sub}]	64,04	77,19	91,49
Maximum substrate costs	[€/t_{Sub}]	77,00	92,81	110,00

Cost scenarios for input substrates

Substrate: **Total plant silage**

	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	160	180	200
Methane content:		53%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,70	1,91	2,12
Electricity yield	[kWh/t _{Sub}]	271	343	424
Process energy (required)	10%	27	34	42
Electricity for sale	[kWh/t _{Sub}]	244	309	382
Income from electr. sales	[€/t_{Sub}]	40,30	51,00	62,96
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	3,1	3,9	4,8
Maintenance costs	[€/t _{Sub}]	4,1	5,2	6,4
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	9,5	12,0	14,8
Maintenance costs	[€/t _{Sub}]	1,7	2,1	2,6
Total costs	[€/t_{Sub}]	18,30	23,16	28,59
Maximum substrate costs	[€/t_{Sub}]	22,00	27,84	34,37

Cost scenarios for input substrates

Substrate: **Turkey manure**

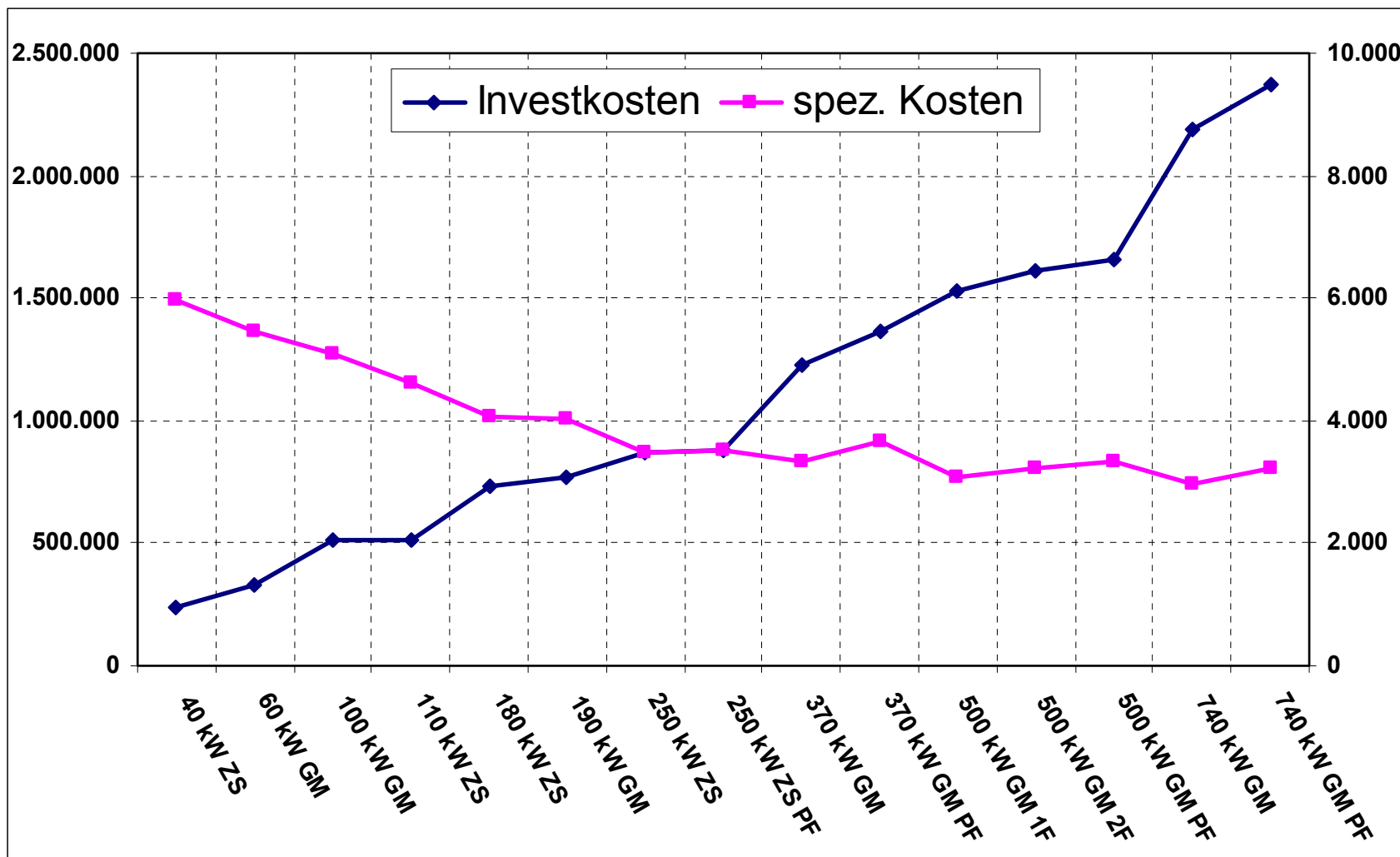
	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	160	200	240
Methane content:		54%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,73	1,94	2,16
Electricity yield	[kWh/t _{Sub}]	276	389	518
Process energy (required)	10%	28	39	52
Electricity for sale	[kWh/t _{Sub}]	249	350	467
Income from electr. sales	[€/t_{Sub}]	41,06	57,74	76,98
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	3,1	4,4	5,9
Maintenance costs	[€/t _{Sub}]	4,1	5,8	7,8
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	9,7	13,6	18,1
Maintenance costs	[€/t _{Sub}]	1,7	2,4	3,2
Total costs	[€/t_{Sub}]	18,64	26,22	34,96
Maximum substrate costs	[€/t_{Sub}]	22,41	31,52	42,03

Cost scenarios for input substrates

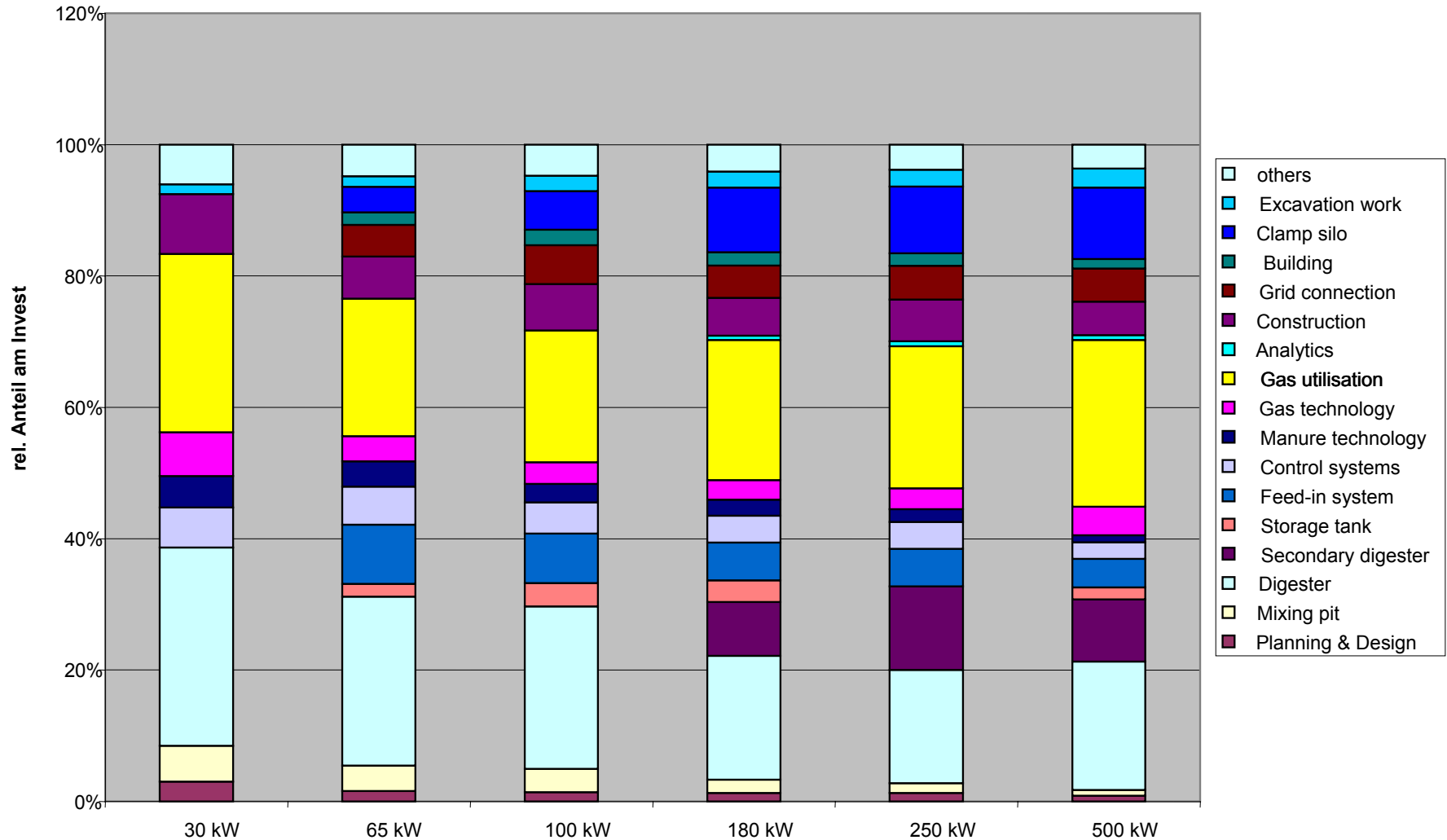
Substrate: **Grass silage**

	Scenario	pessimistic	normal	optimistic
Gas yield:	[m ³ /t _{Sub}]	190	210	230
Methane content:		54%		
El. efficiency CHP		32%	36%	40%
Specific electricity yield	[kWh/m ³ BG]	1,73	1,94	2,16
Electricity yield	[kWh/t _{Sub}]	328	408	497
Process energy (required)	10%	33	41	50
Electricity for sale	[kWh/t _{Sub}]	295	367	447
Income from electr. sales	[€/t_{Sub}]	48,76	60,62	73,77
Costs CHP unit				
Costs of capital	[€/t _{Sub}]	3,7	4,6	5,6
Maintenance costs	[€/t _{Sub}]	4,9	6,1	7,5
Costs biogas plant				
Costs of capital	[€/t _{Sub}]	11,5	14,3	17,4
Maintenance costs	[€/t _{Sub}]	2,0	2,5	3,1
Total costs	[€/t_{Sub}]	22,14	27,53	33,50
Maximum substrate costs	[€/t_{Sub}]	26,62	33,10	40,28

Investment costs:



Share in investment costs:



Current Costs:

- Depreciation costs
- Interest charge (related to 1/2 of investment costs)
- Maintenance & repair of biogas plant
- Maintenance CHP
- Insurance
- Labour costs
- Costs for input substrates
- Costs for land spreading digestate
- Costs for ignition oil

Depreciation costs:

Afa Gruppen	Distribution	Years
Construction	55%	20
Technology	32%	10
CHP	13%	6
Total/ average	100%	12

Interest charge:

- Static calculation
- Interest rate on 1/2 of total investment
- General costs: 4 – 5 % interest

Maintenance & repair costs:

- Labour costs
- Spare parts, equipment, lubricants, etc.
- General costs: 1 – 2 % of investment costs

Maintenance CHP:

- Manufacturers offer maintenance contract (approx. 2 Cent/kWh)
- Coordinate depreciation period with type of CHP (gas engine vs. dual fuel engine)
- General costs: 1 Cent/kWh

Insurance:

- General costs: 1 – 1,2 % of investment costs

Labour costs:

- occur basically for „feeding“ the biogas plant
- Control, data collection, management
- General costs: 15 €/h

Costs for input substrates:

- general costs for maize silage: 1.100 €/ha at 45 t FM/ha
- For substrates produced in organic farming different cost structures might occur as the main target may not be a high biomass yield per ha (e.g. legumes as intercrops)

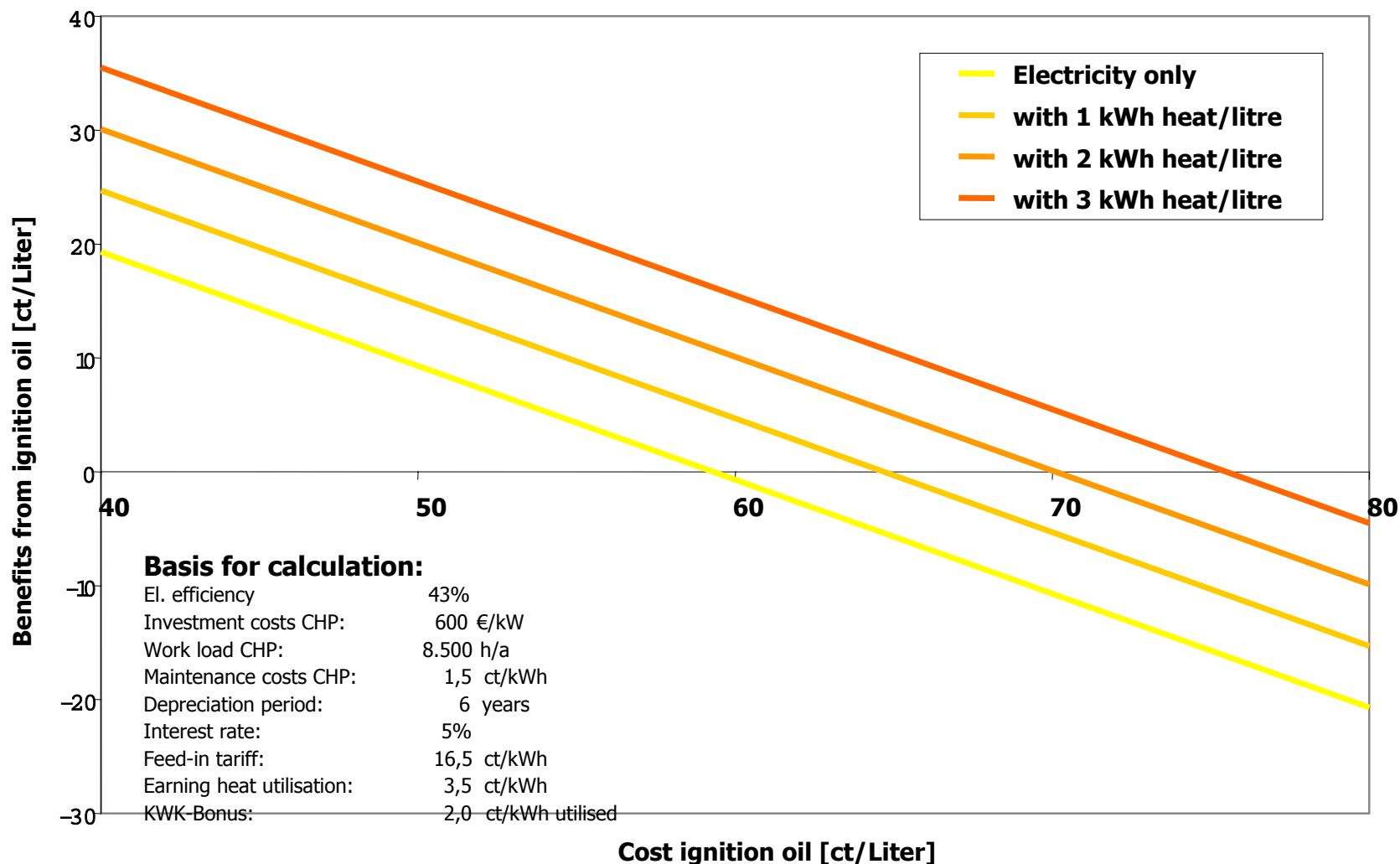
Cost for landspreading digestate:

- General costs: 3 ... 5 €/m³
- Costs only occur, if digestate has to be „disposed off“
- in organic farming those costs don't occur as they are credited to plant/ crop production

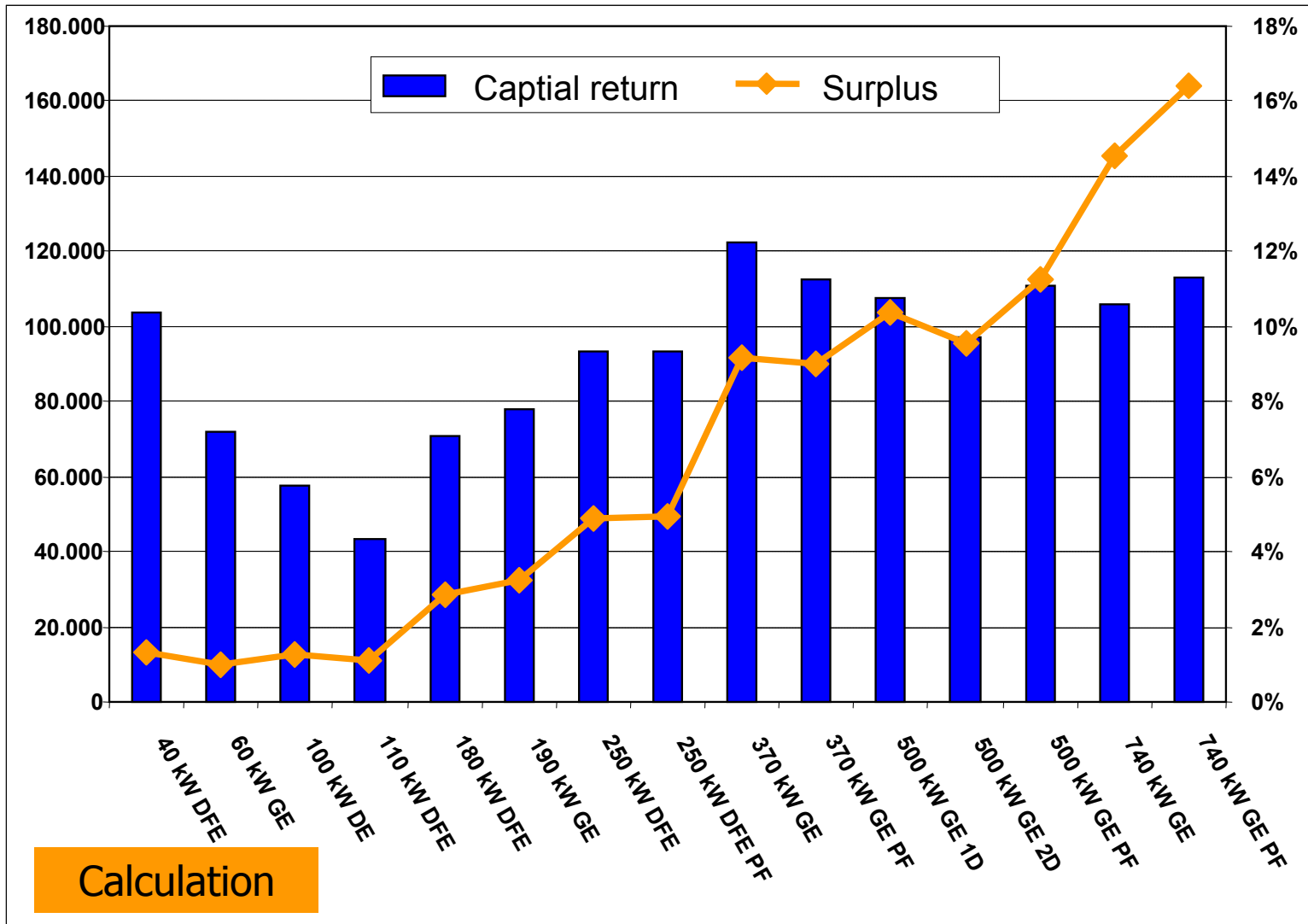
Costs for ignition oil:

- High level of economic uncertainty
- Increasingly uneconomic if only electricity is produced
- CHP requires high electric efficiency to compensate fuel costs

Benefits and cost of utilizing ignition oil:



Economy of exemplary biogas plants:



**Thank you for your
attention!**

