

BioEnergy Farm II

Micro scale biogas installations in Belgium

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Definition micro scale biogas plant

- No real standard or regulation in Belgium
- Unofficial consensus between involved parties
 1. Maximum 5000 tons input per year
 2. Mainly own input streams (manure and leftovers)
 3. Only provides their own energy demands
- $10 \text{ kW}_e < P < 200 \text{ kW}_e$

Small scale biogas installations (10-30 kWe)



Situation in Belgium

- 71 small scale digesters (also called “Pocket digester”)
 - 61 installations of 11 kW_e
 - 10 installations of 22 kW_e
- All constructed and placed by the same company
- All installations are placed at dairy cattle farms
 - Pig manure degrades too rapidly
 - C/N ratio too low (6 for pigs vs. 10 for cows)
- Since 2011

Bioelectric

- Manufactures small manure gas installations
- Turnkey company
- Belgian company

Installation	11 kW	22 kW	33 kW
Input of manure			
Yearly (m³)	1500-3000	3000-6000	6000-12000
Daily (m³)	4-8	8-16	16-32
Investment	€ 95.000	€ 140.000	€ 155.000
Maintenacnce cost (year)	€ 3.500	€ 5.500	€ 7.000

Generation 1

- 2011 – 2013
- Parts
 - Combined Heat Power
 - Container
 - Pump in slurry pit
 - Plastic reactor bag
 - 21 m * 12 m ; 200 m³ manure
 - Reactor mixer
 - External digestate storage
 - Gas tubes
 - Manure tubes





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Generation 1: growing pains

Growing pain	Consequence
Pump in slurry pit	Blockage
Reactor mixed by tractor	No time for farmer
Construction of reactor	When there's not enough production the bag isn't stretched. Accumulation of rain.
Accumulation of rain	Biogas outlet point drops in the manure, manure is pumped into the engine
Not insulated gas tube	Condense
H ₂ S	Engine wear
Circulation of manure for heating	Blockage
No quality limit manure	Low biogas production

Generation 2 (2013 -)

- Bag is replaced by silo
- More insulated
- Grinder pump in slurry pit
- Electrical mixer in reactor
- H₂S is removed by carbon filter
- Gas tube is heated to prevent condensate
- Higher quality required from manure, labo analyses by Bioelectric before the installation is sold
- No manure is circulated, manure is heated by circulating hot water
- 10 % of produced power is used by the installation



Build-up

- <http://www.youtube.com/watch?v=gdck4udKTEI>

Regulations Flanders

- Environmental permit (Vlarem II)
 - Class III permit (lowest)
 - Notification requirement
 - Announcement of change in production process in section 9 of Vlarem III
 - Easy to acquire

Regulations: Building permit

- “Short” type
- Application for a building permit for which a simple file structure is sufficient
 - No architect required
 - Implantation drawing
 - 3 Area photos
 - Brief description

Subsidy

1) Reduced Taxable Profits

- Federal measure to support energy saving measures
 - € 5000 for each 11 kWe
 - 5% of total investment

Subsidy

2) CHP certificate (WKC in Belgium)

- A unique, marketable and electronic property that shows that a particular production plant saves an amount of primary energy by utilizing qualitative cogeneration compared to standard installations
- 1 WKC = 1000 kWh primary energy saved
- 1 WKC = € 31

Subsidy

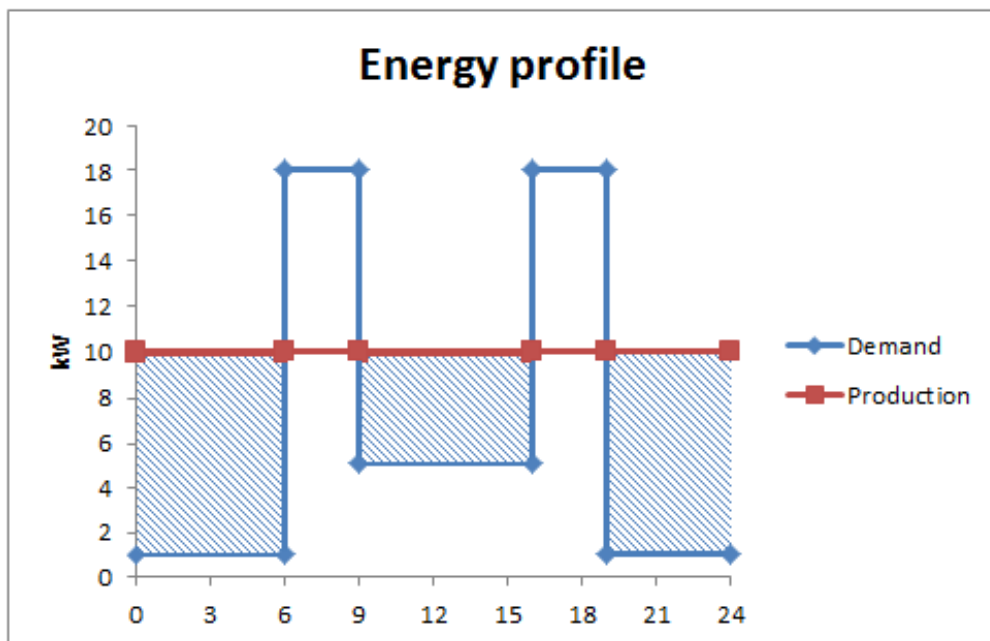
3) Green Power certificate (GSC in Belgium)

- A unique, marketable and electronic property that shows that a particular production plant produces an amount of renewable energy
- 1 GSC = 1000 kWh produced electricity
- 1 GSC = € 93

Power production > Power demand

Installed electric power < 10 kw

- Bidirectional meter
- Produced electricity has equal value as electricity power grid



Installed electric power > 10 kW

- Two meters
- No equal value
 - Consumption (-16 c€ /kWh)
 - Injection (+2 c€ /kWh)

Potential in Flanders (2013)

- 8,5 million ton pig manure
- 16,5 million ton cattle manure

- 0,581 million ton manure digested
→ 2,4 % of available quantity

Potential Dairy Cattle in Flanders

- 280.000 dairy cows in Flanders
- 8,12 million m³ dairy cattle manure (29 m³ / cow)
- Minimum quantity for micro digester = 80 dairy cows

- 720 farms with at least 80 dairy cows
 - ➔ Theoretical potential of 1,67 million m³ digested cattle manure. (Realistically 2,5 million m³)
= 20 % (30%) of total dairy cattle manure

Input feasibility study

Electrical Power	10	kWe
Total production electricity	64.372	kWh
Netto production electricity	53.115	kWh
Total Heat Production	96.558	kWh
Investment	95.000	euro
Depreciation period	10	year
Interest	4	%
Electricity cost	0,16	euro/kWh
Expected raise electricity price	2	%
Maintenance	3000	euro
Inflation maintenance	2	%
GSC	93	euro
WKC	31	euro

Feasibility study < 10 kWe

- Case medium production of 65.000 kWh

Year	1	2	3	4	5	6	7	8	9	10
Gains										
Avoided electricity purchase	8.498	8.668	8.842	9.019	9.199	9.383	9.571	9.762	9.957	10.156
GSC	5.987	5.987	5.987	5.987	5.987	5.987	5.987	5.987	5.987	5.987
WKC	4.590	4.590	4.590	4.590	4.590	4.590	4.590	4.590	4.590	4.590
Investment subsidy	4.670									
Costs										
Investment	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500
interest	3.800	3.420	3.040	2.660	2.280	1.900	1.520	1.140	760	380
maintenance	3.000	3.060	3.121	3.184	3.247	3.312	3.378	3.446	3.515	3.585
Annualy gains	16.944	12.765	13.257	13.751	14.248	14.747	15.248	15.752	16.259	16.767
Accumulated	-78.056	-65.291	-52.034	-38.283	-24.035	-9.288	5.961	21.713	37.971	54.739

- Payback period medium production = 7 years

Feasibility study < 10 kWe

- Case high production of 78.000 kWh

Year	1	2	3	4	5	6	7	8	9	10
Gains										
Avoided electricity purchase	10.369	10.576	10.788	11.004	11.224	11.448	11.677	11.911	12.149	12.392
GSC	7.303	7.303	7.303	7.303	7.303	7.303	7.303	7.303	7.303	7.303
WKC	5.599	5.599	5.599	5.599	5.599	5.599	5.599	5.599	5.599	5.599
Investment subsidy	4.670									
Costs										
Investment	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500	9.500
interest	3.800	3.420	3.040	2.660	2.280	1.900	1.520	1.140	760	380
maintenance	3.000	3.060	3.121	3.184	3.247	3.312	3.378	3.446	3.515	3.585
Annualy gains	21.141	16.998	17.528	18.062	18.598	19.138	19.680	20.226	20.776	21.328
Accumulated	-73.859	-56.861	-39.333	-21.271	-2.673	16.465	36.145	56.372	77.148	98.476

- Payback period high production = 6 years

Feasibility study > 10 kWe

- Injection rate

Year	1	2	3	4	5	6	7	8	9	10
Yearly Gains										
Injection 0%	46.848	36.616	37.443	38.267	39.089	39.908	40.725	41.540	42.353	43.163
Injection 20%	42.558	32.320	33.139	33.956	34.771	35.584	36.394	37.202	38.008	38.811
Injection 40%	38.268	28.023	28.835	29.645	30.454	31.259	32.063	32.864	33.662	34.458
injection 60%	33.978	23.726	24.531	25.335	26.136	26.935	27.731	28.525	29.317	30.106
Injection 80%	29.688	19.429	20.228	21.024	21.819	22.610	23.400	24.187	24.972	25.754
Injection 100%	25.398	15.132	15.924	16.714	17.501	18.286	19.069	19.849	20.627	21.402
Accumulated										
Injection 0%	-178.152	-141.536	-104.093	-65.826	-26.738	13.170	53.896	95.436	137.789	180.952
Injection 20%	-182.442	-150.123	-116.984	-83.028	-48.256	-12.673	23.721	60.923	98.931	137.742
Injection 40%	-186.732	-158.709	-129.874	-100.229	-69.775	-38.516	-6.453	26.411	60.073	94.531
injection 60%	-191.022	-167.296	-142.765	-117.430	-91.294	-64.359	-36.628	-8.102	21.215	51.321
Injection 80%	-195.312	-175.883	-155.655	-134.631	-112.813	-90.202	-66.802	-42.615	-17.643	8.111
Injection 100%	-199.602	-184.470	-168.546	-151.832	-134.331	-116.045	-96.977	-77.128	-56.501	-35.099

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