Urban waste for biomethane grid injection and transport in urban areas

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Good Practice for Biogas Production from Waste and Up-grading for Grid-injection and Use in Transport

- Explanatory notes -

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1 Introduction

In order to facilitate a comparison of European good practice examples for waste-to-bio-methane plants, displayed in individual fact sheets, a database is created where the "hard" facts from the fact sheets are assorted. This document will guide you through the database which consists of two tables: one for the biogas plant and one for the upgrading plant.

2 Good Practice Examples of Waste to Bio-methane Plants

The two tables give information on eleven installations from all over Europe where MSW (municipal solid waste) is processed to bio-methane. There first column of each table shows the city and the country where these plants are operating.

Biogas plants

The first table describes the biogas production plant. The years of commissioning indicate that most of the plants (>2000) are of modern state of the art. Two installations in Sweden incorporate their older but nevertheless well maintained equipment for biogas production in the modern concept for bio-methane production.

The third column gives information on the initial investment (in 1,000 €) necessary for the biogas plant. As a first approach you can expect a relation of approximately 3/4 on the biogas plant and 1/4 on the upgrading unit. The figures of Lille and Madrid cover more than the biogas plant, e. g. unloading and pre-treatment facilities. In the example of Bern only investments for the extension of the existing biogas plant were considered.

The column "contractor" shows that manufacturers as well as consultants and general contractors are assigned for the installation of the complex plant technology.

Information on the total annual amount of feedstock and its main components are given in the following two columns. It's obvious that the good practice examples cover plants from medium to vast size. The majority of these installations were designed for the processing of organic wastes. Some installations are based on an existing sewage treatment plant. And a few one treat residues from agriculture beside organic debris.

The following two columns illustrate the capacity of the digesters which is in line with the annual amount of feedstock. Most of the biogas plants prefer vertical cylinders for the reactors equipped with a central stirrer.

The biogas production is given as an average hourly figure. The individual yields mainly correspond to the feedstock mass flow and the kind of substrate. The concentration of the energy carrier - the methane - varies around 60 vol.-%.

The auxiliary energy which is necessary to produce one m^3 of methane shows a remarkable discrepancy between plants designed for waste processing and sewage treatment plants. The latter show specific energy demands beyond 2 kWh/m^3_{CH4}. This is due to the fact that the input material mainly consists of water which has to be heated up and doesn't contribute to the biogas production.

Only a few of the biogas plants publish the specific biogas production costs. The figures displayed give a good impression of the range one has to consider.

The majority of the digestate is either used as a fertiliser or compost. A few installations use it as soil improver or pass it on into an incineration plant.

Upgrading plants

The second table covers the upgrading units. A glance at column “commissioning” reveals the novelty of almost every plant depicted.

The investment costs are numbered only by a few operators. More information on specific investment costs are given in the respective training documents (D4.2).

The predominant technology for upgrading biogas to bio-methane is the water scrubber followed by the pressure swing adsorption (“manufacturer” + “technology”).

The capacity of the biogas upgrading units varies from small scale applications to large scale plants (“capacity”) and goes along with the annual input of feedstock.

The product quality of bio-methane is displayed in the column “quality [vol.-% CH4]“. It reveals that water scrubbers offer a higher methane concentration in the product than PSA-plants which is system immanent and not a question of the maker. And the same applies for the respective methane losses via the off-gas.

Sales of the product bio-methane go equally into the gas grid and into the transport fuel sector as well.

Specific costs for the production of bio-methane are not widely published. The few figures will – at least – give the reader an impression on the magnitude to be expected for a new investment in these technologies. More information on specific investment costs are given in the respective training documents (D4.2) too.

3 Conclusion

Good practice plants which convert organic residues into the product bio-methane consist of different state of the art biogas plants and modern upgrading units with presently two predominant technologies, namely water scrubber and PSA (pressure swing adsorption). Main feedstock sources are MSW and sewage sludge with a variety of organic residues as co-substrates. The amounts for investment and specific production costs of the plants illustrated in the table vary significantly and can be used as an indication only.

Biogas Plant

City / Country	starting year	investment [k€]	contractor	mass flow [to/a]	major feedstock	digester volume [m³]	digester type	biogas production [m^3_N/h]	biogas quality [vol.-% CH_4]	process energy [kWh/m^3_{NCH4}]	costs [€/kWh]	digestate use
Lille / France	2007	75,000	Linde	108,000	MSW, green waste	6,200	horizontal cuboid	1,200	60	0.21	n.a.	compost
Madrid / Spain	2008	79,000	Gocsa	369,000	MSW	21,200	vertical cylinder	4,000	60	0.19	n.a.	compost
Västerås / Sweden	2005	6,000	Rosroca	20,550	MSW, gras silage, grease	4,000	vertical cylinder	280	63	0.35	n.a.	fertiliser
Hendriksdal / Sweden	1969	n.a.	n.a.	790,000	sewage sludge, food waste	38,400	vertical cylinder	1,400	63	2.40	0.030	soil improver
Linköping / Sweden	1996	n.a.	n.a.	53,800	slaughter waste, others	7,400	vertical cylinder	400	65	2.20	0.025	fertiliser
Inwil / Switzerland	2008	19,000	Kompogas	60,000	manure, food waste	4,550	flat cylinder	500	57	n.a.	n.a.	fertiliser
Bern / Switzerland	2004	1,500	n.a.	247,000	sewage sludge, others	18,000	vertical cylinder	835	66	2.00	0.030	incineration
Rostock / Germany	2010	n.a.	Kompogas	40,000	MSW, food waste	3,600	horizontal cylinder	1,000	55	n.a.	n.a.	n.a.
Altenstadt / Germany	2001	4,000	Hochreiter	40,000	food waste	7,800	n.a.	1,200	67	n.a.	0.030	incineration, fertiliser
Werlte / Germany	2002	7,000	Hese	110,000	manure, slaughter waste	6,400	vertical cylinder	1,000	66	n.a.	n.a.	fertiliser
Bruck a.d.L. / Austria	2004	6,500	n.a.	30,000	organic residues	19,000	vertical cylinder	730	63	n.a.	n.a.	fertiliser

Biomethane Plant

City / Country	starting year	investment [k€]	manufacturer	technology	biomethane capacity [m^3_N/h]	CH4 quality [vol.-% CH_4]	losses [%]	utilisation	costs [€/kWh]
Lille / France	2006	1,480	Greenlane Biogas	water scrubber	1,200	98	1.0	transport fuel	n.a.
Madrid / Spain	2008	3,200	Greenlane Biogas	water scrubber	4,000	98	0.9	grid injection	n.a.
Västerås / Sweden	2005	n.a.	Malmberg	water scrubber	700	95	2.0	transport fuel	n.a.
Hendriksdal / Sweden	2003	n.a.	Malmberg	water scrubber	1,400	97	n.a.	transport fuel	n.a.
Linköping / Sweden	1997	n.a.	several	several	2,120	97	n.a.	transport fuel	n.a.
Inwil / Switzerland	2008	n.a.	CarboTech	PSA	225	98	n.a.	grid injection	n.a.
Bern / Switzerland	2008	1,500	CarboTech	PSA	300	96	3.0	transport fuel	0.030
Rostock / Germany	2011	n.a.	Cirmac	water scrubber	350	98	n.a.	grid injection	n.a.
Altenstadt / Germany	2009	n.a.	Rosroca	water scrubber	690	98	n.a.	grid injection, fuel	0.027
Werlte / Germany	2007	1,000	CarboTech	PSA	500	94	n.a.	grid injection	n.a.
Bruck a.d.L. / Austria	2007	n.a.	axiom	membrane	180	98	0.0	grid injection	n.a.