Urban waste for biomethane grid injection and transport in urban areas

Project No: IEE/10/251

URBAN BIOGAS
www.urbanbiogas.eu

Good practice projects for biogas production from waste, upgrading and utilization

WP 2 – Task 2 / D 2.2

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Fraunhofer IWES

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UrbanBiogas website: www.urbanbiogas.eu

List of fact sheets

Glossary

Biogas	A combustible gas derived from decomposing biological waste under anaerobic conditions. Biogas from organic waste normally consists of 50-75 Vol. % methane.
Biomethane	Raw biogas which is produced through anaerobic digestion normally consists of 50-75 Vol. % methane, 25-55 % carbon dioxide, 0-10 % water vapor and small amounts of nitrogen, hydrogen, oxygen, ammoniac and sulphur hydrogen. Upgraded or purified biogas is called “biomethane”. Biomethane has a methane content of >95 Vol. %.
Capacity	The maximum energy output (electricity or heat) that a machine or system can convert, e.g. from biogas. The capacity of generating equipment is generally expressed in kilowatts or megawatts.
Digestate	The digested effluent from the AD process. Digestate still contains all nutrients from the input substrates. Thus, it is an excellent organic fertilizer.
Energy consumption	The energy consumption comprises electricity and heat energy that is necessary to produce one unit biogas or biomethane.
Hydraulic retention time (HRT)	The average HRT is an important influence on the economic efficiency of biogas plants and on the methane yield that is produced. The average hydraulic retention time must be high enough to enable the degradation of the biomass and the reproduction of active biomass. Due to the methane-forming microorganisms’ doubling time of about 10 – 12 days, the HRT should exceed 12 days.
Organic load	Organic load of a digester is the quantity of organic matter fed per unit volume of the digester per time. The organic loading rate plays an important role in continuous anaerobic digestion systems and is a useful criterion for assessing the performance of the digesters.
Plant availability	Plant availability of an upgrading plant is related on the time during one year in per cent that an upgrading plant is able to upgrade raw biogas. The plant availability is not related to the degree of utilization.

1
Västerås, Sweden

(Picture: Svensk Växkraft AB)

LOCATION
Biogas plant Västerås
SE-721 87 Västerås
Sweden

OPERATOR
Svensk Växkraft AB
Phone +46/21 35 00
www.vafabmiljo.se/svensk_vaxtkraft_ab_s224.html

GENERAL INFORMATION ABOUT THE PLANT

Biomethane as a vehicle fuel in the public transport sector has been produced in Västerås since 2005. The biogas plant and the upgrading plant are operated by Svensk Växkraft AB. The company was established in 2003 through the municipality of Västerås (Vafabmiljö), the National Federation of Swedish Farmers (LRF) and Mälarenergi, a local energy company and local farmers.
The upgrading plant purifies biogas from two biogas plants, a waste digestion biogas plant and a wastewater treatment plant. Source seperated household waste - collected in the region, grease trap removal sludge and grass silage are the main feedstock materials for the production of biogas in the waste digestion biogas plant.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2005	Biogas production	280 Nm³/h
Duration of plant set-up	2003 till 2005	Hydraulic retention time	24 d
Number of digesters	1	Organic load	*no data*
Volume of digesters	4 000 m³	Biogas quality	60 – 65 Vol. % CH_4
Gas storage capacity	500 m³	Energy consumption	0.35 kWh/Nm³ CH_4 eq

FEEDSTOCK

Total amount of feedstock	20 550 t/yr	100 %
Household waste	15 400 t/yr	75 %
Grease trap removal sludge	2 150 t/yr	10 %
Grass silage	2 990 t/yr	15 %

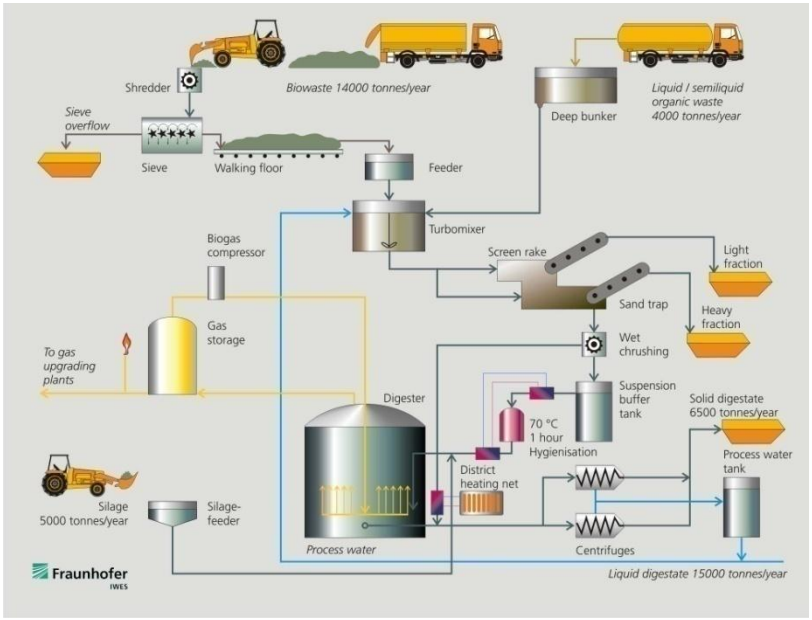
(Picture: vafabmiljo)

DIGESTER RESIDUES UTILIZATION

Utilization as agricultural fertilizer on the fields of the participating farmers.

ECONOMICAL DETAILS

Initial investment	ca. 6 million € (without upgrading technologies)
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*



BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2005	Plant availability	>95 %
Upgrading system	Water scrubber	Biomethane utilization	Vehicle fuel
Plant manufacturer	Malmberg	Waste air treatment	Bio filter
Upgrading capacity (raw gas eq)	700 Nm³/h	Methane loss	< 2 % of the purified gas
Methane content	>95 %		

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production cost	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

The biogas plant in Västerås is part of the region`s recycling system for waste, nutrients and energy between urban and rural areas. With the production of biomethane the biogas plant contributes to regional energy savings of fossil fuel and reduces the amount of incinerated organic waste and CO_2-emissions. Produced digester residues with its use as fertilizer help to close nutrient cycles and substitute mineral fertilizers.

LESSONS LEARNT

Experience showed that all stakeholders participating in the biogas and biomethane production value chain should be involved in the project at an early stage. Legally binding contracts should be drawn up for the supply of substrates and delivery/disposal of digester residues.

(Picture: www.vafabmiljo.se)

2 Henriksdal, Sweden

(Picture: Fraunhofer IWES)

LOCATION
Biogas plant Henriksdal
SE-106 36 Stockholm
Sweden

OPERATOR
Stockholm Vatten AB (SVAB)
Phone: +46/ 8 522 120 00
stockholm.vatten@stockholmvatten.se
www.stockholmvatten.se

GENERAL INFORMATION ABOUT THE PLANT

Biogas is produced at Henriksdal since 1969, whereas biomethane as a vehicle fuel is produced since 2003. The wastewater treatment plant (WWTP) treats wastewater equivalent to about 800 000 people. Stockholm Vatten AB, a municipal water company, operates the wastewater and the biogas plant. Whereas the upgrading plants are operated by the company Scandinavian biogas.
Beside sewage sludge, food waste collected from local restaurants and markets as well as sludge from grease separators is digested at the biogas plant.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	1969	Biogas production	1 400 Nm³/h
Duration of plant set-up	*no data*	Hydraulic retention time	19 d
Number of digesters	7	Organic load	1.6 kg oDM/m³·d
Volume of digesters	38 400 m³	Biogas quality	60 – 65 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	2.4 kWh/Nm³ CH_4 eq

FEEDSTOCK

Total amount of feedstock	790 000 t/yr	100 %
Sewage sludge	760 000 t/yr	96 %
Food waste	30 000 t/yr	4 %

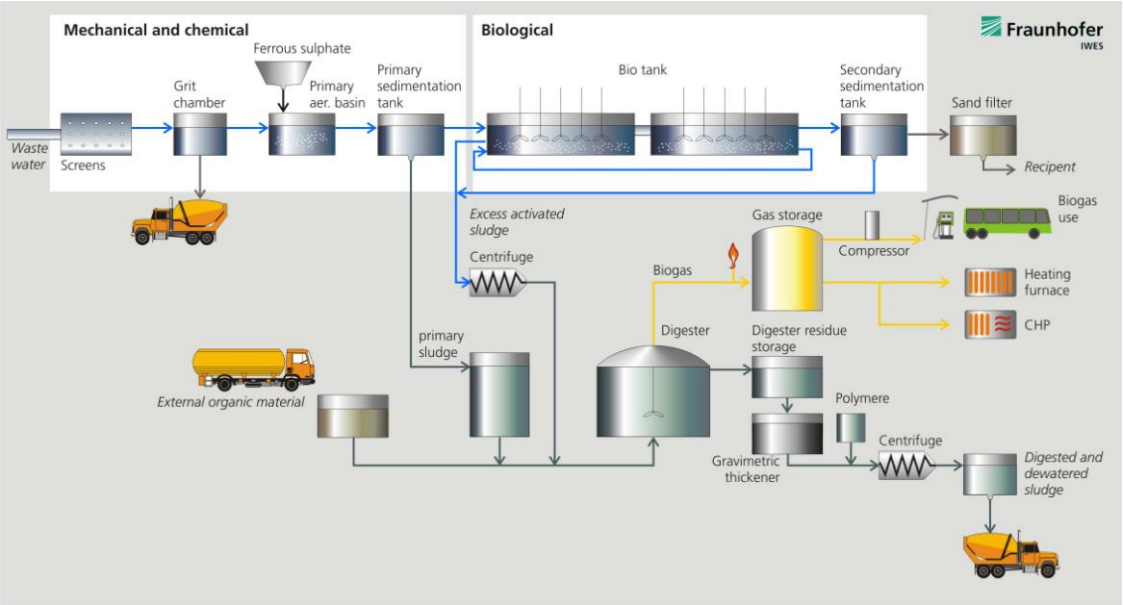
(Picture: Fraunhofer IWES)

DIGESTER RESIDUES UTILIZATION

Utilization of digester residues as agricultural fertilizer is planned in the future. Today the solid residues are used as soil improver after solid-liquid separation. Liquid residues are transported back into the wastewater treatment process.

ECONOMICAL DETAILS

Initial investment	*no data*
Revenues for the disposal of organic waste materials	50 - 80 €/t
Biogas production costs	*2 – 4 €Cent/kWh*



BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2003 and 2006	Plant availability	>95 %
Upgrading system	Water scrubber	Biomethane utilization	Vehicle fuel
Plant manufacturer	Malmberg	Waste air treatment	*no data*
Upgrading capacity (raw gas eq)	600 and 800 Nm³/h	Methane loss	*no data*
Methane content	96 - 98 %		

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

The City of Stockholm has an extensive program to introduce gas driven vehicles and targets to be fossil fuel free until 2050. Biomethane as vehicle fuel has been used in Stockholm since 1996. The sale of biomethane as vehicle fuel has increased continuously since then.

LESSONS LEARNT

The waste management department in Stockholm continuously works to increase the share of biological treatment of food waste. The anaerobic digestion process at the biogas plant is continuously under optimization. A further increase of produced biogas was reached through a higher thickening of sewage sludge before it is charged into the digester.



(Pictures: Fraunhofer IWES)

3
Linköping, Sweden

(Picture: Fraunhofer IWES)

LOCATION
Linköping
581 15 Linköping
Sweden

OPERATOR
Svensk Biogas AB
581 15 Linköping
www.svenskbiogas.se

GENERAL INFORMATION ABOUT THE PLANT

The Linköping biogas plant in southeastern Sweden is in operation since 1996. The initial partners were Tekniska Verken, Swedish Meats and LRF (the Federation of Swedish Farmers). Since 2004, the Linköping biogas plant is part of Svensk Biogas, a subsidiary within the Tekniska Verken group. Tekniska Verken operates a wastewater treatment plant and two biogas plants.
Three upgrading plants are located at the premises close to the waste digestion biogas plant. Additionally to the biogas produced at the waste digestion plant, biogas from a wastewater treatment plant is purified at the site.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	1996	Biogas production	400 m³/h
Duration of plant set-up	*no data*	Hydraulic retention time	50 d
Number of digesters	2	Organic load	2.8 kg oDM/m³ d
Volume of digesters	7 400 m³	Biogas quality	64 - 65 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	2.2 kWh/Nm³ CH_4 eq

FEEDSTOCK

Total amount of feedstock	53 800 t/yr	100 %
Slaughter waste	27 500 t/yr	51 %
Pharmaceutical waste	8 600 t/yr	16 %
Ethanol residues	7 500 t/yr	14 %
Dairy	9 100 t/yr	17 %
Others	1 100 t/yr	2 %

(Picture: Fraunhofer IWES)

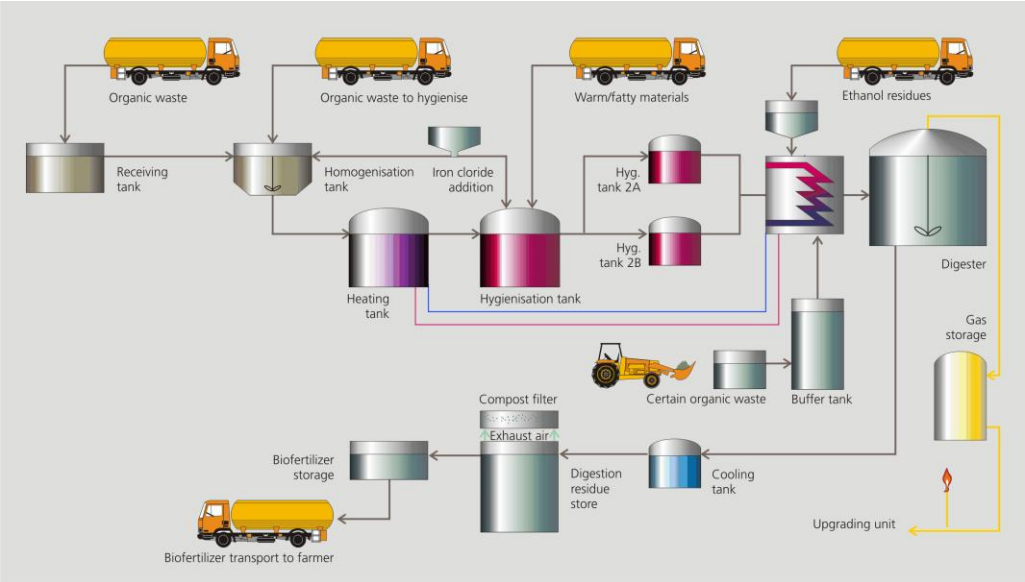
DIGESTER RESIDUE UTILIZATION

Digester residues are used as agricultural fertilizer through local farmers.

ECONOMICAL DETAILS

Initial investment	*no data*
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	2 - 3 €Cent/kWh

Fraunhofer IWES



(Source: Fraunhofer IWES)

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	1992, 1997 and 2002	Plant availability	*no data*
Upgrading system	Water scrubber; PSA	Biomethane utilization	vehicle fuel
Plant manufacturer	Carbotech; Flotech; YTI Vatten och miljöteknik AB	Waste air treatment	Compost filter
Upgrading capacity (raw gas eq)	2 120 Nm³/h	Methane loss	*no data*
Methane content	97 %		

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

Since 2002 all city buses run on biomethane in the Linköping city center. Another environmental benefit is a public train, which is now working with biomethane instead of diesel.

LESSONS LEARNT

When the biogas plant started its production in the 1990's it was one of the first biogas plants in Sweden. In the early stages a few difficulties were experienced to find suitable feedstock material. During the last year many local authorities in Sweden are now developing biogas plants, which increase the competition among companies for organic wastes.

Experiences of the biogas plant in Linköping have shown that it is recommended to investigate the local market for organic waste materials to determine the most suitable substrate that will guarantee a reliable supply and profitability.

(Pictures: Fraunhofer IWES)

4
Inwil, Switzerland

(Picture:Swiss Farmer Power Inwil AG)

LOCATION
Im Feld
6034 Inwil
Switzerland

OPERATOR
SwissFarmerPower Inwil AG
Im Feld
6034 Inwil
www.sfpinwil.ch; philip.gassner@sfpinwil.ch
Mobil: +41(0)79 403 92 94

GENERAL INFORMATION ABOUT THE PLANT

The biogas plant at Inwil is located in the region of Luzern, which is characterized through a high livestock farming density. The plant has been operated by SwissFarmerPower AG since 2008 which consists of ewl (Erdgas Zentralschweiz AG), 72 farmers as well as fenaco (Swiss agricultural economy group).

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2008	Biogas production	500 m³/h
Duration of plant set-up	1 year	Hydraulic retention time	*no data*
Number of digesters	3	Organic load	*no data*
Volume of digesters	4 550 m³	Biogas quality	55 - 58 Vol. %
Gas storage capacity	*no data*	Energy consumption	*no data*

FEEDSTOCK

Total amount of feedstock	60 000 t/yr	100 %
Liquid and solid manure	30 000 t/yr	50 %
Food and green waste	30 000 t/yr	50 %

(Picture: Fraunhofer IWES)

DIGESTER RESIDUE UTILIZATION

Solid-liquid separation of digester residues. Liquid and solid residues are used as organic fertilizer on agricultural land in the vicinity of the biogas plant.

ECONOMICAL DETAILS

Initial investment	about 19 million € (upgrading and biogas facility)
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2008	Plant availability	*no data*
Upgrading system	PSA	Biomethane utilization	Gas grid injection
Plant manufacturer	*no data*	Waste air treatment	*no data*
Upgrading capacity (raw gas eq)	225 Nm³/h	Methane loss	*no data*
Methane content	98 %		

ECONOMICAL DETAILS			
Initial investment	about 19 million €	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

Before the biogas plant in Inwil was built, the amount of manure produced through local livestock farming exceeded the local demands. Farmers had additional costs for transporting the residues over long distances to dispose the excess slurry. This situation changed with the production of biogas based on manure and its subsequent digester residue liquid-solid treatment. Compost produced of solid residues that can be used on private gardens as soil conditioner. Furthermore, compost is available for free for private consumers at the Kompogas biogas plant site.

LESSONS LEARNT

no information available

(Pictures: www.sfpinwil.ch)

5
Bern, Switzerland

(Picture: Fraunhofer IWES)

LOCATION
Neubrückstrasse 190
Postfach 58
CH 3037 Herrenschwanden
Switzerland

OPERATOR
ara region bern ag
phone: +41 31 300 52 52
www.arabern.ch

GENERAL INFORMATION ABOUT THE PLANT

The arabern company treats wastewater of about 250 000 inhabitants. The biogas plant situated at the waste water treatment plant (WWTP) began its operation 1967. Since 2004, with the goal to increase the biogas production, the biogas plant treats organic waste materials additionally to the sewage sludge.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2004	Biogas production	835 Nm³/h
Duration of plant set-up	one year	Hydraulic retention time	25 d
Number of digesters	3	Organic load	1.2 kg oDM/m³d
Volume of digesters	18 000 m³	Biogas quality	66 Vol. % CH_4
Gas storage capacity	4 500 m³	Energy consumption	2 kWh/Nm³ CH_4 eq

FEEDSTOCK

Total amount of feedstock	247 000 t/a	100.0 %
Sewage sludge	221 000 t/a	89.3 %
Grease trap removal sludge	2 700 t/a	1.1 %
Thickend fats	2 200 t/a	0.9 %
Restaurant waste	8 400 t/a	3.4 %
Ethanol	580 t/a	0.2 %
Others	12 600 t/a	5.1 %

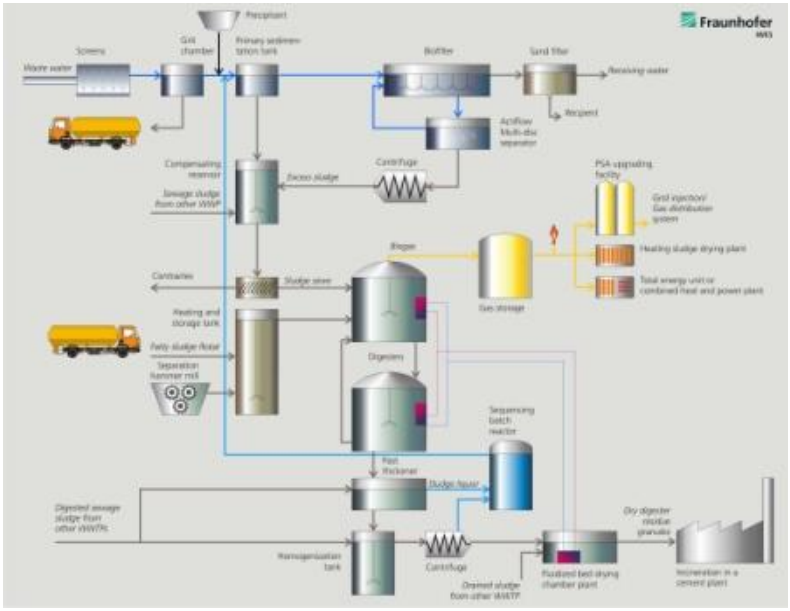

(Picture: arabern)

DIGESTER RESIDUES UTILIZATION

Incineration of digester residues in cement plants.

ECONOMICAL DETAILS

Initial investment	1.5 million €
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	<3 €ct/kWh



BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2008	Plant availability	>95 %
Upgrading system	PSA	Biomethane utilization	Vehicle fuel
Plant manufacturer	Carbotech	Waste air treatment	none
Upgrading capacity (raw gas eq)	300 Nm³/h	Methane loss	<3 %
Methane content	>96 %		

ECONOMICAL DETAILS			
Initial investment	1.5 million €	Biomethane production costs	<3 €ct/kWh

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

In order to increase biogas production, co-substrates from industry and from restaurants are fed additionally into the digesters of the WWTP. Since co-substrates have been introduced and digested at the biogas plant, the biogas production has significantly increased.
The local energy company ewb (Energie Wasser Bern) has successfully carried out a strong marketing campaign for biomethane as vehicle fuel. Today many companies and institutions have replaced partialy their fleets with gas driven vehicles.

LESSONS LEARNT

Special efforts in Bern were given to the development of biomethane filling stations. Most challenging was the indoor filling station at the bus depot of Bernmobil (public transport of the region of Berne). A slow filling station for buses was implemented inside the bus hall to fill up buses during the night. But methane emissions inside the bus hall caused problems. The financial results of the indoor filling station show that the experiment is not recommended to repeat it elsewhere.

(Pictures: Fraunhofer IWES, arabern)

6
Rostock, Germany

(Picture: EVG Entsorgungs-und Verwertungsgesellschaft mbH Rostock)

LOCATION
18147
Rostock
Germany

OPERATOR BIOGAS PLANT
EVG Entsorgungs-und
Verwertungsgesellschaft mbH Rostock
Ost-West Straße 22
18147 Rostock
Tel.: +49 (0)381 67330-10

OPERATOR UPGRADING PLANT
E.ON Hanse Wärme
GmbH
Rigaer Straße 5
18311 Ribnitz-Damgarten

GENERAL INFORMATION ABOUT THE PLANT

Municipal organic waste of the municipalities Hansestadt Rostock, Bad Doberan, Nordvorpommern and Güstrow is treated at the organic recovery center (ORC) in Rostock. Before the biogas plant was built, the waste was used to produce compost and to substitute fossil fuel in an incineration plant. Since 2010 the digestible organic waste fraction is used to produce biogas in a biogas plant. E.ON Hanse Wärme GmbH (energy utility) uses the biogas in two CHP plants for the cogeneration of electricity and heat. Since February 2011 the surplus biogas production is upgraded to biomethane and injected into the public gas grid.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2010	Biogas production	1 000 m³/h
Duration of plant set-up	*no data*	Hydraulic retention time	12-16 d
Number of digesters	3	Organic load	*no data*
Volume of digesters	3 600 m³	Biogas quality	>55 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	*no data*

FEEDSTOCK

Total amount of feedstock	40 000 t/yr	100 %
Food waste	4 000 t/yr	10 %
Municipal waste	36 000 t/yr	90 %

DIGESTER RESIDUES UTILIZATION

No information available

ECONOMICAL DETAILS

Initial investment	*no data*
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*

Fraunhofer IWES

(Picture: www.evg-mba-rostock.de/teilstromvergaerungsanlage)

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2011	Plant availability	>96 %
Upgrading system	water scrubber	Biomethane utilization	gas grid injection
Plant manufacturer	Cirmac	Waste air treatment	*no data*
Upgrading capacity (raw gas eq)	350 m³/h	Methane loss	*no data*
Methane content	>98%		

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION
The biogas plant at Rostock reduces 15 200 t/yr CO_2 emissions in the region through the production of biomethane, heat and electricity.

LESSONS LEARNT
No information available

(Pictures: E.ON Wärme Hanse GmbH)

7 Altenstadt/Schongau, Germany

(Picture:Ökopower GmbH & Co. KG)

LOCATION

Biogas plant Altenstadt
Wolfgarten 1
86972 Altenstadt, Germany

OPERATOR

Öko-Power GmbH & Co. KG
Wolfgarten 1
Phone: +49 8861-234411
Email: oekopower-gmbh@t-online.de

GENERAL INFORMATION ABOUT THE PLANT

Biomethane has been produced at the biogas plant in Altenstadt since 2009. The biogas plant started its biogas production in 2001. During the first nine years the produced biogas was used to generate electricity in combined heat and power stations (CHP). After 80 000 CHP operation hours the company decided to implement a upgrading plant instead of investing in new CHPs. Today Öko-Power GmbH & Co. KG operates the upgrading plant together with Erdgas Schwaben GmbH.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2001	Biogas production	1 200 m³/h
Duration of plant set-up	9 month	Hydraulic retention time	60 d
Number of digesters	6 primary 2 secondary	Organic load	*no data*
Volume of digesters	7 800 m³	Biogas quality	65 - 70 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	*no data*

FEEDSTOCK

Municipal waste (food waste, canteen waste, fats, slaughterhouse waste)	40 000 t/a	100 %

[Source: Biomasse Kompetenz Zentrrum]

DIGESTER RESIDUES UTILIZATION

Digester residues in the biogas plant are separated into liquid and solid fraction. The solid residues are incinerated in a heating plant together with dewatered sewage sludge. Liquid residues are used as agricultural fertilizer.

ECONOMICAL DETAILS

Initial investment	4 million €
Revenues for the disposal of organic waste materials	ca. 10 €/t
Biogas production costs	2-4 €ct/kWh

Fraunhofer IWES

(Picture: Öko-Power GmbH & Co. KG)

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2009	Plant availability	98 %
Upgrading system	Water scrubber	Biomethane utilization	Gas grid injection; Filling station at the plant site
Plant manufacturer	Ros Roca	Waste air treatment	Thermal treatment
Upgrading capacity (raw gas eq)	690 m³/h	Methane loss	*no data*
Methane content	98 %		

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production costs	about 2.5 - 3 €ct/kWh

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

The biogas plant in Altenstadt produces biomethane from municipal organic waste streams without competing for energy crops with the food processing industry.
A filling station is also charged with biomethane at the plant site. Waste collection trucks are operated with 100% biomethane when collecting organic wastes in the region.

LESSONS LEARNT

When the biogas plant started its operation in 2001 it was the first plant which digested organic wastes in the region. Since then other biogas plants have started to digest organic waste and competed on the organic waste market. Thus, revenues for disposing organic waste streams became less which affects the overall economy of the plant.

8
Werlte, Germany

(Picture: Fraunhofer IWES)

LOCATION
Biogasanlage Werlte
Loruper Straße 80
49757 Werlte
Germany

OPERATOR
EWE Biogas GmbH & Co. KG
Isums 45a
26409 Wittmund
Telefon: 04462 9199-0
Telefax: 04462 9199-19
E-Mail: biogasanlage-wittmund@ewe.de
biogasanlage-werlte@ewe.de

GENERAL INFORMATION ABOUT THE PLANT

The biogas upgrading plant in Werlte was one of the first upgrading plants in Germany. EWE Biogas GmbH & Co. KG which is part of the EWE AG (large German energy supply company) has been operating the biogas plant since 2006. The biogas upgrading plant was installed in 2007 to inject biomethane into the natural gas grid.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2002	Biogas production	1 000 m³/h
Duration of plant set-up	*no data*	Hydraulic retention time	47 d
Number of digesters	2	Organic load	*2-5 kg oDM/m³*
Volume of digesters	6 400 m³	Biogas quality	62-69 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	*no data*

FEEDSTOCK

Total amount of feedstock	110 000 t/yr	100 %
Slaughterhouse waste	40 000 t/yr	36 %
Liquid manure	70 000 t/yr	64 %

DIGESTER RESIDUES UTILIZATION

Digester residues are used as organic fertilizer on agricultural fields.

Fraunhofer IWES

ECONOMICAL DETAILS	
Initial investment	7 million €
Revenues for the disposal of organic waste materials	-3 - 8 €/t FM
Biogas production costs	*no data*

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2007	Plant availability	>96 %
Upgrading system	PSA	Biomethane utilization	gas grid injection
Plant manufacturer	Carbo Tech Eng.	Waste air treatment	*no data*
Upgrading capacity (raw gas eq)	500 m³/h	Methane loss	*no data*
Methane content	94 % (L-Gas)		

ECONOMICAL DETAILS			
Initial investment	1 million €	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

The biogas plant helps to close nutrient cycles by treating organic waste of slaughterhouses and farms. The digester residues with highly valuably nutrients are spread on agricultural fields close to the biogas plant.

LESSONS LEARNT

Organic waste treated at the biogas plant leads to a discontinuous biogas production because of its inhomogeneity. Thus, the biogas production efficiency of the biogas plant can be increased with (more) homogenous feedstock material. Organic waste is an important source of renewable energy and helps to close the nutrient cycles.

(Pictures: Fraunhofer IWES)

9 Bruck an der Leitha, Austria

(Picture:Biogas Bruck/Leitha GmbH)

LOCATION
Szallasweg 1
2460
Bruck/Leitha
Austria

OPERATOR
BIOGAS BRUCK/LEITHA GmbH
Szallasweg 1
2460 Bruck/Leitha
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GENERAL INFORMATION ABOUT THE PLANT

The biogas production and upgrading plant in "Bruck an der Leitha" was implemented and operated within a research and development project called "virtual biogas" (www.virituellesbiogas.at). One part of the produced biogas is used to generate electricity in two CHPs. Another part is upgraded to biomethane through a membrane upgrading system. Biomethane is injected into the national gas grid to substitute natural gas.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2004	Biogas production	650-800m³/h
Duration of plant set-up	*no data*	Hydraulic retention time	60 d
Number of digesters	3 primary 2 secondary	Organic load	2 kg oDM/m³d
Volume of digesters	9 000 + 10 000 m³	Biogas quality	60-65 Vol. % CH_4
Gas storage capacity	1 000 m³	Energy consumption	*no data*

FEEDSTOCK

organic waste (green waste, kitchen debris, food waste, remains from food industry, expired food, beer malt, fat separator, residues from vegetable oil production)	30 000 t/yr	100 %

(Picture: Biogas Bruck/Leitha)

DIGESTER RESIDUES UTILIZATION

Digestate is used as fertilizer on agricultural fields.

ECONOMICAL DETAILS	
Initial investment	6.5 million €
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2007	Plant availability	*no data*
Upgrading system	Membrane	Biomethane utilization	Gas grid injection
Plant manufacturer	Axiom Prozesstechnik	Waste air treatment	Fed to gas engines
Upgrading capacity (raw gas eq)	180 Nm³/h	Methane loss	0 %
Methane content	>= 98 %		(exhaust methane is used by gas engines)

ECONOMICAL DETAILS			
Initial investment	*no data*	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

800 000 m³ of natural gas per year can be substituted through biomethane produced at the biogas plant in "Bruck an der Leitha".
Membrane biogas upgrading technology is an innovative technology in the biogas sector. But it can especially in connection with gas filling stations become a mature technology in the future.

LESSONS LEARNT

The plant is built and operated within a research and development project. During the project the biogas production process and upgrading process was continuously improved e.g. a chemically oxidative desulphurization was implemented to improve the desulphurization.

(Picture: Biogas Bruck an der Leitha GmbH)

10
Madrid, Spain

[Picture: Greenlane Biogas GmbH]

LOCATION
Valdemingómez, Madrid, Spain

OPERATOR
UTE Biometanización La Paloma (Urbaser S.A. - Sufi S.A.)

GENERAL INFORMATION ABOUT THE PLANT

The biogas plantin Valdemingómez is operated by UTE Biometanización La Paloma. The biogas production is based on organic household waste collected from private households in Madrid.
The company "Greenlane Biogas" produces biomethane using a water scrubber. The upgraded biomethane is compressed an injected into the gas pipeline. The injected biomethan is used at vehicle fuel for public buses.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2008	Biogas production	4 000 Nm^3/h
Duration of plant set-up	2 years	Hydraulic retention time	21 d
Number of digesters	4 prim., 5 sec.	Organic load	*no data*
Volume of digesters	*no data*	Biogas quality	60 Vol. %
Gas storage capacity	*2 200 m^3*	Energy consumption	0.19 kWh/Nm^3 raw gas

FEEDSTOCK

Total amount of waste (Organic household waste)	369 000 t/yr	100 %

(Picture:Greenlane Biogas GmbH)

DIGESTER RESIDUES UTILIZATION

Annually about 190 000 tonnes compost are produced from the digestate.

ECONOMICAL DETAILS	
Initial investment	79 million €
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*

BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2008	Plant availability	98%
Upgrading system	Water scrubber	Biomethane utilization	Gas grid injection
Plant manufacturer	Greenlane Biogas GmbH	Waste air treatment	Biofilter
Upgrading capacity (raw gas eq)	4 000 Nm^3/h	Methane loss	0.9%
Methane content	98%		

ECONOMICAL DETAILS			
Initial investment	3.2 million €	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

The biogas plant in Valdemingómez treats organic waste collected from private households in Madrid. Therefore about 370 000 tons per year are used for energy production instead of being wasted. About 300 000 tons CO_2 emissions can be saved per year through anaerobic digestion of organic waste. 34 million m^3 raw biogas can be produced using the collected organic waste. The upgraded biogas (2 600 m^3/h) is used for 250 buses from "*Empresa Municipal de Transportes*" (EMT) which equals 20% of its total fleet.

LESSONS LEARNT

no information available

11
Lille, France

(Picture: LMCU)

LOCATION
Lille
France

OPERATOR
Lille Métropole Communauté Urbaine - LMCU
www.lillemetropole.fr

GENERAL INFORMATION ABOUT THE PLANT

The Organic Recovery Centre (ORC) is located in the Lille metropolitan area and has been in operation since 2007. The organic waste comes from selected refuse collectors, from recycling centres located in the metropolitan area and from institutional public catering.
Biogas from the ORC and from a waste water treatment plant (WWTP) is upgraded to biomethane quality. Biomethane is transported to a public transport bus center located close to the ORC site or injected into the natural gas grid. Gas-driven buses are filled with a mixture of natural gas and biomethane at the filling station.

BIOGAS PLANT

TECHNICAL DETAILS

Start of operation	2007	Biogas production	1 200 Nm^3/h
Implementation time frame	1 year	Hydraulic retention time	*no data*
Number of digesters	3	Organic load	*no data*
Volume of digesters	*no data*	Biogas quality	60 Vol. % CH_4
Gas storage capacity	*no data*	Energy consumption	0.21 kWh/Nm^3 raw gas

FEEDSTOCK

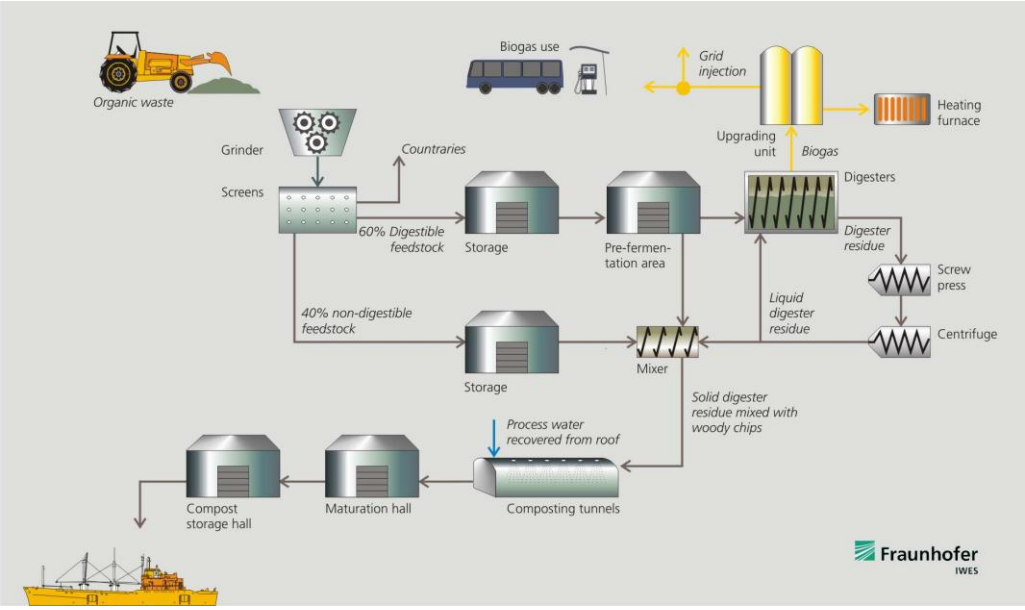
Total amount of feedstock (organic household waste, green waste)	108 000 t/a	100 %

DIGESTER RESIDUES UTILIZATION

Compost is produced by mixing the dried digester residues with wood chips. The compost is used as organic fertilizer on agricultural fields.

ECONOMICAL DETAILS

Initial investment	*no data*
Revenues for the disposal of organic waste materials	*no data*
Biogas production costs	*no data*



BIOGAS UPGRADING PLANT

TECHNICAL DETAILS			
Start of operation	2006	Plant availability	98%
Upgrading system	2006	Biomethane utilization	vehicle fuel
Plant manufacturer	Greenlane Biogas	Waste air treatment	*no data*
Upgrading capacity (raw gas eq)	1 200 Nm³/h	Methane loss	1%
Methane content	98 %		

ECONOMICAL DETAILS			
Initial investment	1.48 million €	Biomethane production costs	*no data*

ADVANTAGES AND LESSONS LEARNT

ADVANTAGES FOR THE MUNICIPALITY/REGION

LMCU has pioneered biomethane gas grid injection in France. The use of produced biomethane as vehicle fuel contributes to better air quality and lower environmental impact on the city of Lille, in comparison to the use of fossil fuels.

LESSONS LEARNT

LMCU has pioneered biomethane gas grid injection in France. The biogas plant has been in operation in 2006 but the delivery of biomethane to the bus filling station started in 2010. The main reason for the delay of the biomethane delivery was a gap between the innovative project and national legislation regarding gas grid injection and transportation of gas through gas pipelines and the natural gas grid.

(Pictures: www.biogasmax.eu)