Biogas Action Brochure on Best Regional-Integrated Biogas Plants

Biogas Action Project: Promotion of Sustainable Biogas Production in the EU

Biogas ACTION

Biogas Action

Biogas Action aims to promote the production of sustainable biogas throughout the EU, especially by exchanging best practice, creating new business models, and increasing investment in biogas production.

The project's purpose is to serve as a vehicle for the rapid development of the European biogas/biomethane sector. This undertaking will contribute to the EU 2020 targets, by focusing on the removal of non-technical barriers to the widespread production of biogas from manure and other waste. The project is founded on the idea of a deeper cooperation between the different policy levels (European, national and regional), and aims to foster the implementation of this cooperation in various EU regions.

Deliverable:	D.2.4 Comprehensive guidelines for biogas promotion at regional/local level with associated development of institutional frameworks and tools available as well as market support
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This brochure is a deliverable within Work Package 2. It contains information on the ten most interesting biogas plant projects of the Biogas Action project countries, providing the reader with technical data for each plant as well as background information concerning the start-up conditions.

The brochure offers a detailed analysis of the current situation and the environment in which the project was drawn up. It also explains the driving forces behind the project's conception and the construction of the plants, and outlines the obstacles faced, along with the involvement of the municipality and the residents of the area around each biogas plant.

The financial conditions for each project are described, including detailed analysis of local support tools and financial subsidies. The technical data for each biogas plant is included in detail, with explanation of the types and amounts of feedstocks and the products of the biogas process. The use of the products of biogas, heat and digestate, is important for an efficient and sustainable biogas project.

This brochure describes biogas plants that are not only outstanding but also offer a model of success that can feasibly be adapted and applied in other European regions.

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Bioplinsko Postrojenje

Waste to Energy and Fertiliser

Municipality of Gradec, Vrbovec, Croatia

Contact details

Agrokor-Energija

www.eihp.hr

Technical Data

Year of construction	2012
Plant size	2,134 MW_{el}
Digester volume	• Fermenters: 6,000 m^3 • Post-fermenter: 2,500 m^3 • Two hydrolysis tanks: 1,256 m^3
Gas Storage	2,000 m^3
Hydraulic retention time (HRT)	35 - 40 days
Process temperature	Mesophilic at 42° C
Digestion technology	CSTR, two-stage digestion

Background Story

The determining factor for this project was the company's waste to energy strategy. The plant is very close to the Croatian capital Zagreb, where the extensive food processing industry offers a broad spectrum of wastes which can be treated in a biogas plant. Additionally, Agrokor Group, a vertically integrated agricultural and food processing retail entity in the Republic of Croatia, enjoys access to a range of strategically important locations able to provide high quantities of different resources. This ensured a reliable supply of high-quality raw materials, by-products and wastes for the AD production process. Agrokor Group also owns companies which are consumers for part of the output of the production process (heat and organic fertilisers) to the mutual benefit of both parties.

This plant was the demonstration/learning plant for a string of biogas investments (9.8 MW in five plants).

Municipalities/Regions Involved

Agrokor Energija had public trust. They put a lot of effort into communication with the local community by organising numerous discussions and a study tour to biogas plants with digestate lagoons for locals. The existing pig farm became far more acceptable when the smell nuisance was reduced in the vicinity by building a biogas plant.

Main Interest in the Project

This project is very interesting because many different technologies which are used in the biogas industry are implemented in one place. The hydrolysis-step of the two-phase fermentation makes sure that substrates are digested as efficiently as possible. Additional thermomechanical equipment is installed (heat exchangers, thermal oil and storages) to allow as much heat utilisation as possible. Sterilisation and other specialised technology makes the use of many different wastes possible. The plant generates income from thermal energy, waste collection and agricultural soil fertiliser as well as electricity, which makes this project a very flexible and attractive model for the development of plants in many different regions.

Specialties

At first, the Biogas Plant Gradec was built as a 1 MW_{el} plant with combined heat and power generation (CHP) but was developed further with the addition of two separate hydrolysis tanks and a 2nd CHP in 2015. Production with a capacity of 2 MW started in the 4th quarter of 2015.

The plant is built next to the pig farm and meat processing facility, within Agrokor Group. Maximum efficiency of the CHP engine can be reached by utilising most of the heat. There are two forms of heat storage for heat from the CHP; two water tanks (2 x 100 m^3) and two thermal oil tanks (2 x 20 m^3). Heat from exhaust fumes at the exhaust pipe is captured with additional thermos technical equipment and stored using thermal oil tanks at up to 300 °C. The heat, combined with natural gas (as back up), is used for pressure sterilisation (133 °C at 3 bar for 20 minutes) of slaughter-house waste. Heat is also used as process heat to support hydrolysis in the pre-fermenter, the main fermenter, and for the digestate thickener.

Pig slurry is connected to an underground gravity piping system from the farm to the plant to avoid smell nuisance.

Financial Conditions

Total investment costs: 9.2 Mio EUR

Investors: The investor is a private company. Agrokor-Energija Ltd (est. 2010) is a member of Agrokor Group, which is vertically and horizontally integrated in the food & beverage industry.

Investment support: One part was provided by EBRD loan

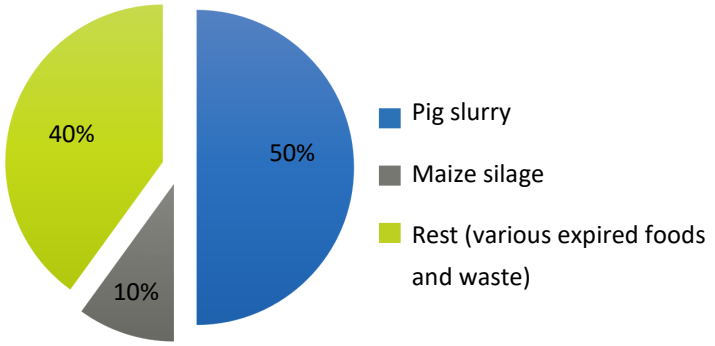
Operation support: FiT with a 14-year price guarantee of 17 euro cent per kWh including a 'local community' bonus for minimum 50% energy efficiency of the CHP.

Additional support: -

Feedstock/Substrates

The plant processes up to 220 tonnes of feedstock per day.

The plant processes 80,000 tonnes per year of a mixture of 11-20 different types of substrates. The largest portion of this (55-60%) is pig slurry, while the rest are animal by-products and waste from various stages of food processing and food retail within the Agrokor group, as well as waste from third parties (ex-food, slaughterhouse waste, flotation sludge, glycerine, beer yeast, various grains not intended for human consumption etc.). Maize silage is only used for balancing the process with a share of 11-15%.



Use of Products from Biogas Process

Use of biogas: In form of electricity and heat

CHP/electricity: Yes

Amount of generated electricity: 10,177 MWh (data is for 2015, with the provison that 2nd CHP started production in 4th quarter).

Use of electricity: Electricity is injected into the grid and sold.

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: Heat is used as process heat for fermenters, post-fermenter, hydrolysis tanks, digestate thickener and to heat the management offices and pig stables. Heat from oil tanks is used for the sterilisation of slaughterhouse waste.

Amount of heat: 6,288 MWh (used heat)

Use of digestate: Digestate is collected at lagoons and used as fertiliser within the company's own cropping system. One part of the digestate is treated in mechanical separators to get a solid phase which is also used as a fertiliser.

Plant Zdar nad Sazavou

Remote Cogeneration: Biowaste to Power and Heat for Industry and Municipality

Vysocina, Czech Republic

Contact details

Iva Zeronikova

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Technical Data

Year of construction	2010
Plant size	0.6 MW_{el} 0.6 MW_{th}
Digester volume	7 × 1,050 m^3 (operational volume ca 75%)
Gas Storage	467 m^3 (max pressure of 0,15 kPa)
Retention time (RT)	RT is more than 120 days work cycle of one fermenter is 28 days, ca. 70% of the digestate is used as inoculum and mixed with new substrate
Process temperature	Mesophilic at 38 °C
Digestion technology	One-stage digestion in batch mode, dry fermentation with 7 digesters, batch regime

Municipalities/Regions Involved

Neither the municipality nor the region was involved in the realisation of the project. However, the town is cooperating with the organisation of biowaste separation. The town is also the heat consumer.

Background Story

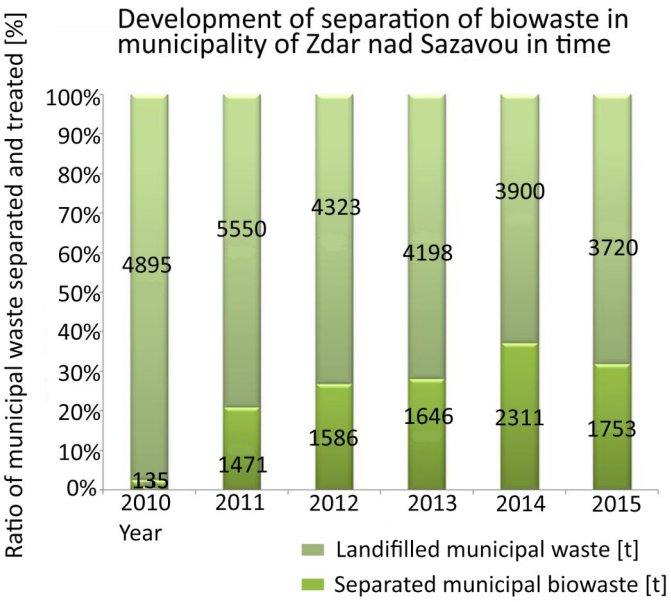
The idea was to provide the surrounding municipalities with the possibility of treating biowaste, without the limitations of standard composting facilities and with higher added value, namely, energy production. The investor assumed that a legal obligation to treat biowaste would come into force for the municipalities earlier than it actually did in the end. Almost no biowaste was separated or treated in the region prior to the construction of the facility.

Main interest in the project

Batch dry fermentation is a suitable technology for biowaste treatment. The project is also very efficient in its energy use (both heat and electricity).

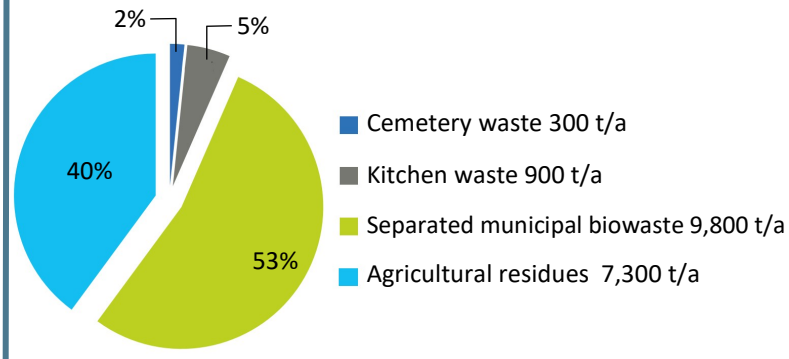
The biogas plant is very beneficial for the region as it reduces the amount of organic waste being landfilled and supplies electricity for a local industrial company as well as heat for the municipality. Nutrients are also recycled as the digestate is being spread on arable land in the area.

This project is not economically feasible under current conditions. However, that is partially due to the lack of legislation on biowaste treatment in the Czech Republic at the time of its start-up and in subsequent years, as well as reduced operational support for biogas plants treating waste (as opposed to energy crops).



Feedstock/Substrates

The plant processes up to 18,300 tonnes of biowaste per year.



Specialties

The produced biogas is transported via a 1.5-km-long pipeline to an industrial enterprise ZDAS where the CHP unit is located. All heat and electricity is used there which is a unique concept in Czech conditions.

There is a very good co-operation between the municipalities (production of biowaste/substrates), other producers of biowaste (industry, restaurants), operator (SME) and the consumer (large industrial enterprise).

The concept of the biogas plant allows not only the treatment of municipal waste but also other feedstock types.

Financial Conditions

Total investment cost: 103 Mio CZK (3.8 Mio EUR)

Investors: Waste treatment company ODAS ODPADY, Ltd.

Investment support:

- 35.9 Mio CZK (ca. 1.33 Mio EUR) from the European Structural and Investment Fund - Cohesion Fund (35%)
- 6.3 Mio CZK from the State Environmental Fund of the Czech Republic (6%)
- A loan of 30 Mio CZK (ca. 1.1 Mio EUR) from a bank

Operational support: Green bonus

Additional support: -

Use of Products from Biogas Process

Use of biogas: A remote CHP is located at an enterprise which uses the heat and electricity.

CHP/electricity: Yes

Amount of generated electricity: 0.6 MW

Use of electricity: In the industrial company ZDAS, a.s.: (ZDAS' manufacturing programme is focused on the production of forming machines, forging presses, metal scrap processing equipment, rolled product processing equipment, castings, forgings, ingots and tooling, especially for the automotive industry).

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: Central heating system of the municipality of Zdar nad Sazavou.

Amount of heat: 0.6 MW

Use of digestate: The digestate is regularly analysed and spread on surrounding arable land.

Solrød BiogaS

Biogas Plant Solving Nutrition Oversupply and Seaweed Problem at Bay of Køge

Zealand, Denmark

Contact details

Mikkel Busck

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Technical Data

Year of construction	2015
Plant size	5.4 Mio Nm^3 biogas per year 200,000 tonnes biomass per year
Digester volume	2 x 8,000 m^3 primary 2 x 1,500 m^3 secondary
Gas Storage	2,000 m^3
Hydraulic retention time (HRT)	37 days
Process temperature	Thermophilic at 52 ^oC
Digestion technology	CSTR , two-stage digestion, only first stage is heated

Municipalities/Regions Involved

The Municipality of Solrød was involved in the project. The municipality wished to take action regarding climate change and wanted to reduce their CO_2 emissions. They saw great potential in building a biogas plant that could address both the climate issue and the seaweed problem at the beach.

Background Story

Large parts of the beach area at the Bay of Køge used to be covered by rotting seaweed and the odour was a great nuisance to visitors and residents.

This led the Municipality of Solrød and the homeowner associations along the beach to establish a beach cleaning association to tackle the problem.

Hence, the idea was born to build a biogas plant digesting collected seaweed, organic residues, and livestock manure for the generation of energy.

Main Interest in the Project

The idea to build a biogas plant in Solrød emerged from the need to find a sustainable solution to the community's odour problem, caused by seaweed accumulating on the beach. The Solrød Municipality also wished to fight climate change by generating green energy.

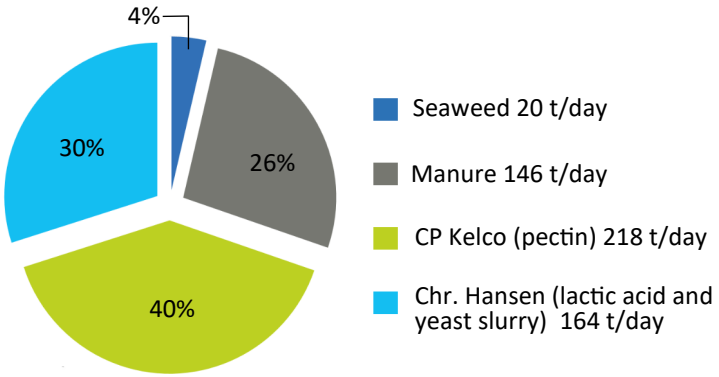
This project shows how a municipality can contribute to sustainable energy production with a growing focus on sustainability and environmental issues and how cooperation between different partners can lead to new solutions. The different partners, both private and public, gained from collaboration on a joint project.

Specialties

Solrød BiogaS is one of the only publicly-owned plants in Denmark. It was built from 2014 to 2015 as a result of the growing focus on sustainable energy in the municipality and is owned by the municipality of Solrød. It was developed in close collaboration with private companies in the municipality which had unused bio resources. The biogas plant helps both the private companies and the municipality to address different challenges and solve problems.

Feedstock/Substrates

The biogas plant has a treatment capacity of 200,000 tonnes of feedstock per year.



Financial Conditions

Total investment costs: 11.5 Mio EUR

Investors: The plant was established and is operated by Solrød Biogas A/S, founded May 2014.

Investment support:

The plant received financial support from the EU programme 'Mobilizing Local Energy Investments' in the project development phase.

- Investment of 11.5 Mio EUR (ex. CHP unit)
- EU grant 0.5 Mio EUR; annual revenues of 30 Mio DKK (4 Mio EUR)
- 480,000 EUR/4% (only in the design phase)

Operational support: Feed-in tariff to boost the biogas production from 2012 to 2019

- A price of 79 DKK (10.5 EUR) per GJ (2012 prices). Regulated per price index.
- A price supplement of 26 DKK (3.5 EUR) per GJ (2012 prices). Regulated per natural gas prices.
- A price supplement of 10 DKK (1.35 EUR) per GJ (2012 prices). Reduced by 2 DKK each year from 2016

Additional support: 480,000 EUR/4% (only in the design phase).

Use of Products from Biogas Process

Use of biogas: The biogas production of 6 Mio m^3 per year results in a supply of 60,000 MWh per year renewable energy, comprising 23,000 MWh per year of electricity and 28,000 MWh per year of heat used for district heating.

CHP/electricity: Gas engine

Amount of generated electricity: 23,000 MW

Use of electricity: Electricity is sold to the grid

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

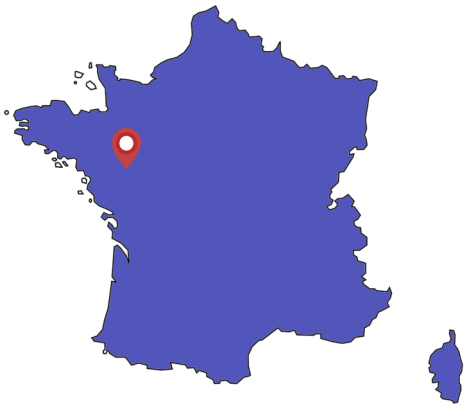
Heat use: The heat is supplied to the local district heating system which is operated by Vestegnens Kraftvarmeselskab I/S and owned by 12 municipalities as stakeholders.

Amount of heat: 28,000 MW

Use of digestate: The produced digestate is used by farmers as biofertiliser.

Agribiomethane

'Valorisons nos lisier en Gaz Vert'
Slurry to Green Gas



Mortagne-Sur-Sèvre, France

Contact details

AILE France

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Technical Data

Year of construction	2013
Plant size	In 2014: 65 Nm^3 biomethane per hour Since January 2016: 90 Nm^3 biomethane per hour During the first year (7/2014-6/2015): 447,209 Nm^3 biogas per hour
Digester volume	Net volume: • Main digester: 1,665 m^3 • Post digester: 1,066 m^3
Gas Storage	1,100 m^3
Hydraulic retention time (HRT)	45 days
Process temperature	Mesophilic at 37 °C
Digestion technology	Wet-fermentation, one preliminary tank for manure and two preliminary tanks for fats which are heatable

Municipalities/Regions Involved

The plant is close to a district border and so the district council supported the project by public subsidies on the condition that the plant was built in their district.

Background Story

The main driving force behind the project was a joint effort by farmers to improve nutrient management in the region. As the investment for a shared slurry treatment is the same as for one farm only, investors decided to find a joint solution. Another motivational factor was the decision of farmers to join together to streamline the creation of storage facilities.

Main Interest in the Project

This biogas project provides a model for other regions because of its shared investment. The advantages for farms are the diversification of production, the additional source of income and supporting the retention of livestock breeding in the area. Farmers profit from a new personal endeavour on behalf of a new industry and from exchanges with people they did not know before. The local treatment solution for organic waste (and the avoidance of a lot of transport) brings added value to the co-operative structure.

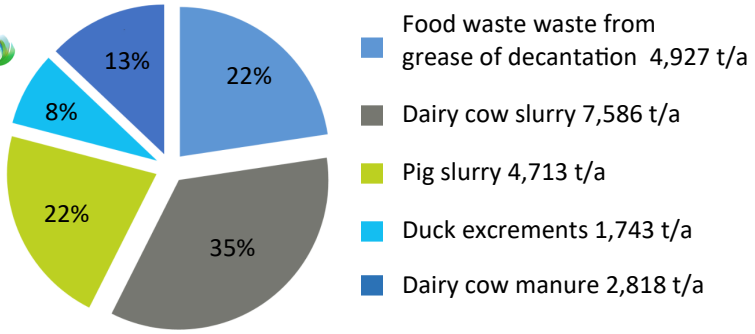
Specialties

AgriBioMethane has been operating for three years and was the first facility in the region to produce biomethane and inject it into the grid. It has been important for the farmers to maintain organisational and financial responsibility for the majority of the project. The first three years have proven that a project collectively run by farmers can be successful when the preparation is well thought-through. In this instance, ten farmers from four different agricultural centres invested in one shared biogas plant and the result was the biomethane generation project described here. The additional substrate is delivered from slaughterhouses that are owned by agricultural cooperatives already working with these farmers.

Feedstock/Substrates

The biogas plant has a treatment capacity of 59 tonnes feedstock per day.

Investors deliver manure and slurry. The overall treatment charge is 34,000 EUR per year for the benefit of the biogas plant and 25,000 EUR per year to buy substrates from waste producers.



Financial Conditions

Total investment costs: 3.4 Mio EUR

Investors: The investors are ten farmers on four farms, Terrena and Lyonaise des eaux. The French investment fund for green energy is part of the consortium.

Investment support:

- 760,000 EUR from the National Waste and Energy Agency (ADEME)
- 60,000 EUR from the district council
- 195,000 EUR FEDER allocated by the district council
- 70,000 EUR subsidies from the water supply agency Loire Bretagne

Operational support: Investors received support from consultants for technical and social/economic planning and for the application process for public finance.

Feed-in tariff: Excluding the price of the certificates of origin, in 2014 when the project began operation, the production volume was 65 Nm^3 per hour for 13 euro cent per kWh HHV (higher heating value). This price is related to the production volume: with the recent rise of production volume to 90 Nm^3 per hour, the price sunk to 12 euro cents per kWh HHV.

Additional support: Tax Exemption: plants with more than 50% of capital investors from agricultural backgrounds and 50% of substrate with agricultural origin are exempt from local taxes.

Use of Products from Biogas Process

Use of biogas: Upgrading to biomethane and grid injection

CHP/electricity: No

Amount of generated electricity: Not applicable

Use of electricity: The energy is sold as biomethane to ENGIE (ex GDF). An increase in the production volume to 90 Nm^3 per hour has recently been agreed on by the investors.

Biomethane generation/injection: Yes

Amount of injected biomethane: 8,000 MWh in 2016

Use of biomethane: The biomethane is consumed locally by a large bakery but the certificates of origin are sold to local authorities. Additionally, in the future the project aims to implement a filling station for gas vehicles (busses and lorries) using compressed biomethane.

Heat use: No

Amount of heat: Not applicable

Use of digestate: The digestate was originally separated by a screw press and is now separated by a newly installed centrifuge. The liquid phase is spread by an external company and the solid phase is composted by FertiEveil (cost 10 EUR per tonne solid phase for the transport).

TERRAGR'EAU

Biogas Plant to Protect the Quality of Evian Mineral Water

Auvergne-Rhône-Alpes , France

Contact details

Eric VAN TROYS , eric.vantroys@serfim-recyclage.fr

2, chemin du Génie – CS 60222 – 69633 Vénissieux Cedex

Technical Data

Year of construction	2016 First injection in January 2017
Plant size	111 Nm^3 biomethane per hour
Digester volume	2 X 3,617 m^3
Gas Storage	6,750 m^3
Hydraulic retention time (HRT)	65 days
Process temperature	Mesophilic at 38 °C
Digestion technology	Infinity-mixed wet fermentation, two-stage digestion

Municipalities/Regions Involved

Aside from the need to protect the water table itself, motivation for the municipality to support the biogas project came from the importance of the farms for tourism, landscape and cheese production in the region. The municipality initiated the feasibility study, and decided to be the owner of the plant and delegate building and operation to a private company. They received subsidies for financing the project.

Background Story

EVIAN, as a provider of natural mineral water, has exacting requirements: absence of chemical and bacteriological contaminants, stability of the mineral composition, and maintenance of a very low nitrate content. Compliance with regulatory requirements is essential to the sustainability of the industry and related jobs. Preserving the quality of the mineral water is intrinsically linked to the protection of the supply and of Evian's catchment area, located in the territory of the Community of Communes Pays d'Evian (CCPE).

However, the water source is in an area where spreading of manure poses a risk to the water quality because of contamination with nitrates. Almost 50% of the impluvium are grasslands. The local authority of Evian and Danone made a commitment to protect the territory.

Main Interest in the Project

TERRAGR'EAU is an example of the territorial integration of a biogas plant involving farmers, local companies and the local community. The aim of the project is to collect all organic matter (especially manure) to protect Evian water's impluvium and secure the quality of Evian water sold by Danone. The local authority is the project owner and also initiated the project. TERRAGR'EAU provides biomethane for gas grid injection and has a territorial approach. All farmers involved supply manure and use the digestate that is produced. This is not a renewable energy project but a project to protect the water of an impluvium. This approach is interesting to all regions with water sources.

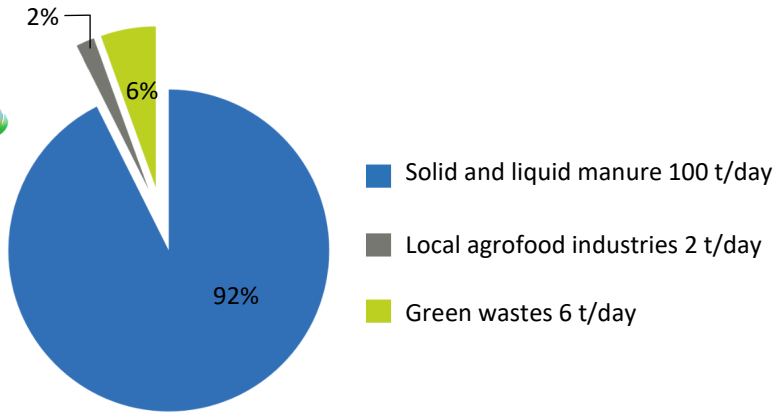
Specialties

The Terragr'Eau project is in line with local (departmental) and national policies. The "Thousand Biogas Plants" programme is of particular relevance. It promotes nitrate control through the management and spreading conditions of digestate.

One of the key elements of the project is the establishment of a farmers' co-operative dedicated to the management of the digestate and its spreading conditions, in order to protect the quality of water. This co-operative was recognised in February 2015 as one of the first Economic and Environmental Interest Groups (EEIG) by the Minister of Agriculture. Stakeholders in the project are convinced that Terragr'Eau has all the qualities to be a role model for other regions.

Feedstock/Substrates

The biogas plant has a treatment capacity of 40,600 tonnes feedstock per year.



Financial Conditions

Total investment costs: 9.3 Mio EUR

Investors: In Evian, the local authority invited investors to privately structure, finance, build and operate the plant as a public service delegation: SAS TERRAGR'EAU was created by a private company that monitored the construction and now oversees the operation of the plant. The second partner is DANONE.

Investment support:

- The local authority Communauté de Communes du pays d'Evian 20%
- Danone 40%
- SAS Terragr'eau 14%
- Subsidies from EU, Regional council, Department, ADEME 26%

Operational support: The project is a gas grid injection plant under construction. A feasibility study was carried out in 2006, and the plant will be in operation in 2017.

Feed-in tariff: 117.6 EUR per MWh

Additional support: Tax Exemption from local taxes paid for the local authority.

Use of Products from Biogas Process

Use of biogas: Biogas upgrading to biomethane

CHP/electricity: No

Amount of generated electricity: Not applicable

Use of electricity: Not applicable

Biomethane generation/injection: Yes

Amount of injected biomethane: 111 Nm^3 per hour

Use of biomethane: The gas will be injected into the grid and sold to an energy supplier, the price will depend on the amount of biomethane supplied and the percentage of manure used, around 117.6 EUR per MWh injected, 111 Nm^3per hour.

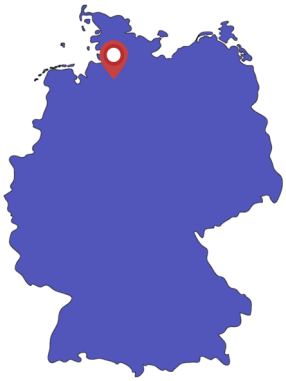
Heat use: No

Amount of heat: Not applicable

Use of digestate: The liquid digestate will return to the field and the dry digestate will be composted and will return to the field of the farmers who provided substrates.

Agrogas & Wärme GmbH & Co KG

Agricultural Waste to Electricity, Heat and Biomethane



Malstedt (Lower Saxony)

Contact details

Agrogas & Wärme GmbH Co. KG
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www.malstedt.de/bioenergiedorf

Technical Data

Year of construction	2010
Plant size	Installed electrical capacity of 1,250 kW Annual electricity production of 10,950,000 kWh Annual produced amount of bio-methane of 3,066,000 Nm³
Digester volume	Two digesters: 4,247 m³ One post digester: 3,619 m³ Three digestate storages: 5,655 m³
Gas Storage	10,279 m³ sufficient for a storage period of about 13 hours
Hydraulic retention time (HRT)	151 days
Process temperature	Mesophilic at 40 °C
Digestion technology	CSTR, two-stage digestion

Municipalities/Regions Involved

The former mayor of the town is also a shareholder in the project. His proactive work increased the level of acceptance in the rural district of Rotenburg (Wümme) and the municipality of Malstedt, the location of the biogas plant and its satellite CHP units. He was also mainly responsible for the side project “Wärmenetz” to construct a district heating system in the area.

Background Story

Dialogue between stakeholders in this project led to a rise in team spirit within the municipality. The former mayor of the municipality was a great support of the project and brought the idea to life.

The idea of building a biogas plant in combination with a heating grid came jointly from residents, local farmers, and representatives of the municipalities and authorities. Many domestic heating systems in the municipality were out of date and consequently the idea of implementing a heating grid was positively anticipated from the beginning.

Main Interest in the Project

The biogas plant ‘Agro Gas & Heat’ is very well integrated into the regional agricultural structure. Agricultural enterprises which do not have sufficient resources to build their own biogas plants benefit from the project. Agro Gas & Heat has become an important economic pillar in the region and brought added value to it. 72% of the total investment (7 Mio EUR from 9 Mio Euro) went into the local economy. The operation and maintenance of the biogas plant provide 4.5 new and eco-friendly jobs in the municipality.

In 2012, the project was presented with an award in recognition of its status as a “Seminal Biogas Plant” by a brains trust at the National Competition Biogas of the German Ministry of Agriculture (organised by KTBL) and identified as an example of best practice and sustainability.

Specialties

The biogas plant was designed to maximise the overall efficiency of biogas produced and use it in three different pathways, to provide electricity, heat and biomethane. Two CHP units are located on-site but three CHP units are so-called satellite- or remote-CHP units located a few kilometres from the biogas plant. They are located strategically where the heat demand is above average. The waste heat is transported from the three satellite-CHP supplies via two heating grids to a farm and to provide 91% of the local households. During the summer the waste heat produced by the CHP is sufficient to supply the full heat demand.

Financial Conditions

Total investment costs: 9.7 Mio EUR (plus individual financial contributions of 1 Mio EUR)

Investors: This is a joint biogas plant project involving 17 farmers. This co-operative is entirely responsible for investment and is the sole owner of the whole biogas plant and the two heating grids.

Investment support: No investment support.

Operational support: The electricity provided by this plant is injected into the electricity supply network and is remunerated per the Renewable Energy Act (German EEG, version 2009).

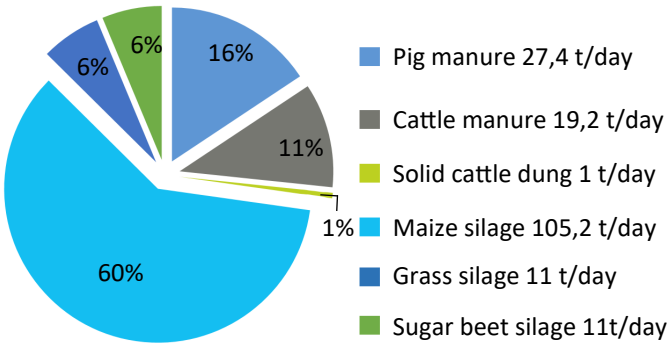
Feed-in tariff: The biogas plant and the three satellite-CHPs receive four different feed-in tariffs for the energy produced and injected into the electric supply network. The average value is about 20 euro cents per kWh_{el}.

The price supplements offer an incentive to boost biogas production from 2012-2019.

Additional support: -

Feedstock/Substrates

The whole feedstock comes from agriculture:



Use of Products from Biogas Process

Use of biogas: 1/3 is used in five CHP units (two CHPs on-site and three remote CHP units); 2/3 is sold to a biomethane upgrading system which runs in cooperation with the plant.

CHP/electricity : Yes, in combination with an upgrading system

Amount of generated electricity: 10,600 MWh per year

Use of electricity: 89% is fed into the electric supply network. 11% is used for operating the biogas plant and the on-site upgrading system.

Biomethane generation/injection: Operated by a pool of different public services

Amount of injected biomethane: 3 Mio Nm^3 per year; the natural gas grid limits the max. injection volume of the produced biomethane to 350 m^3 per hour. The upgrading system is designed for a max. raw gas quantity of 900 m^3 per hour.

Use of biomethane: The biomethane is sold by the operator and owner of the upgrading system to different public services.

Heat use: The two local heating grids supply a total of 69 customers. The heat supply is supplemented with a peak load boiler in the winter months. The price for the sold heat is linked to the price of heating oil (0.04 to 0.06 EUR per kWh).

Amount of heat: 11,280 MW per year:

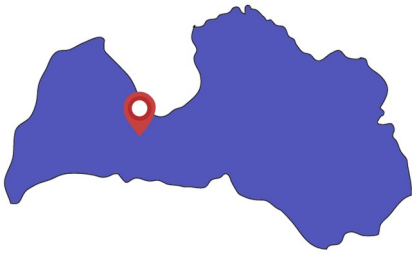
- 2,500 MW per year are sold via two heating grids. Part of this is being used for drying wood
- 3,350 MW per year are necessary for the upgrading system
- 3,170 MW for operation of the biogas plant

The heat utilisation rate of the whole project is about 80%

Use of digestate: 50,000 tonnes per year are used as a fertiliser by participating farmers.

Bio Ziedi Ltd.

Biogas Cogeneration with wide Operating Range



Dobele region, Latvia

Contact details
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Technical Data

Year of construction	2011
Plant size	Installed electrical power: 1,998 kW 850 Nm^3 per hour of gas 7,446,000 Nm^3 per year of gas 90,000 tonnes per year of digestate
Digester volume	4 digesters: 2,078 m^3 1st post-digestion tank: 2,078 m^3 2nd post-digestion tank: 3,400 m^3
Gas Storage	10,000 m^3
Hydraulic retention time (HRT)	65 days
Process temperature	Mesophilic at 34 – 40 °C
Digestion technology	Three-stage digestion

Municipalities/Regions Involved

Neither the municipality nor the region were involved in the development of the biogas plant (no specific support was offered for the construction of the biogas plant), but importantly, there weren't any significant barriers.

Background Story

When work began on the construction of the plant, there was an agricultural crisis in Latvia and it was very problematic to raise finance for the project. Banks in Latvia did not know about biogas CHP plants, which is one of the reasons why the early stages of the project implementation were difficult and uncertain. It was a significant problem that responsible institutions did not know how to administer and manage biogas projects.

Main Interest in the Project

The main advantage of this project is the ability to work with any agricultural organic products, i.e. there are no specific requirements for high-quality raw materials. Plant Bio Ziedi Ltd. has a very wide operating range; for instance temperature can range from 30-55 °C and dry mass from 5-13%, resulting in a varying methane content of 35-70%. Such a biogas plant model can be adapted for almost any operating conditions and materials.

Specialties

The Plant Bio Ziedi Ltd. is one of the largest biogas plants in the Baltic States with an electricity generation capacity of 2 MW and heat production capacity of up to 4 MW. BIO ZIEDI Ltd. was one of the first projects to be built in Latvia, so they have confronted a range of different issues, and subsequently been able to provide assistance to other biogas plants concerning technical matters. This biogas plant has achieved some of the best and the most stable indicators in biogas production, making efficient use of both electricity and heat energy.

Financial Conditions

Total investment costs: 6 Mio EUR

Investors: Existing dairy farm owners invested their own funds and received a loan from a bank.

Investment support: Rural Support Service provided 40% of the total eligible costs for the establishment of the biogas plant.

Operational support: Mandatory purchase of electricity generated from renewable energy sources (feed-in tariff), according to Cabinet Regulation No. 262 (Regulations Regarding the Production of Electricity using Renewable Energy Sources and the Procedures for the Determination of the Price).

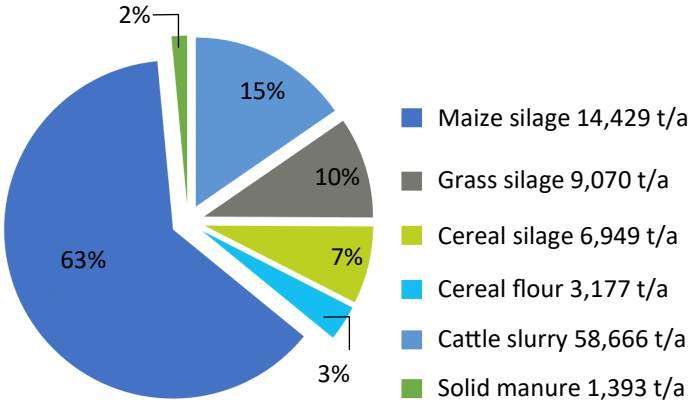
Feed-in tariff: 19 euro cent per kWh + VAT before subsidised electricity tax

Additional support: EU structural funds

Feedstock/Substrates

The biogas plant has a treatment capacity of 240 tonnes feedstock per day.

The price depends on actual costs of raw material. Grain flour is purchased through procurement. In 2015, total costs for raw materials were 1.7 Mio EUR.



Use of Products from Biogas Process

Use of biogas: CHP to provide energy and heat

CHP/electricity: Yes

Amount of generated electricity: 15,821 MWh (in 2015)

Use of electricity: Bio Ziedi Ltd. sells electricity to JSC 'Latvenergo', which is the main energy service provider in Latvia.

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: Heat energy is transferred to the parent company without cost. The parent company uses the heat energy to heat a dairy farm and recently-started fish (sturgeon) and shrimp production.

Heat balance:

- 30% for fermentation tanks
- 45% for cow farm complex
- 25% for fish and shrimp production and processing plant

Amount of heat: First measurements in 2016 - data not available yet

Use of digestate: All digestate is dispersed on agricultural land belonging to Bio Ziedi Ltd. The cost of digestate use for the biogas plant is between 3-6 EUR per tonne.

Greendal vergisting

Digesting up to 70% Chicken Litter in a CSTR

Dalfsen, the Netherlands

Contact details

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Technical Data

Year of construction	2015
Plant size	1.54 MW_{el}
Digester volume	3 x 4,000 m^3
Gas Storage	Unknown
Hydraulic retention time (HRT)	80 days
Process temperature	Mesophilic at 38 ^{o}C
Digestion technology	CSTR, two-stage digestion

Municipalities/Regions Involved

The municipality was not directly involved but importantly, there weren't any significant barriers and the project is well-accepted in the region.

Background Story

The main driver for implementing the Greendal vergisting biogas plant was the need for manure processing at an acceptable cost and an additional source of income for the farmer.

The construction of the plant took several years; the general acceptance was relatively good. The need for manure treatment was more and more recognised. Subsidies for innovation were available which made this project feasible.

Main Interest in the Project

The use of a high share of chicken litter makes this project very interesting. Chicken litter has a high biogas potential, comparable with maize silage.

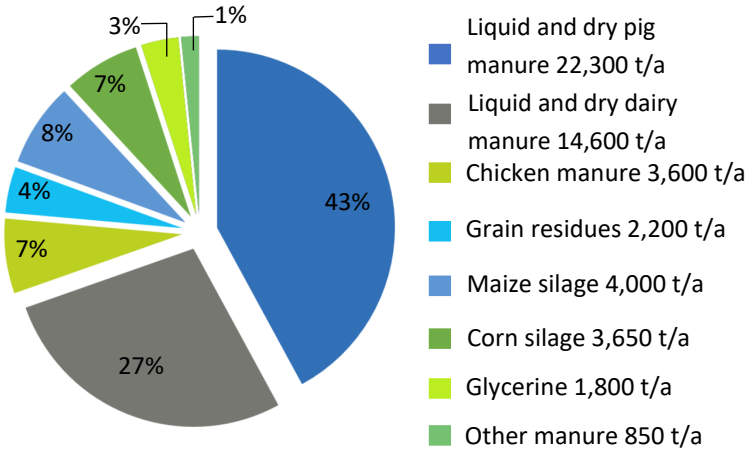
In many countries chicken litter is not used for biogas production on large scale. With this set-up, its potential can be exploited and replaces the use of maize, making it more sustainable. The concept is therefore called "digestion 2.0" referring to a second generation of biofuels.

The capacity is about 50,000 tonnes input per year. The size is manageable for a farmer and makes the Greendal vergisting biogas plant a good example for other farmers throughout the EU.

Feedstock/Substrates

Total feedstock:

- preliminary amount 52,000 tonnes per year
- share of chicken manure will gradually increase to 70%



Specialties

Greendal vergisting biogas plant is based on a chicken farm with the aim of using a high proportion of chicken litter as substrate (> 50%). Due to the high nitrogen loading, no plant prior to this has attempted to operate with such a high percentage of chicken litter in the substrate.

The digestate is separated into a thick and a thin fraction. The thick fraction is pasteurised and exported to garden centres and abroad.

The thin fraction is used in ponds to grow algae which will be used as chicken feed. This represents an innovative nutrient and protein cycle on the farm.

Financial Conditions

Total investment costs: 10 – 15 Mio EUR

Investors: The farmer, a regional investment fund for renewable energy and banks.

Investment support: An innovation subsidy for innovative, nitrogen-rich fermentation.

A provincial subsidy for renewable energy production capacity.

Operational support: SDE+ subsidy, a compensation for the difference between cost price and market price per MWh_{el} produced.

Additional support: Tax reduction for the implementation of an algae pond.

Use of Products from Biogas Process

Use of biogas: Electricity and heat

CHP/electricity: CHP

Amount of generated electricity: 11,500 MWh

Use of electricity: Electricity is sold to the grid for market prices

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: The heat is used for ammonia scrubbing, digestate pasteurisation and for growing algae.

Amount of heat: 13,000 MW

Use of digestate: Digestate is either spread over the fields (cost-intensive) or pasteurised and exported, which accounts for manure treatment under the Nitrogen Directive. Pasteurisation is related to costs but the certificates for the exported phosphate can be sold, so there is a net income. A minor part of the digestate is used to grow algae.

More Biogas Småland AB

Biowaste to Biomethane for use as Vehicle Fuel

Läckeby Kalmar, Sweden

Contact details

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Technical Data

Year of construction	2014
Plant size	80,000 tonnes of substrate per year 500 Nm^3 biogas per hour 2 Mio Nm^3 biomethane per year
Digester volume	6000 m^3
Gas Storage	No
Hydraulic retention time (HRT)	~ 30 days
Process temperature	Thermophilic at 54 °C
Digestion technology	CSTR, one-stage digestion

Background Story

The initiative to start the production of biomethane was taken by the farmers. By using manure as a feedstock, they can industrially process the digestate making it economically possible to spread it to a bigger area and to buy more livestock without the need to buy more farmland. The over-fertilisation of the Baltic Sea was recognised by the local government and is one important reason for the decision to use biogas for public transport. The producers can capture the he methane thus reducing greenhouse gas emissions. The investment will contribute to the target of no net CO_2 emissions in Kalmar County by 2030.

Municipalities/Regions Involved

The municipal energy company is one of the co-owners. The biowaste of the municipality is used to produce biomethane which provides the region with vehicle fuel.

Main Interest in the Project

The use of waste to produce vehicle fuel leads to a double reduction in greenhouse gas emissions: first when the manure is used as feedstock in biomethane production and second when the biomethane is used in preference to other vehicle fuels. The biomethane is a locally-produced vehicle fuel that reduces emissions by more than 70%. It can be mixed with natural gas for a more secure supply and used in heavy vehicles. The concept of More Biogas Småland AB can be applied to all municipalities in every country because all have waste (i.e. substrate) that can be used for biogas and biomethane production.

Specialties

This plant uses mainly manure as feedstock. Manure is the most-used substrate in Sweden because of its many environmental benefits. Even though the plant represents a replicable good example of private investment in biomethane, there are still very few plants of this kind. In this, as in other similar cases, the investment is made by farmers and other private investors. The farmers can separate phosphorus and nitrogen and spread them where they are needed and thus obtain a fertiliser that is more effective than the manure they deliver to the plant.

Financial Conditions

Total investment costs: 75 MSEK (7.66 Mio EUR)

Investors: The company has 29 owners/investors of which 18 are local farmers. The other owners are: an engineering industry (Famax AB), ALMI Invest AB (an investment company), a globally-operating supplier of turnkey plants for bio-methane (Purac), CA Fastigheter (a real estate company), Hund Holding and the municipal company Kalmar Energy. The farmers' share is approx. 35%. The company was established in 2011 and the production of biomethane for the use as vehicle fuel started in 2014.

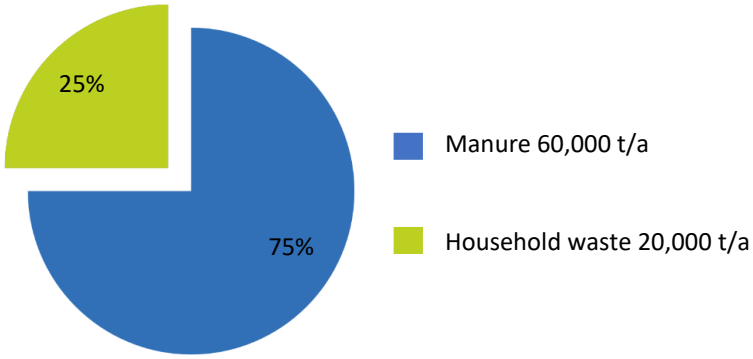
Investment support: 10.5 Mio SEK. (1.07 Mio EUR)

Operational support: The company receives support for the production of biomethane from manure.

Additional support: Biomethane is exempted from energy tax and CO_2 tax until the end of 2020.

Feedstock/Substrates

The substrates used consist of manure (approx. 60,000 tonnes) from the farms that are co-owners of the plant and household waste (approx. 20,000 tonnes) from five neighbouring municipalities. The price for the substrate depends on gas potential, nutrient content and other potential uses as well as market potential. Occasionally, material from the local food processing industry is also digested.



Use of Products from Biogas Process

Use of biogas: The production is approx. 20,000 MWh per year.

CHP/electricity: No

Amount of generated electricity: None

Use of electricity: None

Biomethane generation/injection: No injection

Amount of injected biomethane: None

Use of biomethane: Vehicle fuel

Heat use: The produced biomethane is used as transport fuel, there is no CHP and therefore no heat produced on site. A wood-chip heated furnace is used to provide the heat required to pasteurise the substrate and to provide the process heat needed in the upgrading unit.

Amount of heat: Not applicable

Use of digestate: The digestate is returned to neighbouring farms and used as biofertiliser.

Lodge Farm, Holt, Wrexham

Small, On-Farm, Biogas Plant with Varying Feedstocks

Holt, Wrexham, Wales, UK

Contact details

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Technical Data

Year of construction	2010
Plant size	0.16 MW_{el} and 0.155 MW_{th}
Digester volume	1,000 m^3
Gas Storage	250 m^3
Hydraulic retention time (HRT)	Currently 90 days (historically pre food waste 34 days)
Process temperature	Thermophilic at 52 ^oC
Digestion technology	Modified CSTR – some gas agitation of digestate but also deliberate acceptance of stratification within digester, one-stage digestion

Municipalities/Regions Involved

The local authority was not involved (other than as land-use planning authority) but the Welsh Government provided a grant.

Background Story

The proposal came from an organic dairy farmer who could see the advantages of anaerobic digestion for his farm, as well as a business opportunity for the generation of renewable energy. The original plan was to import residues from the nearby major food production industries – providing a waste management service as well as energy generation - but the local planning authority refused to allow the import of such material onto the site. The scheme (reluctantly) proceeded utilising agricultural wastes only. The plant was designed by an experienced AD practitioner and became the prototype for businesses installing similar plants elsewhere.

Main Interest in the Project

The most interesting aspects of this project are the de-gritting capacity, the higher capacity for digesting chicken litter and the deliberate stratification to allow fully digested material to be removed from the tank. It has proved to be an excellent digester and farm for research purposes. This site provides good evidence to support AD as an agronomically beneficial process. A new project that is raising finance via crowd funding will provide further interest. This project has raised the funds locally to build an on-farm digester with many local investors, using crowd funding; the individual investors have shares in a cooperative which is purchasing the plant.

Specialties

The plant is relatively small and has been operating consistently and successfully for years now. The primary feedstocks were animal manures – including an unusually high proportion of chicken litter. The digester contents are deliberately allowed to stratify and the digestate extracted from a zone where only fully digested material congregates. The technology used is interesting because it incorporates de-gritting that does not involve emptying the digester. Academic research carried out at this site points strongly towards the agronomic advantages of utilising digested slurries instead of the raw material.

Financial Conditions

Total investment costs: -

Investors: The business was set up by the three directors: Chris Morris who had the time and experience to deal with the business set-up process; Jonathon Tomlinson who had the engineering capability to build a digester; Richard Tomlinson who had a dairy herd and land to feed the digester and utilise the by-product (digestate).

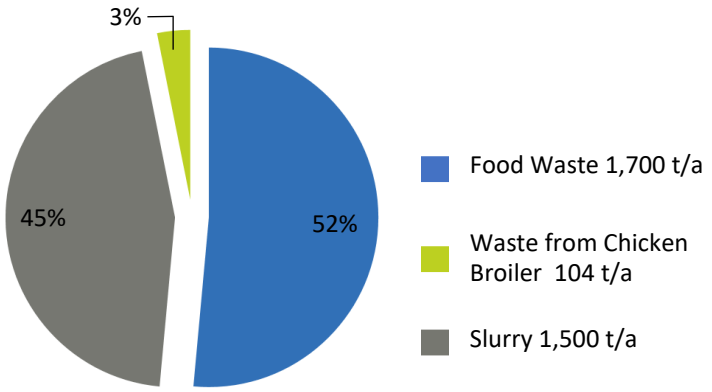
Investment support: The project was directly funded by the three Directors plus a £45,000 (52,784 EUR) innovation grant from the Welsh Government. The grant did not directly support the construction of the plant and thus did not impact upon the ability to claim FiT.

Operation support: All the electricity production (including the sacrificial load on the plant) is subject to FiT payments. The FiT payments would be likely to have started at 12.7 p (17.9 euro cent) per kWh. This payment is index-linked and lasts for a period of 20 years. The electricity used on-site displaces imported power and is thus valued mostly at a business tariff. That which is exported to the grid is subject to around 4.5 p (5.28 euro cent) per kWh (also index-linked).

Additional support: -

Feedstock/Substrates

Historically the digester was fed with cattle slurry and chicken litter. Over recent years the plant has been modified and authorised to take in food waste and this now contributes significantly to the feedstock supply. The plant still utilises cattle slurry and a much reduced quantity of chicken litter. 30 tonnes per day of feedstock were used. With the food waste this has reduced to 5-15 tonnes per day, dependent on the energy potential of the food waste.



Use of Products from Biogas Process

Use of biogas: Biogas is used in a CHP with the outputs of 0.16 MW of electricity and 0.2 MW heat.

CHP/electricity: Yes

Amount of generated electricity: 1,103 MWh (over the last 12 months).

Use of electricity: Approximately 0.3 MW of electricity is used on-site to power the engineering business, the Fre-energy office, and a large 7-bedroom-farmhouse. The remainder of the electricity is exported to the national grid.

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: A district heating system was constructed to make use of the available heat at the house, office, shop, drying room, food waste pasteuriser and engineering business. The heat has to be metered and only that which is used productively receives a Renewable Heat Incentive RHI subsidy, which is unique in the EU. The payments were negotiated with the government regulator (OFGEM).

Amount of heat: Generation and utilisation over the last 12 months:

- Heat generated 1,100 MWh
- Heat used productively 957 MWh
- Heat lost or rejected by the radiators 145 MWh

Use of digestate: The digestate was originally run through a separator. The liquid was spread onto the grassland. The solid digestate was used for growing winter crops. The new operating regime extracts the solid portion of the digested material via the patented de-gritting process. Digestate used on the farm.

EC Network

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Czech Republic

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Energy Institute Hrvoje Pozar
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