

Integration of an Anaerobic Digestion Plant into the Passau Biogenous Waste Composting Facility

Donau-Wald mbH (BBG) is an organic composting company founded in 1996 as a public-private partnership. BBG is a subsidiary of the waste management company Donau-Wald mbH (AWG), Ausserzell in Bavaria and SIUS GmbH, Homburg, Saarland. AWG is the majority owner at 51 %.

AWG is a 100 %-subsidiary of the Bavarian special-purpose waste management association Donau-Wald, which includes the municipalities of Deggendorf, Freyung-Grafenau, Passau and Regen as well as the municipality of Passau. The AWG is entrusted with the municipal task of disposing and utilizing waste in accordance with existing regulations. The population of the area for which the AWG is responsible is about 520,000. The collection area covers 4,500 km² and is, consequently, one of the largest in Bavaria (Figure 1, shaded area).

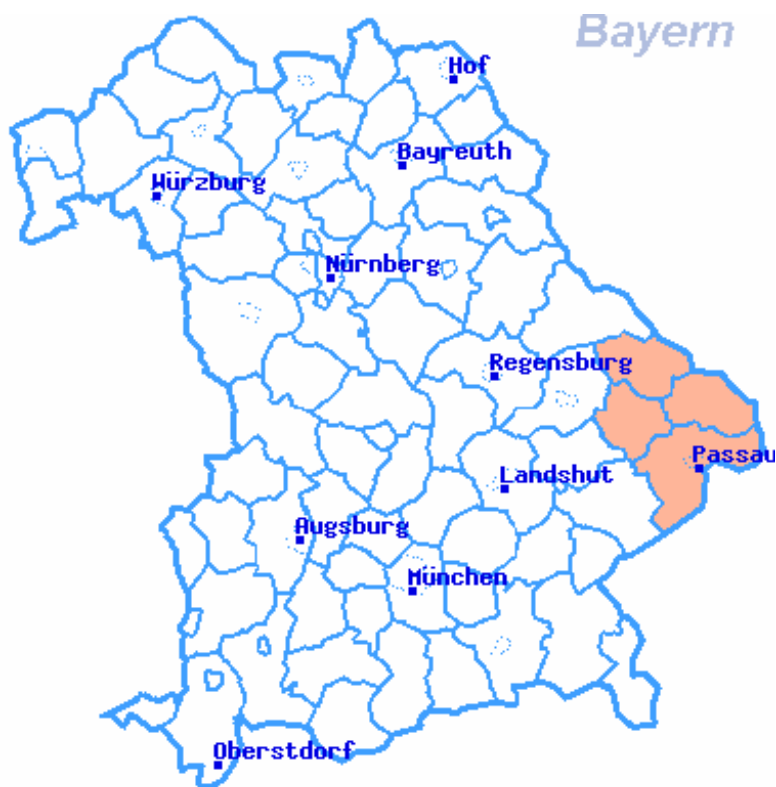


Figure 1: Bavaria (Passau Region)

AWG collects and BBG treat wastes for the entire AWG area, accumulating source separated organic waste from households, as we do with garden and park waste and organically treatable industrial waste.

BBG's contracted waste disposal obligations are defined by its contract with AWG.

- Proper recycling of all separately collected household biogenous wastes accumulating in the districts for which the municipality is responsible, as well as garden and park wastes and organically treatable industrial wastes.
- Independent management of:
 - The BAVA biogenous waste recycling plant (40,000 metric tons/yr) in Passau;
 - The biogenous waste composting facility (12,000 metric tons/yr) in Regen;
 - Eight green waste composting plants (40,000 metric tons/yr) and 11 green waste collection points.
- Marketing of approx. 29,000 metric tons/yr compost products.

SIUS GmbH, located in the Saarland, is a private-sector company with many years of experience in mechanical-biological waste treatment. Its expertise includes all levels of project management, such as inviting tenders, licensing, planning, construction and operation of plants, as well as the marketing of waste treatment products. SIUS does not develop and market its own technologies and is not contractually bound to any manufacturers. SIUS operates seven composting and digestion plants throughout central and southern Germany.

The Problem

In 1994, on the basis of the then national average of approx. 30 to 40 kg per person per year of separately collected biogenous waste, the two composting facilities at Passau and Regen were built to process 14,000 t/a and 8,400 t/a of biogenous waste (in addition to structural material – i.e., branches, gardening waste). However, the amount of source-separated biogenous waste rapidly increased in this municipality to the current level of 130 kg per person per year. This is considerably more than the Bavarian average of 50 to 60 kg per person per year and about three times as much as the current German average of about 44 kg per person per year. Nowhere in the world is more biogenous waste separated at source than in the ZAW Donau-Wald area.

BBG responded to these increases by continually optimizing operations at the facilities so that in 2003 the composting facilities were processing 20,000 metric tons/yr in Passau and 12,000 metric tons/yr in Regen of biogenous waste. At this point the plants reached their maximum capacity and further increases of throughput capacity were not feasible technically and economically. Since the total collection of biogenous waste amounted to roughly 52,000 t/a (or metric tons per year), available capacity was exceeded by about 20,000 t/a. This excess material had to be transported over large distances to third-party plants for processing resulting in extra costs for the company. Hence, the construction of an anaerobic digestion plant in Passau became a viable option to deal with this waste.

The Solution

For several years, AWG intended to expand its treatment capacities from its current 32,000 t/a to handle the unforeseen 20,000 t/a. Its goal was to improve the situation both ecologically and economically, eliminating the transport of the excess waste while making its own treatment facilities more economic than those of its third-party subcontractors.

To this end, SIUS developed the idea of integrating an anaerobic digestion plant in the existing Passau composting facility. This made it possible to boost throughput from 20,000 t/a to 40,000 t/a. The goal was to integrate the new technology into the existing Passau composting facility so that the facility could continue in use with only minor alterations.

For BBG building the plant was an important step toward developing a market for regenerative energy production from biomass. In addition, there was added value in that biogenous wastes previously transported to third-party facilities could now be treated in the municipality's own plant.

The BBG plan foresaw that after capturing the thermal and electrical regenerative energies of the biogenous wastes, the remaining organic material could be composted and sold as fertilizer. Both the fertilizer and thermal content of the bio-waste could be exploited. Disposal of the biomass through incineration was, therefore, not necessary.

Regulatory Environment

It was possible to implement this project because the regulatory framework was revised to promote regenerative energies (for both electrical and heat generation) and interest rates were favourable. This greatly improved the economic prerequisites for constructing the municipality's biogas plant.

To attain these goals legislation was implemented to promote renewable energy sources. The *Renewable Energy Sources Act* was drafted and came into effect on April 1, 2000. It was amended on July 21, 2004. The amendment raised rates of compensation for electricity generated from renewable resources and supported the utilization of thermal energy. The Act regulated the purchase of and compensation for power produced from regenerative sources, particularly for power generation from biomass, which is significant for BBG. As a result of the legislation, grid system operators must allow power plants using regenerative energy sources to connect to the grid, to give priority to the power produced by these plants and to provide appropriate compensation for it.

To protect the environment and the climate, as well as to reduce the dependency on fossil fuels, the German government and the German Bundestag (Federal Parliament), in agreement with the European Union, have set a goal to at least double the contribution of regenerative energy sources by 2010. This objective is in keeping with the declared commitment of the Federal Republic to decrease greenhouse gas emissions by 21 % by 2010 under the European Union's burden-sharing arrangement for the Kyoto Protocol to the United Nations Framework Convention On Climate Change, as well as with the aim of the German government to decrease carbon-dioxide emissions by 25 % of 1990 levels by 2005.

Furthermore, grid system operators were required to record both the quantity and price paid for the renewable energies. This information was used to evenly distribute the additional costs among all the network owners, so that a local energy provider – in this case, Passau municipal utilities – would not be disadvantaged by disproportionately large purchases of renewable energy.

Project Description

The plant was approved under the Federal Emissions Act. The licensing authority was the Passau environmental office. The approval procedure required a public hearing as the plant throughput exceeded 30,000 tons/a. Citizens had a six-week period in which to lodge objections to the project. At the time, SIUS was already operating our old composting facility at the plant location for nine years. No resident in the vicinity raised any objections to the plans. Twenty competent authorities took part in the licensing procedure. Nevertheless, the licensing authority succeeded, while closely cooperating with SIUS, in completing the licensing procedure within 2.5 months. Given the situation in Germany, this was a record time.

Construction began in July 2003 and was completed in December 2004 (approximately 17 months) and the plant reached full capacity one month earlier than planned, after start up.

Operational Sequence Summary

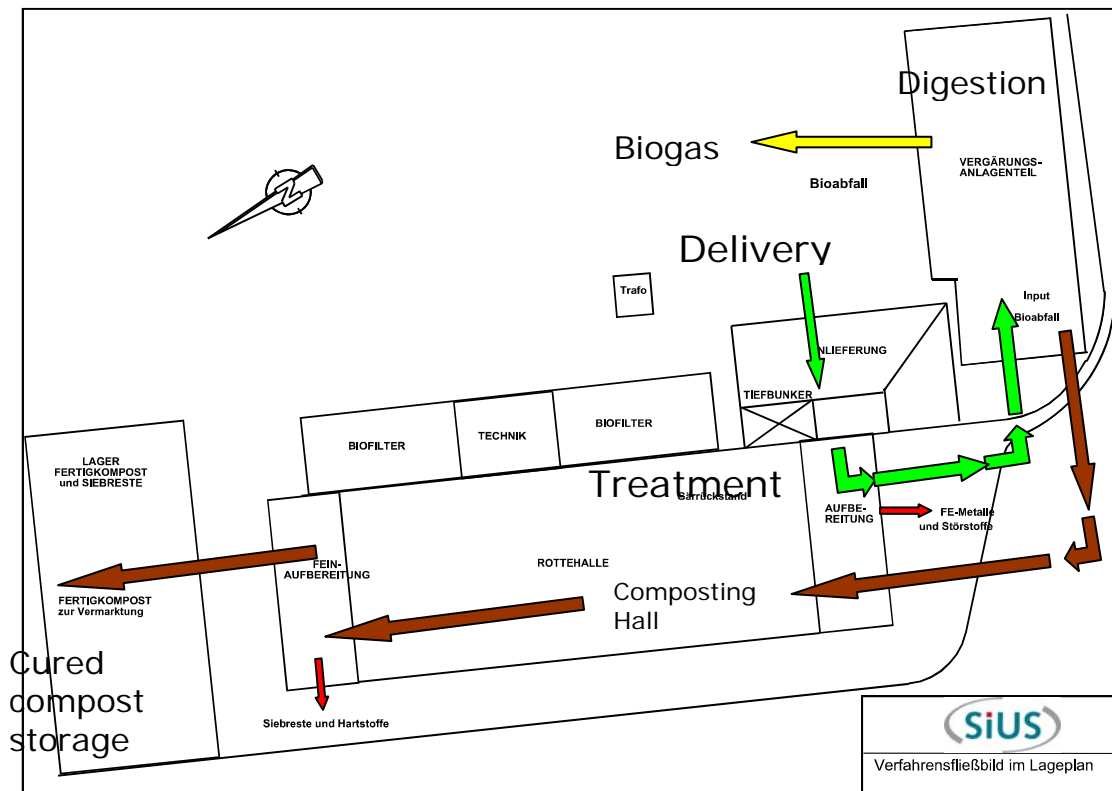
The new Kompogas anaerobic digestion plant doubled the capacity of the existing Passau composting facility from 20,000 tons/a to approx. 40,000 tons/a. Because of the high remuneration for regeneratively produced power from biomass, it pays to digest all biogenous waste on site and then to compost the waste solids in the existing composting plant. The basic components of the plant consist of:

- Collection area (existing);
- Primary processing (existing);
- Digester feedstock preparation (new);
- Intermediate storage (new);
- Fermentation by three fermenters (new);
- Digestate dewatering by five presses (new);
- Composting hall (existing);
- Fine processing of cured compost (existing);
- Finished compost storage;
- Power generation by two block-type thermal power stations (BTPS) (new).

The bio-waste is collected in the existing ground storage bin and submitted to a primary processing. The processed waste then goes to the Kompogas anaerobic digester, where it is fermented, to produce methane. Before the construction of the digester, this material was placed in the composting hall. The fermentation material is conveyed to the three fermenters, where it is digested for about 14 days on a continual basis at temperatures ranging from roughly 50 to 55°C.

Digestion generates a gas containing methane, which is burned in two Jenbach block-type thermal power generators, each having a power output of 836 kW. In the process approximately 10,000,000 kWh/a of regenerative electrical power and about the same amount of useable heat are produced.

The digestate is dewatered and left to finish composting in the composting hall. Fine processing removes undesirable substances like plastic or stones. The finished compost is stored in a hall until it is sold. To avoid release of odours, all operations take place in sealed halls kept under negative pressure and biofilters clean the exhaust air.



Operating Results

The anaerobic digestion plant was planned for 39,000 tons/a and was intended to process 3,235 tons monthly. According to the manufacturer, this throughput could be exceeded by 25 % for a maximum of two consecutive months.

As the result of optimized plant management, in the first year of operation the plant was able to process about 46,000 tons. At its peak nearly 5,000 tons was processed monthly, far surpassing the manufacturer's specifications.

The manufacturer guaranteed a gas output of $115 \text{ m}^3_{\text{N}}/\text{ton}_{\text{Input}}$ (m^3_{N} : cubic metres of gas at standard temperature and pressure conditions). The measured gas output was between 120 and $125 \text{ m}^3_{\text{N}}/\text{ton}_{\text{Input}}$. Each fermenter can produce up to $320 \text{ m}^3_{\text{N}}/\text{h}$ of biogas. The entire daily production of biogas hovers between 12,000 and $16,000 \text{ m}^3_{\text{N}}/\text{d}$. According to the manufacturer, the generated biogas contains 55 % methane. Actual methane measurements, depending on the quality of the feedstock, range from 58 to 64 %.

Generated Power Output

The manufacturer guarantees an (electrical) power output of 9,125,000 kWh/a. This corresponds to a daily generation of 25,000 kWh/d. In the first operating year, the measured power generated was 10,000,000 kWh/a or 27,400 kWh/d. By further optimizing plant operations, the power generation could be further increased in coming years. The plant's own power consumption amounts to approx. 8 % of the output.

Problems in the First Operating Year

The plant is maintained with great care. Even after normal working hours, standby service is available to remedy technical defects within half an hour. Operated in this fashion, the plant ran very smoothly. A three-month trial run was successfully concluded. Toward the end of April 2005, we cooperated with the plant manufacturer to clear up difficulties relating to the dewatering of the digestate. Apart from this, no other issues of any significance arose.

Economic Viability

The planned investment for the plant was approximately 10.1 million €. The actual investment was 10.6 million € (\$15 million). Extra costs mainly ensued from expenditures for additional equipment for capturing and transporting thermal energy. As the Renewable Energy Sources Act amendment provides for additional compensation when thermal energy is utilized, these additional costs did not affect the financial plan. The additional revenue resulting from the use of the thermal energy covered the capital costs of these supplementary expenditures.

The projected operating costs of the anaerobic digestion plant amount to 920,000 € (\$1.3 million) annually. When the capacity was doubled, one additional employee was hired. On a full-time basis, plant operation requires nine employees.

Power production was estimated at 8.4 million kWh/yr. On the basis of compensation paid under the Renewable Energy Sources Act, 960,000 €/yr income was envisaged. In 2005, 10.0 mill. kWh/yr (electrical) was produced and earnings amounted to approx. 1.15 million €. The plant's own power consumption, at approximately 800,000 kWh/yr, amounted to 8 % of the total output.

Contract Model

AWG, as investor, pays the capital costs amounting to approximately 960,000 €/yr. As compensation, BBG guarantees payment to AWG from revenues resulting from the sale of the electricity, 960,000 €/yr. If BBG succeeds in attaining higher earnings by improving the power output, the AWG retains these to an amount of not exceeding 1.17 million €/yr. Any earnings in excess of this are paid to BBG. No additional incentives are necessary on the part of AWG to ensure that BBG will always try to attain optimal power earnings. In return for operating the anaerobic digestion plant, BBG receives a price of 46 €/ton (\$64/ton) of bio-waste.

Economic Results

For AWG as contractor, the investment in the Kompogas anaerobic digestion plant (made by KOGAS of Switzerland), in addition to a substantial enhancement of the ecological standards, resulted in overall savings totalling 400,000 €/yr, by not employing third-party subcontractors, which had cost 1.1 mill. €/yr. In this calculation, 190,000 €/a due to earnings from the generation of electricity, in excess of the guaranteed BBG payment of 960,000 €/a, were not considered. If the AWG share of BBG gains is included in the calculation, the savings would be even higher. For the investor AWG and the operator BBG, the integration proposed by SIUS of an anaerobic digestion plant in the existing Passau bio-waste composting facility is a profitable investment, with an estimated payback of about 8 - 10 years for AWG.

Outlook

Given its good experiences with the Passau anaerobic digestion plant, the BBG intends to continue to utilize biomass to generate energy. Currently, SIUS is planning the construction of two biogas plants with a total power capacity of 2.4 MW, which will utilize green waste and agriculturally grown biomass. The decision to implement the projects will be made by May 2006.

Summary

It was possible to implement this project because the regulatory framework was amended to promote regenerative energies (compensation for the generation of electricity and heat) and interest rates were favourable, which greatly improved the economic prerequisites for constructing the municipality's own plant.

For BBG, the building of the plant was an important step toward developing a market for generating regenerative energy from biomass. In addition, there was added value in that biogenous wastes previously transported to third-party facilities could now be treated by the municipality's own plant.

The Kompogas anaerobic digestion plant produces approx. 10,000,000 kWh of electrical power. This means considerable reduction of carbon-dioxide emissions, not including the halting of trucking the excess bio-waste to third-party plants. In terms of the numbers alone, 3,000 to 4,000 households are being supplied with regenerative energy. In addition, more than 750 truck transports yearly were eliminated and approx. 100,000 l/a of diesel fuel conserved.

Note: AWG is both the investor and plant operator, therefore two analyses are required as follows

AWG – Plant Investor - Financial Analysis

Factor	Details
Capital Investment	10.6 million Euros (\$15 million)
Annual Revenue Stream – guaranteed	960,000 Euros (\$1.34 million) electricity
Annual electrical generation bonus	190,000 Euros (\$266,000)
Annual thermal generation bonus	24,000 Euros (\$33,000)
Payback	8 - 10 years
Carbon Credit Revenue*	0
Estimated Plant Life	30 – 35 years

*No Carbon Credits are received due to preferential electricity rates

AWG – Municipal Contractor - Financial Analysis

Factor	Details
Annual Projected Savings with 3 rd party contractors eliminated	400,000 Euros (\$560,000)

BBG – Financial Analysis

Factor	Detail
Annual Operating Cost	920,000 Euros (\$1.29 million)*
Design Throughput	40,000 tonne
Operational Cost	30 Euros/tonne (\$42)
Actual Throughput (2005)	46,000 tonne
Waste Processing Revenue (20 year contract)	46 Euros/tonne (64.4)
Waste Heat Revenue (all used on site)	40,000 Euros bonus (\$56,000)
Liquid Fertilizer Sales (10,000 m ³ /year)	Donated to Farmers
Compost Fertilizer Sales (9,000 tpy)	90,000 Euros/year
Electricity Generation Price (site)	.115 Euros/kWh (\$.157)

Data Sheet:

Passau Anaerobic Digestion Plant Technical Data

Process:	Kompogas, dry fermentation
Input material:	Source separated organic waste from households
Reactor size:	3 x 1,050 m ³ (3 x 40,250 cubic feet)
Input:	From 110 to 150 tons/d
Digestive chamber:	Approx. 8 kg/m ³
Temperature:	Thermophilic process, from 50 to 55 °C
Dry matter content:	Approx. 30 % in input
Retention period:	Continuous plug flow, 14 days
Biogas production:	From 12,000 to 16,000 m ³ _N /d
Methane content:	From 58 to 64 %
Sulphur content (H ₂ S):	210 to 440 mg/m ³
Investment costs:	10,600,000 €
Generation Capacity:	1.7 MW
Generated electricity:	Approx. 10,000,000 kWh electric
Electricity Price Paid	.115€/kWh (\$.184/kWhr)
Thermal utilization:	Approx. 3,300,000 kWh for own heat consumption Approx. 2,000,000 kWh for heating purposes
Excess water:	Approx. 10,000 m ³ /yr liquid fertilizer for agricultural purposes Own distribution system
Compost:	Approx. 9,000 metrics tons/a (sold to the public/private sector) Own distribution system
Personnel:	On full-time basis, nine employees on one shift; nightly standby service