ENGINEERING TOMORROW

Case Story

Full-scale biogas plant in Kalundborg ensures the return of all nutrients **back to nature**

AC drives from Danfoss Drives help convert biomass from insulin and enzyme production to energy

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AC drives from Danfoss help ensure reuse of biomass for energy production

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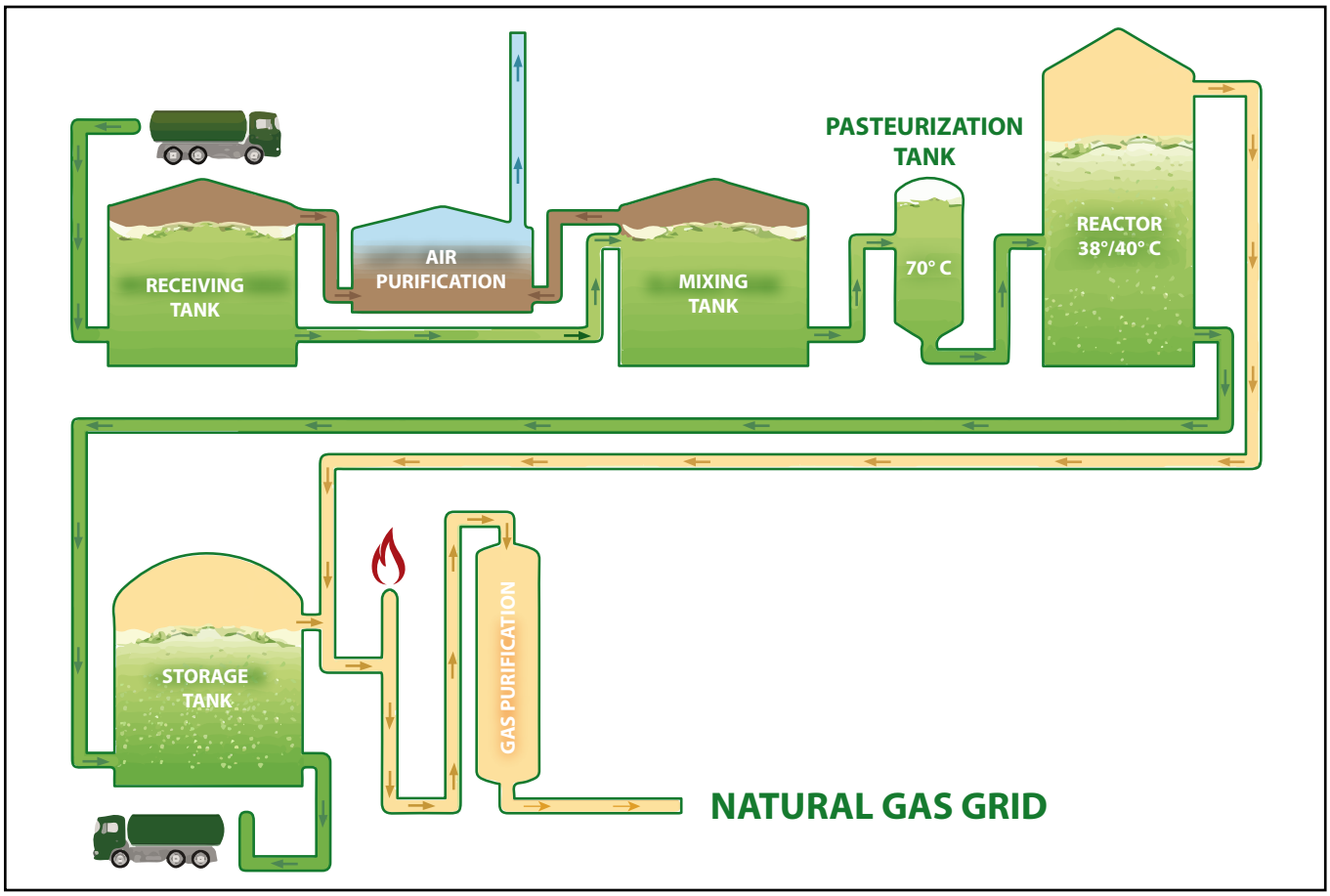

Kalundborg Bioenergi transforms the residual products from insulin and enzyme production at Novo Nordisk and Novozymes to biogas, which is upgraded to bio natural gas.

Full-scale biogas plant

Together with Ørsted (formerly DONG Energy), Bigadan has established a full-scale biogas plant in Kalundborg, which exclusively uses residual products from insulin and enzyme production at Novo Nordisk and Novozymes. The construction began in the early spring of 2017 and the biogas plant was commissioned in the spring of 2018, inaugurated by, among others, Mayor Martin Damm and Energy, Utilities and Climate Minister, Lars Christian Lilleholt. The plant is currently the largest biogas plant in eastern Denmark and is situated near Ørsted's Asnæs plant in Kalundborg. Approximately 60 m^3 of biogas is produced per ton of biomass—a total of 18 mill. m^3 biogas annually.

From residual product to biogas, to bio natural gas

The plant in Kalundborg transforms the residual products to biogas, which is upgraded to bio natural gas. The climate-friendly bio natural gas can replace fossil-fuel natural gas and therefore allows for a notable reduction in CO_2. This way the yield from reuse is doubled, which helps support the green agenda, explains Erik Lundsgaard, Production Manager at Bigadan.

The residual product contains large amounts of phosphor, is free of heavy metals and other unwanted environmentally alien substances, and is in demand as a phosphorus fertilizer by the local farmers. To make the biofertilizer easier to transport, the dry matter content is concentrated in a decanter, which results in approx. 250,000 tons of liquid phosphorus fertilizer that can be used freely for the cultivation of all forms of crops. For the suppliers of the biomass, the biogas plant can be used directly in its sustainability reporting, as both the gas and the residual products are re-used.

Kalundborg Bioenergi facts:

- The biogas plant is expected to treat some 300,000 tons of biomass annually from Novo Nordisk and Novozymes.
- The plant can produce 8 million cubic meters of bio natural gas per year, equivalent to the consumption of 5,000 households.
- Each cubic meter of bio natural gas contains approximately 10 kWh of energy. Therefore, approx. 220,000 kWh of energy is "stored" every day in the natural gas grid.
- The production of natural gas using industrial waste creates CO_2 savings of approx. 17,000 tons of CO_2 annually.

Source: Ministry of Energy, Utilities and Climate

World's largest production of insulin and enzymes

Not far from Kalundborg lie Novo Nordisk and Novozymes. Insulin and enzymes are produced here and then sold around the globe. Now their residual products will be converted to energy and fertilizer at the facility in Kalundborg. This way the value in the residual products left over from production at Novo can be utilized. Normally, only slurry and kitchen waste are converted to biogas, but now it is also possible to utilize the industrial waste from Novo Nordisk and Novozymes. The result will be natural gas production equivalent to the annual natural gas consumption of approximately 5,000 households.

300,000 tons of biomass

While other biogas plants focus on sludge, kitchen waste and the like, the focus at Kalundborg Bioenergi is exclusively on the biomass from Novo. It is a 100% industrial plant, explains Erik Lundsgaard. The plant is furthermore approved for 400,000 tons annually, but 300,000 tons per year are already expected, despite the plant only having opened in the spring of 2018.

Among the most environmentally friendly energy sources

In many traditional biogas plants, the gas is used directly for the production of electricity in a gas engine. As a result of changes in the Danish energy supply system, with increasing amounts of renewable wind and solar energy, there has been a decline in the need for continuous production of electricity and district heating using gas engines. Instead, there is now a need to store large amounts of energy for times when wind and solar energy cannot meed demands.

At the Kalundborg plant, the biogas is purified to the same quality as the natural gas and therefore can be stored for distribution in the Danish natural gas grid. The "raw" biogas contains 60% methane—the rest is CO_2 and hydrogen sulfide. In the post-treatment plant, the gas is cleaned to 99% pure methane. The sulfur bonds turn into sulfuric acid, which is added to the residual product as fertilizer. CO_2 may potentially be sold to other customers in the future.

Danfoss Drives' VACON® 100 was supplied by Bilfinger directly from Germany, mounted in a container, ready for use when the plant was commissioned in April 2018.

The pure biogas is an important CO_2-neutral energy source that can be used directly for fueling city buses and in power plants for the production of electricity and district heating. This is a good example of sector coupling, where all energy forms in the future will be linked together, such that society can use the least expensive and most environmentally friendly energy sources at all times, says Lundsgaard.

Energy storage and sector coupling facts:

• In 2018, over 45% of electricity production in Denmark comes from wind and solar. Wind and solar are practically inexhaustible energy sources, but in order to use energy, it must be available in an accessible form and it must be storable.

• Energy is typically stored in the form of electrical energy (batteries), thermal energy (heat and cold) and chemical energy (for example, methane)

• Sector coupling consists of coupling the different forms of energy together, so the energy forms can be used optimally and energy is stored at the lowest possible cost.

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The facility was built in record time—less than one year—thanks to Bigadan's long experience with the construction and operation of similar facilities. At the same time, it was decided to build with factory-made modules as much as possible. Most electric control panels are placed in finished containers, where many of Danfoss's AC drives were installed, programmed and tested with PROFIBUS controls at the premises of the company supplying the containers.

Over the past 20 years, Bigadan has had particularly positive experience with Danfoss AC drives and specifies them whenever possible. This facility uses 50 AC drives from Danfoss—both the VLT® AQUA Drive FC 202 and VACON® 100 series. "The commissioning has been completely problem-free. Many processes are particularly critical and rapid service and accessibility of parts are vital. That's why Danfoss Drives was the optimal choice," explains Erik Lundsgaard.

The facility in Kalundborg is highly automated and is operated exclusively by Erik Lundsgaard and his four colleagues around the clock.

The facility is built in an area near the Asnæs plant on a diked-in seabed that is filled with slag from the Danish power plants, which is good use of the slag material.

VLT® AQUA Drive FC 202 controls pumps and blowers at the large biogas plant.

Production Manager at Bigadan, Erik Lundsgaard, gives a tour of the new biogas plant in Kalundborg.

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