

ENGINEERING
TOMORROW

Danfoss

Case story

Generating **surplus power** from wastewater treatment

Marselisborg wastewater treatment plant produces more electricity and heat than it consumes

130%

electricity generation
results in 30% annual
net surplus, after
internal consumption.

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VLT[®]
THE REAL DRIVE



We have always specified Danfoss VLT® frequency converters specifically for the features we need which only VLT® can offer. The difference between 25 years ago and today is that processes now run right at their limit – but not beyond. And to achieve that we cannot do without the precision control we can get from VLT®s.

Flemming Husum
Plant Manager
Marselisborg WWTP



Biogas power generation: VLT® AQUA Drives control cooling fans and booster plant.

Maximising energy surplus

Since 2010, Marselisborg wastewater treatment plant has transformed its focus beyond minimising energy consumed, to maximising net energy surplus. Nowadays the facility has net production of both electricity and heat, supplying the district heating system in Denmark's second-largest municipality, Aarhus. The carbon footprint has been reduced by 35% accordingly.

Water and wastewater treatment facilities are normally the single largest electricity consumer for a municipality. Typically water and wastewater

treatment processes account for 25 – 40% of the municipal electricity consumption. The high consumption is related to the energy intensive processes but also its continuous operation cycle, 24/7 and 365 days annually.

Over the years focus has been on developing new processes and control strategies to reduce energy consumed per litre of water processed. However at the same time the increasing demands upon wastewater treatment quality, for example in nutrient removal, in turn increase net energy consumption.

Energy balance optimisation

Water and wastewater treatment processes are characterised by high load variation during the 24 hour cycle and seasonally throughout the year. The use of frequency converters has therefore steadily increased in order to control blowers, pumps and other motorised equipment, to adapt to the changing demand.

Since 2010 Aarhus Water has worked intensively together with water environment consultants to improve the energy balance for Marselisborg wastewater treatment plant.



Activated sludge nitrification & denitrification: 16 VLT® drives rated 4 kW with PROFIBUS, RFI filter, IP66 enclosure rating and climate shield control the aeration mixers.

Key steps in the strategy:

1. Optimisation of the nitrogen removal process using online sensor control. The frequency converter adapts the level of aeration precisely to the need. This control system reduces energy consumption and increases the amount of carbon left in the system.
2. Blower technology upgrade to a high speed turbo blower. The upgrade achieves further reduction of energy consumption in the aeration process.
3. Aerobic sludge age control as a function of temperature and load on the plant. Here frequency converter control of the return sludge pumps is the key to achieving energy reduction and increased retained carbon in the system.
4. Upgrade of combined heat and power (CHP) process for energy production, with 90% energy efficiency.

These changes together with improvements including the effective co-production of electricity and heat based on methane gas extracted from the aerobic sludge digestion process have created the impressive results of:

- 130% electricity production (30% excess electricity)
- Excess heat production of about 2.5 GWh/year

We use VLTs in every corner of the plant. We are constantly seeking the ideal operating point. Our goal is to maximise litres of water processed per kilowatt consumption. The current measure is 0.32 kWh/m³ treated wastewater.

Flemming Husum
Plant Manager
Marselisborg WWTP



VLT® in every corner

Frequency converters are installed on almost all rotating equipment at Marselisborg WWTP: blowers, pumps, mixers and dewatering pumps. The frequency converters allow the plant to adapt to load variations, with maximum flexibility. Over 100 motors are controlled by VLT® frequency converters at Marselisborg.

Energy generation vision

The vision for Aarhus City is to extend energy generation even further, to achieve surplus production of energy from its wastewater treatment plants so high, that it can also meet the energy requirement of the city's potable water supply. This will transform the single largest electricity consumer for the authority into an energy-neutral party.

For more information

- See the VLT® AQUA Drive video here: <https://www.youtube.com/watch?v=Au5wopBCeJl&feature=youtu.be>
- Read more about VLT® for water and wastewater applications here: <http://vlt-drives.danfoss.com/Industries/Water---Wastewater/>

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Discharge pumping station: A VLT® rated 160 kW with IP54 enclosure controls this pump weighing 1.25 tonnes

Aarhus Water WWTPs

More than 300,000 people live in Aarhus, Denmark's second largest city. Aarhus Water serves the population with both water supply and wastewater treatment. The wastewater treatment plants receive a total of 35 million m³ of wastewater annually.

At the largest of these plants, Marselisborg, capacity is 200,000 PE (person equivalent units). Here the wastewater treatment efficiency has been optimised using Danfoss VLT® frequency converters ever since initial commissioning in 1990. Today, control using VLT®s is more relevant than ever.

The long-term plan is to close several plants and upgrade the remaining three. The upgrade will comprise implementation of new technologies, for example anaerobic digestion techniques such as anammox processing, and increasing capacity to 500,000 PE.