

ENGINEERING
TOMORROW

Danfoss

Case Study | VACON® NXC Air Cooled Drive

Battery retrofit not only **saves fuel** but **improves air quality**



20,000
litres

less fuel consumption
annually after ferry
conversion to hybrid
electric power

drives.danfoss.com

VACON®

Denmark's shortest ferry route is now a **pioneer** of **battery power**

Since 1958 the shortest ferry route in Denmark has provided a lifeline to Venø island in northern Jutland. It's a highly-scenic ride which today takes only two minutes over the narrow but deceptively 17-meter-deep sound. The current Venø Ferry has transported passengers at 30 minute intervals 36000 times annually since 2010. For six years it used diesel for electric power generation and propulsion, consuming 90,000 liters of fuel each year. In the drive to cut costs and achieve more sustainable

operation, the ferry sought solutions to reduce the fuel consumption for the auxiliary power generators. The process was a collaborative development project with Danfoss Drives, EPTechnologies, Super B, Hvide Sande Shipyard, and contractor Vest-El, where the ferry was assessed, the battery supply and power conversion extensively tested, and finally the ferry equipped with a customized hybrid power generation system.

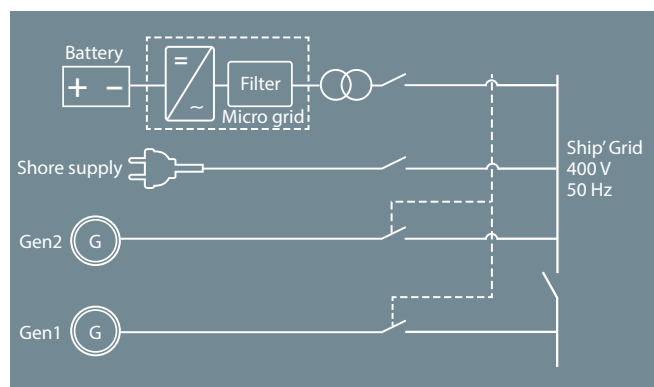
From 19 hours of diesel power....

Before the retrofit, the two diesel auxiliary generators were powering the hotel load, bridge equipment, engine room pumps, fire extinguishing equipment and more. With a capacity of 2 x 86 kW dimensioned for worst case scenarios such as fire on board, the typical load was 12 kW, with fuel consumption rather high at 300g/kWh. To meet the demand, these generators ran for 19 hours daily.

... to only 20 minutes

Now, the battery bank powers electricity consumption on the ferry for each crossing of the 200-m neck of water from Struer to Venø island. To maximize charging time, the staff connect to shore power supply as soon as the ferry reaches shore. In this way, the batteries recharge whilst the next passengers are boarding.

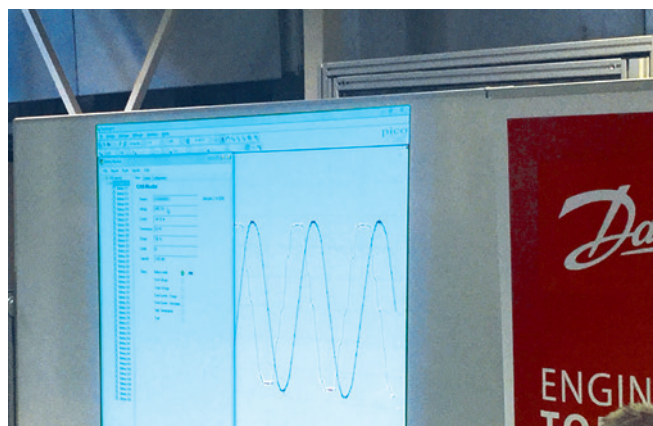
With the bank of 88 kWh batteries installed, the auxiliary generators start up to automatically recharge the batteries only when battery power levels begin to drop. Fuel consumption has dropped to 209 g/kWh and the daily generator running time has dropped to only 20 minutes!



Simplified schematic diagram of the hybrid power generation system.

Extensive testing

Before the retrofit Danfoss Drives thoroughly tested the system by using a test rig to simulate the generator. The actual battery and microgrid were employed in this test. The ship's load was simulated by a Danfoss drive with a load resistor and electrical motors. Danfoss and EPtechnologies performed the economic calculations predicting the reduction in fuel consumption expected with battery-hybrid operation.



Test rig simulation of the Super B battery system and VACON® NXC micro grid converter at Danfoss Drives.



As the first in Denmark, the ferry's electric equipment now runs primarily on battery power, connecting to a shore power supply to recharge batteries between trips. The 2016 conversion from pure diesel to hybrid operation has reduced diesel consumption by 20,000 l annually – from 90,000 l to 70,000 l.

Søren Adersen, Operations Manager

Propulsion redundancy

The double-ended ferry is powered by two identical Volvo Penta marine diesel engines with Schottel azimuth thrusters at each end of the vessel; each with its own engine room. There is full redundancy of the diesel propulsion.



Volvo Penta marine diesel engine.



Søren Adersen explains the power conversion system which uses a VACON® NXC Air Cooled microgrid converter. The battery bank is on the left.

Heart of the hybrid solution

Battery-powered operation has been made possible by a fire-safe battery bank and reliable VACON NXC drives. The two existing diesel propulsion systems remained in place and the battery system, transformers, and VACON NXC drives were installed in vacant space below decks.

The Super B battery bank supplied by EPTechnologies was selected according to stringent fire safety criteria and

therefore the choice was the safest existing battery type: LiFePO4. These batteries are designed to ensure that fire in one cell does not spread to the other cells.

Furthermore, these batteries have a long lifetime of minimum 10 years, at a high volume of charging cycles (1 cycle = fully charged to fully discharged and back to fully charged).



Staff connect to the shore power supply to commence charging the battery bank.



On the bridge

From loss to profit

After many years of running the ferry at a loss, today the ferry operator, Struer Municipality, enjoys a healthy economy, with annual fuel savings of 20,000 liters. The projected return on investment in battery power is under eight years, and beyond that point the ongoing reduced fuel consumption will directly benefit the ferry's bottom line with earnings in the battery lifetime projected to be more than 40,000 euros.

And as a direct result of the reduced diesel consumption, the emissions are reduced as well.

An extra benefit of the hybrid propulsion system is that the engine room is now normally unmanned. With no crew present most of the time, this means that the door from the noisy engine room can remain open. So now the engines heat the entire below-deck area with no extra heating system required, which saves on heating overheads during chilly weather for six months of the year.

Winters on board can be bitter but the ferry Operations Manager Søren Adersen is enthusiastic all year round: "It's a huge success for us. With cost neutrality within eight years we're totally satisfied." He smiles.

Parties involved

Danfoss Drives collaborated with a range of other suppliers and service providers to develop just the right technical solution for the hybrid retrofit:

EPTechnologies develop and manufacture marine control systems and hybrid battery solutions using Super B batteries. www.eptechnologies.dk

EPTechnologies
Energy Power Technologies

Super B: 'The safest in the industry' is the motto of Super B, battery supplier established in 2004. To achieve an elevated level of passive safety the batteries are manufactured of the highest quality LiFePO₄ cells available, with casing designed to resist extreme environments and abuse. www.super-b.com



Hvide Sande Shipyard: Hvide Sande Shipyard has specialised in the building and maintenance of a wide range of vessels. Their experience is well-proven in custom-designed new builds in fibreglass, aluminium, steel and wood. www.hvsa.dk



Vest-El: Electrical contractor with expertise in electrical installations for ships, industry and households. www.vest-el.com

