ENGINEERING
TOMORROW

Case Study | Marilyn Bell I Ferry

Driving **Decarbonization** Through **Electrification**

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Electrification with **VACON®** **Drives** and **Common DC Bus**

Across the globe, the marine industry is moving toward decarbonization, replacing diesel engines with electric power. Greenhouse gas emissions and air pollution from diesel fuel, along with noise pollution and the potential for oil and chemical spills, have a significant impact on both human life and the marine ecosystem. Many ports and municipalities have implemented initiatives to decrease carbon emissions and noise volume from vessels. But retrofitting older vessels with a new power system is a challenge.

PortsToronto, faced this challenge with its Marilyn Bell I ferry. Named after the first person to swim across Lake Ontario in 1954, the ferry had been in use since 2009, providing passenger, vehicle and cargo transportation to Billy Bishop Toronto City Airport, a regional airport owned and operated by PortsToronto and located on the Toronto Islands. Ports Toronto had launched an initiative to reduce carbon emissions from the airport and all the vessels in their fleet. In 2018, the ferry was converted to run on biodiesel fuel, but by 2020, they were looking to fully decarbonize.

Achieving Full Electrification

PortsToronto hired Ontario-based Canal Marine and Industrial, a leading provider of electrical engineering installations, to deliver the complete electrification retrofit of the formerly diesel ferry, from conception to installation. Canal had a long history of working with Danfoss Drives and knew that its VACON® Common DC-Bus electrification products would work seamlessly to power the electrical system. "Danfoss drives are robust and well-accepted in the industry and integrate with a variety of applications," said Shawn Balding, general manager at Canal.

The vessel's propulsion system consists of two electric motors, each powering a thruster, forward and aft. There are two autonomous power plants – for redundancy - each utilizing battery arrays, air-cooled VACON® NX Series drive modules, grid converters and DC/DC converters plus filters, all working together in common DC bus topologies to provide power conversion between the batteries and motors to power the vessel's thrusters and other electrical systems. The batteries are charged through the common DC bus distribution system via an automatic power connection to shore.

Each vessel function – ventilation, radar, pumps, hydraulics – is connected to the main AC bus distribution, supported from the common DC buses via dual redundant grid converters. "Fundamentally, all functions relating to energy storage, propulsion and essential services are duplicated and autonomous," said Balding.

The vessel makes four round trips per hour during a 19-hour day and recharges each time it docks at the mainland via an automated 400 kW pantograph charging system. This creates a shore-to-vessel DC connection, the first of its kind in North America, which integrates with the Danfoss electrification system, utilizing the active front end module to convert the AC utility power to DC power for use by the vessel systems. As soon as the vessel docks and the vehicle ramp is lowered, the vessel starts charging via the pantograph, initiated using wireless communication between the vessel and the equipment on shore.

"The Danfoss VACON® product line is a complete range," said Chris Wright, lead electrical engineer at Canal. "The DC/DC converters, drives, active front ends and grid converters are all based on the same platform and are flexible and scalable. It's great to have all that available in one set."

Installation and Implementation

Once the system was designed, built and factory tested, installation and commissioning – including tearing out the existing engines and related equipment - took about five months, with the ferry back in service by the end of 2021. The ferry was fully operational from the first day and with the electric power system, it starts up with just a flip of a switch. Aside from reducing start-up time – with its diesel engines, the vessel would need about a half hour to warm up and for the crew to check fluid levels – the electric system is easier and cheaper to maintain, saving PortsToronto an average of $150,000 in energy and operating costs per year. Other than periodic checks of the vessel's fans, motor and filters, little maintenance is required. A monitoring system alerts the crew if something requires their attention.

The electric motor has also significantly reduced noise from the ferry's operation, to the benefit of the surrounding neighborhood. And by eliminating the use of 196,000 liters of diesel fuel per year, the electrification of the ferry has helped PortsToronto lower their carbon footprint substantially.

"Powered entirely by electricity from clean wind and solar sources, the retrofitted Marilyn Bell has eliminated greenhouse gas emissions from the ferry operation, reducing Billy Bishop Airport's direct emissions by approximately 530 tons per year," said Chris Sawicki, vice president of infrastructure, planning and environment at PortsToronto. In addition to operating more efficiently and eliminating related air emissions, the retrofitted vessel builds on the airport's award-winning Noise Management Program, as it will operate far more quietly, dramatically reducing related noise in the surrounding community."

"This project shows the potential for electric-powered vessels, particularly short-haul ferries, and also highlights that the technology is as applicable to existing vessel conversions as it is for new builds," said Andy Wright (no relation to Chris above), technical opportunity manager at Danfoss. "The savings in expensive diesel fuels, zero emissions and much lower operating noise levels all justify the investment. This is another example of deploying proven technologies to meet emissions reduction targets."

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