

CASE STUDY

ZERO-EMISSION URBAN PUBLIC TRANSPORT PASSENGER BOAT



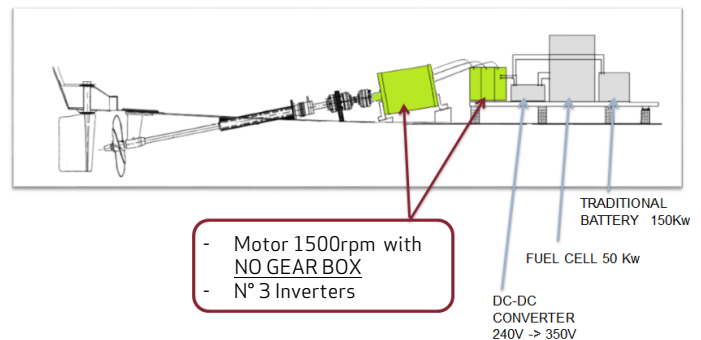
A shock for innovation

- Because of increasingly stringent environmental regulations, Venice public transport authority is experimenting with hybrid motor solutions for a zero emission lagoon.
- Moog is a leading player in an initiative for a zero emission lagoon.

A fleet of boats for public transport with hybrid diesel/electric motors is ready to start operating in the lagoon. Among those collaborating in creating the fleet are Moog and Dolomitech. The latter is an innovative Italian company specializing in the research and production of low environmental impact propulsion systems with solid expertise in fuel cell technology. Dolomitech's customer for a project, whose development has lasted about two years, is the authority that handles passenger transport in the lagoon. Their goal was to keep exhaust and noise pollution to a minimum.

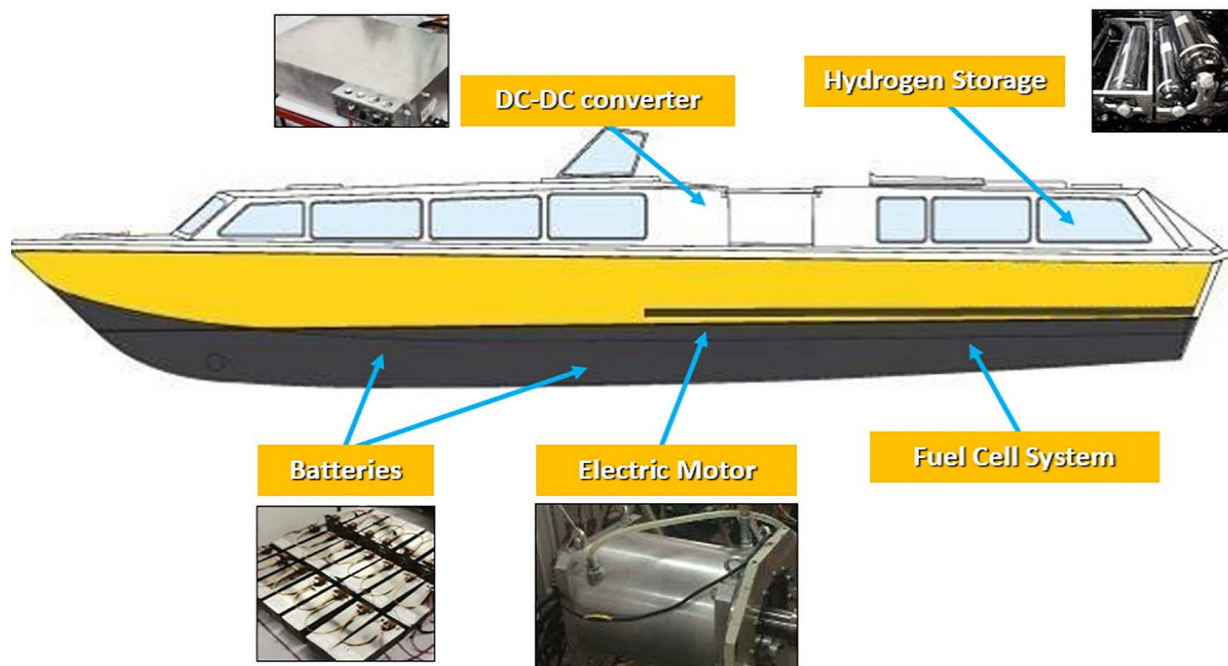
Currently three entirely new vessels have been delivered: they feature a diesel/electric motor with lithium manganese accumulators and a motor and inverter produced by Moog.

The partner company has developed architectural solutions which allow the boats to use only electric power, hence with zero emissions, for the urban part of their routes. This means uncoupling the electric motor from the diesel engine, which will be used to cover the stretch from the Marco Polo airport to downtown Venice.



FUEL CELL SYSTEM ON FULLY ELECTRIC BOAT

Zero Emission Hybrid-System Configuration



A solution that looks at our tomorrow

In the beginning, there was the HEPIC project started up by provincial institutions together with the transport authority. The name of the project is an acronym for Hydrogen Electric Passenger VeniCe Boat. Taking part were players of various origins united for the occasion in a public/private group who involved Dolomitech as an outside supplier.

And it was this company, which had worked in the past on sustainable transport programs for some major sporting events held in Trentino, that wanted to work with Moog in the next phase of the project. The aim was to deliver a complete zero emissions solution that could show the way forward for public transport in the lagoon. The competences of Dolomitech in the sector and those of Moog in the motors and actuators field were determining factors in developing a better, extremely innovative prototype. The idea was to add the energy equivalent of 300 kWh that could be produced by hydrogen powered fuel cells, to the energy (100 kWh) stored in lithium/polymer batteries.



The motor has two separate and independent coils powered by two inverters.

Total flexibility and maximum yield

The most demanding challenge, was making a motor that was going to be unique in Moog's range. We started from the specifications of the boat propeller and by direct coupling on the shaft; we adapted ourselves to the mechanics of the passenger ferry. The design of the motor optimized for a yield of about 97% around the optimum speed of 1600 rpm and with a very fault tolerant architecture. This resilience was made possible by a motor with two separate and independent coils powered by two inverters: these twin components can thus cover a breakdown of one element and allow the ferry to continue its journey albeit under reduced power. With this application Moog not only successfully designed an innovative type of motor, but demonstrated its versatility and flexibility even beyond the customer needs.

Motor and Inverters Characteristics

	Unit	S1	10 min.
Torque	Nm	1115	1220
Power	kW	175	200
Speed	rpm	1500	1570
Voltage	Vdc	350-400	350-400
Current	Arms	322 x 2	355 x 2
Motor efficiency	%	96.5	96.5
Inverter efficiency	%	> 97.4	> 97.5
Motor weight	kg		240
Inverters weight	kg		23
water temperature	°C		25
water flow rate	l/min		15

WHAT MOVES YOUR WORLD

Route to the future

The effectiveness of the system, which receives the power of 50 kW from the fuel cells, with a total of 20 kg of hydrogen in four containers, and a further 200 kW from the lithium batteries, has been fully demonstrated. A test voyage on the open sea saw the boat reach a top speed of about 40 km an hour, about 10% faster than with diesel engines. We can safely say the mission was accomplished.

Hybrid power, which is one of the leading trends in contemporary mobility, has thus become amphibious: from dry land, it has taken now to the water.

Coming back to the lagoon — and not just the lagoon, as we shall soon see — a more rigorous approach to better protect its environment is consolidating and for this reason partnerships between the public sector and industry are expected to intensify remarkably. For Moog and its partners, such as Dolomitech, this will mean the acquisition of many more business and research opportunities.

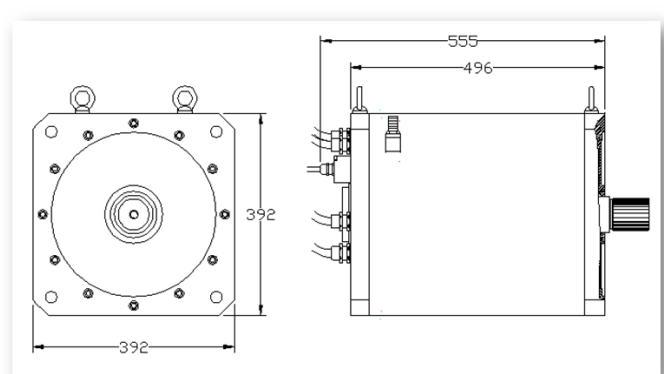
No Limits

For zero-emission transport of this kind to be definitively accepted, it is now imperative to reduce market costs.

One of the main costs is represented by the batteries and the range they have to provide. A lot of design effort went into keeping them as small as possible, but an increase in motor efficiency, alongside other technological solutions of industrial origin, made possible by the expertise accumulated by Moog, were the elements that made the goals set for the project ultimately reachable.

In view of the more and more restrictive measures adopted worldwide to safeguard wildlife and protect nature reserves, the need to bring zero emission propulsion to an ever increasing public will grow exponentially. A more efficient, solution-oriented approach, such as the one offered by Moog, is what is going to make the difference.

Mechanical dimensions of the motor



For further information visit moog.com/industrial

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