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**Source**: Guarnieri, M., Morandin, M, Ferrari, A., Campostrini, P. and Bolognani, S. (2018). Electrifying Water Buses: a case study on diesel-to-electric conversion in Venice, IEEE Industry Applications Magazine, January/February 2018, 1077-2618.





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# Converting to electric waterbuses in Venice


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**This study is about the conversion of waterbuses for public transport in Venice (Italy) from diesel to electric power. It examines energy storage systems, electrical machines and drives, and takes into consideration economic, environmental and social issues. Alternative solutions based on hybrid diesel-electric and full-electric powertrains are compared. The study concludes that a hybrid diesel engine with lithium battery is the best option for an easy first implementation, even when taking existing infrastructure into consideration.**

Advances in electric watercraft lag behind those of road vehicles because the boat market is much smaller and sea-travel ranges are prohibitive for all-electric vessels. However, in recent decades, research has led to a number of technological advances. Concept designs have been developed and electric watercraft built – some through cooperative initiatives.

A feasibility study of electric waterbuses to meet the needs of the city of Venice was undertaken based on up-to-date propulsion and range technologies. The study compared the diesel engine powertrain combined with four alternative electrical drive solutions.

In Venice, a large public waterbus (known as vaporetto – literally 'little steamer') has a 24 m long and 4.22 m wide hull. It displaces 37 tons of water and can transport 200 passengers. It has a single-rudder propeller powered by a 147 kW marine diesel engine and runs at least 16 hours each day.

An operating profile of a waterbus's engine found that it is very uneven. The peak power of 147 kW is used intermittently when cruising and for a few tens of seconds when slowing down and speeding up at docking. The engine power reduces to 45 kW when it is idling at a mooring for landing and boarding operations. The daily average engine power is 65 kW.

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# Converting to electric waterbuses in Venice

The simplest design for a hybrid or all-electric waterbus involves retrofitting an existing vessel while maintaining the present single stern propeller. The study considered the following alternatives:

1. A conventional diesel engine and powertrain.
2. An all-electric lithium battery feeding an electrically driven propeller.
3. A serial hybrid powertrain consisting of a reduced-size diesel engine and lithium battery energy storage feeding an electrically driven propeller.
4. A serial hybrid powertrain consisting of a reduced-size diesel engine and an ultracapacitor energy storage feeding an electrically driven propeller.
5. An all-electric serial hybrid consisting of a fuel cell and an ultracapacitor energy storage feeding an electrically driven propeller.

The study concluded that a hybrid powertrain, based on a diesel engine and energy-storage device (i.e. lithium battery), would be the best solution. This is due to the long daily operating hours and high energy demand of the waterbuses. It is also the most appealing in terms of cost (investment and running), pollution, payback time and ease of implementation (because it raises only minor infrastructure problems).


Photo credit: Fotolia

The first prototypes, which will be retrofits of existing vessels, will use this type of powertrain with the aim of introducing advanced electric watercraft in Venice.

Retrofitting is considered to be the first step in electrifying public waterbuses in Venice. Subsequent steps require hulls with advanced propeller system that will be extended to private waterbuses. Although the plan is ambitious, it has the potential to reduce air pollution and noise, which will be beneficial to citizens and visitors.