The Hydrogen Barge

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Vision: Afin d'évoluer vers un avenir énergétique durable et sûr, qui ne dépend pas du pétrole.

(To create a pathway to a secure and sustainable energy future that does not depend on petroleum.)

The problem of poor urban air quality due to diesel particulates is well known, and there is no more iconic depiction than the Eiffel Tower on a bad-air day in Paris.

Photo taken on March 11, 2014 shows the Eiffel tower and Paris' roofs through a haze of pollution. French non-governmental organization (NGO) Ecologie Sans Frontiere (Ecology without borders) confirmed on March 11 that they had filed a criminal complaint in Paris to denounce the 'health scandal' of air pollution, as several regions of France experienced high levels of particulate pollution. AFP PHOTO / PATRICK KOVARIK (Photo credit should read PATRICK KOVARIK/AFP/Getty Images)

While most of the attention has been focused on diesel cars and trucks, the marine sector has fallen below the radar screen. In fact, a considerable fraction of the visible diesel particulate emissions come from the marine diesel engines on barges, tour boats and water taxis that ply the rivers and canals in most European urban centers. Marine hydrogen fuel cells in the sub-megawatt class exist

today and are ready for commercialization, but the technology has not been widely deployed due to the challenges of providing shore-based hydrogen refueling infrastructure. Vessels operating in littorals and on inland waterways require access to fueling docks. In the case of hydrogen, no such infrastructure exists, and providing hydrogen at fixed facilities is challenging because real estate along waterways is expensive and the facilities required to produce and store large amounts of hydrogen do not exist.

The Hydrogen Barge (H_2Barge^{TM}) is a concept for making hydrogen aboard a mobile refueling barge, that brings hydrogen to the place where the boats employing fuel cells require it. An inland freighter, typical of those used extensively throughout the European waterways to deliver bulk cargo, is pictured below. A vast network of waterways passes through most large cities in Europe supporting considerable commercial barge traffic. Instead of sand and gravel or grains, the hopper of the hydrogen barge would be filled with pelletized paraffin delivered from conventional conveyor facilities outside the urban area.

The urban waterways also support fleets of excursion boats and ferries, most of which are diesel powered and contribute to urban air pollution. Converting these small boats to hydrogen power

has long been a dream of city planners and environmental groups, but such boats would require a network of hydrogen filling stations at costly shore installations that do not yet exist. By generating hydrogen on a mobile platform, the fleets of smaller boats could be refueled with hydrogen where they operate, largely obviating the need for such shore-based infrastructure. The hydrogen barge would dock periodically at facilities outside the city to replenish with paraffin pellets and refill water tanks. When producing hydrogen, the barge would simply pull up along-side the waterway, providing ready access for other boats needing refueling.

Paraffin is an ideal feedstock for hydrogen production, generating more than 100 grams of hydrogen per kilogram of paraffin. This is accomplished by processing the paraffin at elevated temperatures in a proprietary combined hydrogen and power (CH_2Gen) system, extracting the purified hydrogen, and storing it on-board in high-pressure transfer tanks. Paraffin, as a solid fuel source, is inexpensive, safe and easy to handle in bulk. Furthermore, paraffin does not present any of the environmental hazards characteristic of gasoline and diesel fuel, such as high flammability and water pollution when spilled. Most importantly, hydrogen may be produced on-board a mobile barge using the CH_2Gen system without the need for any additional shore support or power hookup, so the barge can continue producing hydrogen twenty-four hours per day and seven days a week regardless of whether the vessel is underway, at anchor, or parked alongside the waterway. Other vessels requiring hydrogen refueling need only pull up alongside and refill their tanks with hydrogen as needed.

1,000 tons of paraffin will produce more than 100,000 kilograms of hydrogen. At 1000 kilograms per day—the output of a typical large diesel filling station—the barge could continue producing hydrogen for one hundred days before needing to replenish. 1000 kilograms of hydrogen is roughly equivalent to 4000 liters per day of diesel fuel when burned in a marine hydrogen fuel cell rather than in a diesel engine. A single hydrogen barge could supply a fleet of up to ten 500 kW-class boats.