Hydrogen could save regional railways

November 29 2013, by Andreas Hoffrichter

Small, but not for long. Credit: niversity of Birmingham

There is increasing talk of electrification of the UK's railway network. But electrification is an expensive business, requiring much new hardware including masts, wiring, substations and so on. Such an investment can be justified for heavily used lines such as urban metro systems and inter-city routes, but not on less used lines such as regional routes. Railways will continue to need an energy supply system that does

not rely on electrification for the foreseeable future.

This currently takes the form of diesel power. But in addition to environmental concerns over emissions, the price of diesel is likely to continue to increase. A point will be reached in the future where it is no longer economically viable or environmentally acceptable to use diesel, and hydrogen appears to be an attractive alternative.

Like electricity, hydrogen can be produced from many different primary sources including natural gas, coal and petroleum. It can also be produced using electricity to split water into its elements. Then there are several "green" production options being developed including the anaerobic digestion of waste material and the direct use of heat from solar energy. But unlike electricity, hydrogen can be stored and transported in discrete quantities in order to power trains, much like diesel or natural gas.

To release the energy stored in the hydrogen, one option is to use a fuel cell. In this device, hydrogen is combined with oxygen from the air to produce electricity, water and heat. There are no harmful emissions or exhaust fumes, and the technology is quiet, vibration-free and low maintenance – all attractive features for railway applications. Fuel cells are usually combined with batteries which help meet the peak power demand during hard acceleration, and to provide a store for energy recovered during braking.

A recent study by the University of Birmingham showed it is possible to store enough hydrogen onboard a modern train (a lightweight commuter train in this case) to provide a similar range to diesel power. In contrast to battery only systems, re-fuelling takes a similar amount of time to diesel, and only a limited number of re-fuelling points would need to be provided. Commercially, the cost of hydrogen is comparable to that for diesel, and the inherent ability of a hybrid system to store and reuse

braking energy helps reduce overall consumption.

To show the viability of the technology, the UK's first hydrogen-powered locomotive, called the Hydrogen Pioneer, was developed and built using off-the-shelf technology. The locomotive uses a 1.1kW fuel-cell stack to charge four lead-acid batteries that provide the combined power for acceleration and store energy when braking. The 320kg-locomotive can haul wagons and passengers up to 4,000kg.

Elsewhere in the world, hydrogen-powered railway vehicles have been constructed in Spain, the United States, China, and Japan. These have mostly been prototypes, but the first commercial operation of hydrogen power has been for mining locomotives, with a fleet now operating at a platinum mine in South Africa. In 2014, hydrogen-powered trams will start commercial operation in Aruba, with hydrogen generated solely from renewable sources.

It is possible that hydrogen-powered trains will see service on the UK network within the next few years, most likely on lower-speed applications such as trams or shunting locomotives. But hydrogen has the potential to play a larger role, powering those parts of the network where electrification does not make sense.

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