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Hydrogen and Batteries – Two Technologies to Move the Industry

Decarbonisation presents the rail industry with some challenges, but it starts from a good place.

The industry is recognised as one of the most efficient in the global transportation sector. Even so, adding newer, cleaner technologies will require investment, imagination and change. And while there's unlikely to be a one-size-fits-all technology solution, several technologies are moving forward at pace right now offering the prospect of integrated and hybrid solutions, and paths forward for the industry.

The challenges in rail, particularly freight, are specific. When locomotives travel long distances, considerable energy has to be carried on-board. When that energy needs to be replenished, a suitable infrastructure has to be in place. The need to maintain precise schedules means that the time needed to replenish energy has to be factored in. And there are other considerations too, such as noise impact on the environment.

All of this matters as rail explores alternative, more sustainable fuel sources, and everyone in the rail space is on the same journey to evaluate their viability. So, let's

look at the two main contenders – hydrogen fuel cells and batteries.

The Case for Hydrogen

Across the transportation space, hydrogen is an emerging technology, yet with a longer history than many realise. The space programme depended on hydrogen as rocket fuel, and the first hydrogen-powered road vehicle appeared in the mid-1960s.

Some urban public transport is already hydrogen-powered, and car makers are dipping their toe in the water, although the refuelling infrastructure to support cars is in its infancy.

Rail is ahead of this curve. Hydrogen trains are already in service and have been for some years. The Coradia iLint powered by Cummins fuel cell modules that run on hydrogen has been in successful day-to-day commercial service in Europe since 2018, carrying up to 300 passengers as much as 1000km. Germany, Japan and the United Kingdom have all made hydrogen trains part of their plans to decarbonise their national rail networks.

The fuel cells that power locomotives and trains like the Coradia iLint are based on technology that generates electricity through a chemical reaction combining hydrogen and oxygen. Unlike fossil fuels, these resources are abundant and available. The process of releasing hydrogen from water of course needs energy, but that energy can be generated from renewable sources including wind and solar power. Importantly, the technology is developing quickly to do this cost-effectively at scale.

In many ways, the case for hydrogen power in rail is already strong. At point of use, hydrogen fuel cells produce zero harmful emissions, just the water yielded by the chemical reaction in the cells.

Range is not a problem for hydrogen technology for most rail applications. Hydrogen fuel cells have impressive energy storage density, and their power density and efficiency will only improve as the technology develops making it a good fit in more applications.

Critically for rail, hydrogen offers refuelling advantages too. Effectively, vehicles can be refuelled with hydrogen as quickly and easily as with diesel and be ready

to return to service in a matter of minutes.

And the electric motors powered by hydrogen fuel cells are quiet, a real plus in built-up rail environments.

How does hydrogen need to develop to be fit for rail? Well, the materials used in the fuel cells are not cheap, so manufacturing scale is needed to bring costs down. And of course, the supply chain too must and will develop, as will the refuelling infrastructure around the rail network globally.

The Case for Batteries

Driven by decarbonisation goals, the automotive industry globally is progressing towards battery electric vehicles at speed, because batteries are well-suited to passenger cars, capable of providing the power and range consumers need.

Their strength is the robustness and reliability of the core technology. Like hydrogen fuel cells, batteries power electric motors quietly and release no emissions. If renewably generated electricity is used to power charging stations, the carbon benefits can be great.

A key to the viability of battery-powered trains is the energy density of the batteries. Fewer batteries lead to less complex and therefore more robust systems.

In common with the automotive world, charging time is a focus too. Batteries can't currently match the replenishment time of hydrogen or diesel, but here again, the technology is moving swiftly forward.

And battery systems have another trick up their sleeve – regenerative breaking. The massive energy created by a passenger or freight train slowing down can greatly boost battery capacity.

Full Steam Ahead?

The urgency of the net-zero future means that hydrogen fuel cells and batteries are both likely to feature in rail's powertrain technology mix.

Each technology will probably slot into the sector in different places, based on where its combination of advantages fits best. And as hybrid solutions, perhaps combined with high-efficiency diesel engines in the shorter term, they can provide a bridge to the decarbonised rail industry of the future.

Cummins is at the forefront of the technology that our decarbonised future depends on. Wherever you are on your journey, we can help you stay ahead of the curve.

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