

RAIL

On the right track



How we power trains – one of the world's oldest forms of mechanised transport – is being overhauled for a greener future. Michelle Meineke reports.

The rail sector can provide substantial benefits for the energy sector, as well as for the environment. By diversifying energy sources and providing more efficient mobility, rail can lower transport energy use and reduce carbon dioxide (CO₂) and local pollutant emissions,' according to Dr Fatih Birol, Executive Director at the International Energy Agency (IEA).

So, forget billowing smoke chugging from coal-powered trains that snake their way through picturesque hills. Or the ease of turning on the diesel tap, especially amid talk that peak demand is just decades away. Instead, think electrification, hydrogen and solar power. Think sustainability, accessibility and longevity. Think low CO₂ emissions – sometimes none – and minimal noise pollution.

Actions speak louder than words
Tangible progress is rapidly emerging as momentum – political, business and social – behind the

global energy transition towards a greener future quickly builds. What was the odd snowball of change towards a greener, diverse fuels market has turned into an unstoppable avalanche of positive disruption. Rail and other transport sectors – including aviation and shipping – that had time to brainstorm fuel alternatives, now have a ticking clock spurred by the Paris Agreement targets hanging over their boardroom meetings. Examples of progress include the UK's aim to end 'diesel only' trains by 2040 and the Indian government's approval of 100% electrification of broad gauge railways by 2022 through its 'Mission Electrification' plan; monumental for what the UN expects to be the world's most populated country from 2024. This is the tip of the iceberg in global change; the list goes on.

Rail has largely escaped the negative environmental press that aviation and shipping, respectively, have historically received. It helps that it is among the most energy efficient modes of transport for freight and passengers. The sector carries 8% of the world's passengers and 7% of global freight transport, yet it represents just 2% of total transport energy demand, according to the IEA.

Holistic routes

A 'silver bullet' eludes the rail industry. One method does not suit all. But any alternative fuel must tick four boxes – safety, accessibility, affordability and low carbon.

Electrification is the main success story so far. As the bustle of Christmas markets busied the streets of London in December 1890, the world's first deep-level electric railway underground was being launched – 139 years ago. Above ground, electric achievements (arguably less logistically challenging) were achieved in the decade before.

Today, 75% of rail transport activity worldwide takes place on electric trains, up from 60% in 2000, according to the IEA. This makes the rail sector the only mode of transport that is widely electrified today. The regions with the highest share of electric train activity are Europe, Japan and Russia. North and South America still rely heavily on diesel.

Hybridisation is a middle ground for many as bi-mode trains use overhead electrical wires while also having diesel engines. This means the switch from fossil fuels to electrification could be seamless and avoid the costly line closures that spark public ire. The

The Coradia iLint, launched in Germany in 2018, is the world's first passenger train powered by a hydrogen fuel cell and has a range of 1,000 km

Photo: Alstom

Keeping pace with global shifts

The brightening spotlight on what's next for fuel alternatives in rail is partly thanks to global environmental milestones achieved in the shipping and aviation sectors.

It is just two months until the International Maritime Organisation's (IMO) 0.5% sulphur limit, from today's 3.5%, becomes mandatory on all vessels. This heralds the biggest shift in the shipping industry – carrier of 90% of the world's trade – since engines replaced sails.

In the air, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) addresses the increase in total CO₂ emissions from international aviation above 2020 levels. As of 1 January 2019, all carriers are required to report their CO₂ emissions on an annual basis. CORSIA could mitigate 2.5bn tonnes of CO₂ and generate more than \$40bn in climate finance between 2021 and 2035.

The ideas behind the rulings have taken more than a decade to bear fruit. But they now provide a common roadmap for all – something the rail industry lacks. As fuel alternatives in rail gain pace, ensuring international best practices are outlined and sustained will be crucial to maintain the sector's high safety record. ●

latter is especially unhelpful in harnessing investors' support for what are much-needed projects. Rail infrastructure projects often need long-term financing and are subject to the swinging pendulum of political parties' mandates. Raising and protecting funds is critical to improve national mobility.

'Electrification must remain at the top of the hierarchy of options for the decarbonisation of our railways. It is essential that we begin a rolling programme of electrification for intensively used routes, with alternative low-carbon traction options – like hydrogen and battery technology – used for lines where there would not be a business case for electrification,' stressed David Clarke, Technical Director of the Railway Industry Association (RIA) and Task Member of the Rail Industry Decarbonisation Task Force in the latter's final report to the UK Minister for Rail.

Renewables – a cornerstone of the energy transition – are also making an appearance, with hydrogen and solar power. Hydrogen can avoid CO₂ emissions, is quiet and eliminates local emissions, such as particulates. It has the potential, as a complementary solution to electric rail, to replace around 20% of the world's diesel trains. The Coradia iLint launched by Alstom last year is the world's first passenger train powered by a hydrogen fuel cell, with a range of 1,000 km.

'By 2030, one in 10 trains sold for currently non-electrified railways could be powered by hydrogen. By 2050, one in five trains running on non-electrified railways, or one in 10 trains overall, could run on fuel cells. Hydrogen-powered trains are already being introduced for light-rail vehicles, such as trams and regional railways around the world,' points out Pierre-Etienne Franc, Co-Secretary of

the Hydrogen Council and Vice President of Hydrogen Energy at Air Liquide Group.

Solar photovoltaic (PV) is also becoming increasingly attractive as the levelised cost of energy (LCOE) per megawatt-hour (MWh) has fallen by 84% since 2010, according to Bloomberg New Energy Finance. The same goes for battery-powered trains, as the cost for lithium-ion battery storage has plummeted by 76% since 2012.

Applications for solar powered rail operations have been filtering into the mainstream over the last decade. India has rolled out solar panels on the roofs of its trains since 2017 and 4,400 solar panels were unveiled on Blackfriars Bridge in central London to provide 50% of the station's energy in 2014, for example. Now, gateways are opening that could see solar entering the realm of mainstream fuel alternatives. Social enterprise Riding Sunbeams switched on the first ever solar panels to directly supply a railway line with electricity this year – a major stepping stone towards the world's first fully solar-powered trains. The UK's Network Rail estimates that solar energy could provide 10% of the energy needed to power trains on the UK's electrified third rail routes.

Next steps?

Building momentum towards alternative fuels for rail operations requires more research and development (R&D) and more funds. In the aforementioned report by the Rail Industry Decarbonisation Task Force, a periodic five-year R&D plan was part of the recommendations. Focus areas for R&D include freight and yellow plant decarbonisation and increasing the capabilities of battery and hydrogen, including development of appropriate infrastructure and reducing whole system costs. Plus, reducing the whole system cost of electrification, including through various forms of intermittent electrification.

But for science to work, the money equation must also. For example, the upfront costs of electrification can sting, despite being cheaper in the long run. Having emerged from the post-millennium recession and amid talk of an early 2020s economic squeeze, willingness to fling open the purse strings has been more conservative. For example, the US formally cancelled \$929mn that had been awarded to fund California's high-speed rail programme, in May this year. But many ideas are pushing ahead. After a few quasi-false starts, the UK government is investing £48bn to modernise its rail network over the next five years. Meanwhile, a growing green bond market in low carbon transport means that the European Commission thinks a significant share of investment in the European Union's railway sector could be financed by green bonds.

The speedometer is certainly shifting. But it must accelerate to mimic the bullet train of evolution, rather than the coal chuggers of the 1800s. ●

Pressure points

Getting rail fuels 2.0 on the right track is vital as pressure points – rising passenger and freight numbers, and environmental targets – intensify. Achieving efficiency, affordability, sustainability and safety simultaneously for such a vast and logistically complex sector is no small feat. A staggering 15tn passenger kms could be travelled worldwide in 2050, according to the IEA.

In the UK alone, rail passenger journeys in 2018–2019 reached a record high of 1.8bn – roughly the size of the UK and China's population combined. An extra 1bn passenger journeys a year on the UK's network are expected by 2030, while the country tries to achieve net zero greenhouse gas (GHG) emissions by 2050. With nearly a third of the current rail fleet running on diesel fuel, the enormity of this challenge is echoed worldwide. Alternative fuels are a large part of the answer to what is a near-global conundrum. ●



Photo: RIA

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