RAIL ELECTRIFICATION
THE FACTS

Electric railways are better railways – however you define better.

This is why many countries around the world electrified their railways before climate change became a priority. Rail is one of the few proven technologies for high volume passenger and freight transport and is also a sound economic investment. Rail was and still is the green transport choice – and electric railways doubly so.

Rail electrification provides a more efficient, higher-performing railway, with lower life cycle costs and the additional benefit of decarbonising rail traction. This paper provides an evidence base to demonstrate the benefits of electrification, and explains why electric traction is future proof.

Railway Industry Association
The voice of the UK rail supply community

Rail Decarb23
Getting rail decarbonisation on track

1 MORE AFFORDABLE

Over a 30-year vehicle life, the total purchase, maintenance, and traction energy costs of electric trains are £2 to £3 million per vehicle less than diesel or hybrid equivalents[1]. Lighter electric-only trains also reduce track maintenance work costs. Electric railways (including electrification costs) are cheaper over their working lives than any other form of traction, except for lightly used routes[2].

2 MORE RELIABLE

Electric long distance and suburban trains are respectively 40% and 300% more reliable than diesel trains[3]. This makes an electric railway more reliable than a diesel one despite the occasional overhead line fault[4]. Electric trains require less maintenance and so spend less time in depots. As a result, 4% fewer electric trains need to be purchased than diesel/hybrid trains[5].

3 MORE ENERGY EFFICIENT

Electric trains draw energy directly from the grid to power their electric motors and so have no onboard energy storage or conversion process. As a result, they're almost three times more energy-efficient than Diesel or Hydrogen, and 1.2 times more energy-efficient than Battery Electric[6]. Moreover, only electric trains can recover energy from braking (regenerative braking) and feed it back into the grid or directly to nearby trains, recovering between 8% and 30% of the train's energy consumption[7]. Bi-mode trains cannot do this when running in Diesel mode. Unlike all other rail traction, the power of electric trains is limited only by what can be drawn from the wires. This extra power offers improved services at a lower energy cost.

4 REDUCE JOURNEY TIMES AND INCREASE CAPACITY

Electric trains can accelerate faster than diesel ones. They reach the maximum speed for a section of line more quickly meaning trains on a route are all generally travelling at the same speed and so require fewer paths. This reduces journey time but also increases capacity on a route which allows more trains to travel per hour[8]. Metro trains throughout the world use electrification to maintain short journey times with frequent stops. For example, Crossrail will have trains departing every 2½ minutes, a frequency which would not be possible with diesel trains.

5 LONGER AND FASTER FREIGHT TRAINS

Electric freight trains are cheaper to operate, have more powerful electric locomotives which enables faster, longer, heavier trains with obvious commercial and network benefits. In the UK only 5% of the energy used to power freight trains is electric, meaning enormous untapped potential for rail freight carbon savings. The power and range of diesel traction is limited by the amount of energy that can be stored and the capacity of its power plant which are both limited by the available space on the train. For this reason, electric freight locomotives are around twice as powerful as diesel locomotives[9] and so can significantly reduce freight train journey times[10]. In diesel mode, a bi-mode freight locomotive will have about a third of pulling power of an electric locomotive as there is little space for its diesel engine. As batteries and hydrogen have a much lower energy density that diesel they cannot store sufficient energy within a locomotive for freight haulage. Hence Diesel-only or electric traction are the only options for main-line freight traffic.

6 MINIMAL MAINTENANCE

Electrification once installed is a fixed asset requiring minimal maintenance. Diesel, Bi-mode and Hydrogen trains require fuel stores in depots and a network of regular lorry deliveries to sustain them[11]. Electrification reduces heavy road traffic and additional emissions as a result. Traction batteries may require several expensive replacements across the life of the rolling stock due to the rapid charge/discharge cycle that railway operation requires.

7 MORE ENVIRONMENTALLY FRIENDLY

The estimated carbon payback period for electrification is four years[1]. This will be even shorter when more electricity is generated by renewables. Electric trains also remove the environmental issues around battery production and recycling. Electric traction is emissions-free at the point of use and therefore eliminates the air quality issues of diesel trains. As electric trains mainly use their motors for braking, diesel trains produce much more harmful particulate dust from their brake pads when braking. Electric trains are also significantly quieter, especially at stations. This improves the ambience at stations and for lineside neighbours. Passengers also enjoy a quieter journey with less vibration[5].

8 A PROVEN TECHNOLOGY

Electric railway technology is well established with all the key technical problems solved decades ago. Electric trains are simple and cheap to build, with no inbuilt power plant, far fewer moving parts, and a mature competitive market. So electrification does not require the system-level innovation required by alternative traction technologies because performance, safety and reliability are well understood and continue to improve. Problems with some UK electrification projects c2014-17 stem from the 'boom and bust' approach to electrification which dramatically increased electrification delivery over a few years after many years of inactivity. There was no problem with the electrification technology itself and the lessons from this period are being applied to projects being successfully delivered today[12].

9 FUTURE PROOF

There is no more efficient way to power a train now or in the future than feeding electricity directly from wires/third rail to a train's motors. Consequently, electrification is future-proofed and a highly efficient technology. This makes it a safe investment that offers large passenger, freight, and operational benefits. Electric trains are also more independent from global socio-economic (i.e., fuel shortages) and geopolitical situations. This is because electricity can be sourced from a diversified grid fed by renewables, further reducing the impact of climate change.

1 D. Shirres, G. Keenor, N. Dolphin and P. Hooper, "WHY RAIL ELECTRIFICATION?," RIA, 2021

2 Department for Transport, "Britain's Transport Infrastructure - Rail Electrification", DfT, 2009

3 Network Rail, "Our Electric Future," Network Rail, 2021

4 Department for Transport, "Britain's Transport Infrastructure - Rail Electrification", DfT, 2009

5 Network Rail, "Network RUS Electrification," Network Rail, 2009

6 RSSB, "T1145 - Options for Traction Energy Decarbonisation in Rail," RSSB, 2019

7 UN Climate Technology Centre & Network, "Regenerative Braking in Trains", CTCN, 2023. [Online]. Available: https://www.ctc-n.org/technologies/regenerative-braking-trains [Accessed 05 01 2023]

8 Network Rail, "Great Western Route Modernisation – Interim project completion report," Network Rail, 2020

9 Class 92 electric – 6,760 hp, Class 70 diesel – 3,690 hp.

10 https://aether-uk.com/Case-studies/Railfreight-Energy-and-Emissions-Calculator-(REEC) [Accessed 12 03 23]

11 House of Commons Science and Technology Committee, "The role of hydrogen in achieving Net Zero – Fourth Report of Session 2022-23", HoCS&TC

12 Electrification Cost Challenge, RIA, 2019

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