

Scotland's Zero Emission Hydrogen Train Project

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In the year 2019-20 UK diesel passenger trains emitted 1.3 million tonnes of carbon dioxide and presents about 1% of UK domestic transport CO2 emissions. The UK is actively seeking to deliver low carbon solutions for the global rail sector and the Rail Industry Decarbonisation Taskforce and Network Rail in their work have identified mechanisms by which to create a country-wide low carbon transport network.

Recommendations to decarbonise the rail network, include plans for 12,000 km of electrification by 2050 and the adoption of low-carbon traction technologies including electric, hydrogen and battery. This compliments the decarbonisation efforts with the Scottish rail sector.

As part of its bold decarbonisation ambitions, the Scottish Government has set a target date to decarbonise passenger rail transport by 2035. A demonstration project is led by Transport Scotland, Scottish Enterprise and the Hydrogen Accelerator for the development of a 3-car class 314 train being converted to a hydrogen fuel cell electric powertrain.

This is an ambitious project, in its second phase, which will be carried out by an industrial consortium led by Arcola Energy in partnership with Arup, Abbott Risk Consulting and AEGIS. The project will involve full system design, installation and demonstration of the train and will be showcased on the heritage Bo'ness & Kinneil railway during the prestigious COP26 (26th UN Climate Change Conference of the Parties) hosted by Glasgow from 1 to 12 November 2021.

According to Transport Secretary Michael Matheson, "This project has the potential to be a gamechanger for the future of Scotland's rail rolling stock. Our Rail Decarbonisation Action Plan sets out to make our passenger railways emissions free by 2035, but to maximise our climate change ambitions, there is also a requirement to look at what we do with the retired stock. If we can bring those back into use in a carbon neutral way, there are huge climate gains to be made."





As an enabler of hydrogen technologies in Scotland's growing green economy, the Hydrogen Accelerator, funded through Transport Scotland, is a partnership between the University of St Andrews and the University of Strathclyde.

The role of the Hydrogen Accelerator is to catalyse the capabilities that will help Scotland exploit the economic opportunities from the shift to zero or ultra-low emission mobility solutions.

It has been established to facilitate the realisation of Scotland's hydrogen future by bringing together, public bodies, industry, research organisations and higher and further education institutions. The work carried out by the Hydrogen Accelerator aligns closely

with the University of St Andrew's ambition to lead the way in research that addresses climate change and itself become a carbon neutral university by 2025.

The role of the Hydrogen Accelerator in this pioneering zero emission train project is not only to assist the development of decarbonisation technologies but also to support the growth of the rail supply chain and innovation in this sector. Hydrogen-powered trains do not release harmful emissions, they use hydrogen to produce electricity, heat and water.

Hydrogen is an ideal energy store helping to extend the limited capacity of the battery onboard the train.

Additionally, the battery in the train can recover energy during braking, which can then be used to boost the train when it is accelerating. Using a class 314 will demonstrate the refurbishment of rolling stock. This project will allow integration of alternative traction power supply equipment to be utilised within the train which must operate to present railway regulations and safety standards. The innovative technology developed in this project will be transferable to other obsolete passenger trains, thereby assisting the decarbonisation of Scotland's rail sector and most importantly, providing commuters with greener, cleaner trains.

Professor John Irvine from the University of St Andrews and Chair of the Hydrogen Accelerator said: "The aim of this project is not just to develop a new low carbon approach that will reduce carbon dioxide emissions and improve air quality, it is also to develop skills and create new supply chain opportunities. If we are to address climate change, we need to combine disruptive new technologies like hydrogen trains and offshore wind energy with new capabilities and an agile new workforce, delivering on both climate and employment."

As well as developing novel, environmentally friendly technology and using hydrogen in the railway sector, bringing together the

stakeholders of this project will provide additional economic benefits to Scotland, including creating new skills, expertise and training to develop an innovative workforce thereby revolutionising the sector.

Another important aspect of developing this project is that we integrate the use of green hydrogen produced from electrolysis to fully decarbonise this mode of transport. This project provides the opportunity for companies to transition into the hydrogen and rail sectors, diversifying their products and services and strengthening their organisation's propositions within our future green economy.

It is worth noting that in Scotland significant investment has been made in rail electrification over recent years with a view to decarbonising commuter routes. Approximately 40.7 % of the rail network in Scotland is electrified and around 76 % of passenger and 45 % of freight journeys are on electric traction. Between 2012 and 2018, this investment has resulted in a UK-wide decrease in emissions per passenger kilometre by 24 %.

Lowering emissions from rail traction and improving passenger rail service will provide a more attractive travel choice to prospective passengers. The railway is a heavily integrated system with many necessary factors required to contribute to a successful and efficient decarbonisation plan, such as route, rolling stock, power supply, structures and service operations. Finally, it is not economical to electrify all rail routes, particularly rural routes and alternative fuel systems needs to be developed and supported.

The Scottish Government, through its 'Rail Services Decarbonisation Action Plan – Pathway to 2035' continues to invest in other green technologies and supporting infrastructure to create a resilient green transport infrastructure which meets Scotland's 2045 Net Zero target.