HYDROGEN TRAINS – AN EFFECTIVE ALTERNATIVE TO RAIL ELECTRIFICATION?

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Conclusions

Hydrogen is increasingly being used as an energy vector in transport. The Workshop examined these applications and looked at the use of hydrogen, fuel cells for trains as an alternative to electrification. The Workshop concentrated predominantly on regional trains and drew attendees from the hydrogen and rail industries in roughly equal numbers. Policymakers from different tiers of government were also represented. Some participants came from mainland EU and Canada but the majority of participants were from the UK.

Policy Developments

- Alternative solutions to diesel trains are needed so that the rail sector can comply with energy and environmental policies and decarbonise the rail network.
- The European Commission will continue to encourage cleaner fuels, both through "carrots" such as funding for research (including the Fuel Cell Hydrogen Joint Undertaking which is 50% funded by EU money) and "sticks" such as legislative requirements for clean fuels infrastructure
- The UK Railways Minister has challenged the rail industry to look at the way in which diesel only trains can be removed from operation by 2040 as part of a wide challenge to reduce carbon emissions and improve air quality across the rail sector.
- In response to the Minister's challenge, a Task Force has been set up with Malcolm Brown (Chief Executive, Angel Trains) as Chair. It will report back to the Minister in Autumn 2018.
- There is no one size fits all when the UK Government looks at alternatives to diesel. Considerations such as affordability and Value for Money will be important considerations.
- A number of EU Member States and countries around the World are developing hydrogen strategies and are trialling fuel cell trains. There is great potential for the transfer of learning.

Case Studies

- The Alstom Coradia i-Lint train carried passengers for the first time on Friday 13 April 2018 in Northern Germany and will enter full passenger service in the summer 2018 in Lower Saxony.
- In the Northern Netherlands, a Coradia i-Lint train will operate an off-peak passenger service for a four week period before March 2019. The trial will test the interoperability

between German and Dutch systems. The field trials will look at compatibility, infrastructure and safety.

- A Feasibility Study has been carried out in Toronto and this study concluded that a Hydrail System is technologically and operationally alternative to rail vehicles powered by a conventional overhead catenary system
- The assessment of the full life-cycle costs of a Hydrail System showed that they are equivalent to those of the conventional overhead electrification system. However, this comparison is sensitive to the price differential of electricity at peak and off-peak times.
- A Hydrail System introduces socio-economic benefits for Ontario, with the potential to act as a catalyst for the broader hydrogen economy in the Province
- There are a number of significant challenges in implementing a Hydrail System on the GO Transit network, particularly in relation to developing the rail vehicles with the required performance, reliability and safety characteristics.

Technology and Business Case

- The technology developed in vehicles such as buses and trucks is being adapted for heavy duty transport such as trains.
- The New Fuel project funded by the FCH-JU showed that it is possible to produce large amounts of hydrogen from renewable energy or waste incineration which counts as 30% renewable in Germany. An example of a 15MW electrolyser was given. This could produce 6,700 kg of hydrogen a day which is enough to refuel 30-35 regional trains. Any surplus hydrogen could be used in the gas grid. With waste incineration as the power source, the price of hydrogen was calculated to be less than the current price of diesel. Bringing down the price of hydrogen will be an important factor in ensuring that hydrogen is competitive with other types of fuel.
- Bringing down the price of hydrogen will be a pivotal factor in ensuring that hydrogen is competitive with other types of fuel.
- In Germany, a new emission free Coradia i-Lint train has been designed by Alstom based on a diesel design. In the UK, Alstom is developing alongside Eversholt Rail the conversion of existing Class 321 electric train for deployment by 2021. This should significantly reduce CAPEX costs and facilitate the early introduction of hydrogen propulsion.
- Siemens is developing a fuel cell powered Mireo train to enter service in 2021.

Challenges

- The removal of diesel only trains in the UK by 2040 poses a major challenge for both the hydrogen and rail industries, requiring close co-operation between the sectors.
- Further work needs to be done to develop the Business Case and Market Potential for hydrogen fuel cell trains. This is particularly the case with freight trains and shunting locomotives.
- While hydrogen represents a cost effective alternative to electrification on some routes, there is no single solution to the replacement of diesel trains. Hydrogen trains will be judged alongside other alternative fuels and propulsion systems.
- The financing of the introduction of hydrogen trains and associated infrastructure will be a major challenge and new funding and finance mechanisms need to be established.

- Creating confidence with the funders of rail vehicles who take long term residual value risk is essential in the development of financial mechanisms.
- Technical challenges remain in terms of safety, efficiency and the provision of suitable infrastructure particularly hydrogen production, storage and refuelling infrastructure.

Next Steps

- There are a number of studies that will report later this year and will help inform the move from trials to deployment. The studies include the rail industry's response to the Trains Minister's request for a UK Strategy to replace diesel only trains by 2040. This will be informed by a newly launched study by the Railway Safety and Standards Board (RSSB) on decarbonisation.
- The Shift2Rail/FCH-JU study on the use of fuel cell hydrogen in the railway environment will report towards the end of 2018. This will outline case studies and develop the Business Case and market potential for hydrogen fuel cell trains.
- The latter study could lead to a funding call for hydrogen trains in the Shift2Rail/FCH-JU 2019 Work Programme.
- Modelling of service requirements will demonstrate those UK routes best suited to the introduction of hydrogen.
- Several routes in Northern England appear to be strong candidates for the introduction of hydrogen trains.
- Consideration should be given to undertaking a feasibility study similar to the one in Toronto that would perform economic modelling and prepare a Business Case for the implementation of a Hydrail System for the regions of the UK. This would include the quantification of Green House Gas (GHG) reductions and actions for the supply of hydrogen to support the achievement of these benefits.
- There is scope to explore the commonalities between railway and other heavy duty applications for hydrogen including large trucks, refrigerated vehicles, shipping and port operations. This could enable the aggregation of the requirements of hydrogen infrastructure and fuel cell equipment.