Cynulliad Cenedlaethol Cymru / National Assembly for Wales

Pwyllgor yr Economi, Seilwaith a Sgiliau/ Economy, Infrastructure and Skills Committee

Masnachfraint Rheilffyrdd a chyflwyno Metro / Rail Franchise and the Metro

Ymateb gan Ynni Glan / Evidence from Ynni Glan

1. Ynni Glan welcomes the opportunity to submit a response to the Economy, Infrastructure & Skills Committee's Rail Franchise & The Metro Consultation. These comments address how investment in zero emission hydrogen trains and complementary integrated transport infrastructure can mitigate against conventional infrastructure costs; deliver a clean, modern and resilient rail and integrated transport service; provide Wales-wide economic opportunities as well as delivering value for money; and address urgent social, economic and environmental needs while ensuring the well-being of future generations.

2. Ynni Glan is a clean energy consultancy based in Cardiff which specialises in fuel cells and hydrogen (FCH) technologies. Ynni Glan's main focus is business development in Wales and the UK on behalf of international FCH companies including Doosan, www.doosanfuelcell.com, and SolidPOWER, www.solidpower.com, whose commercial products and services are well-established in other markets. Ynni Glan also generates opportunities for Welsh businesses in the rapidly growing FCH sector.

3. FCH technologies can be applied in the electricity, heat and transport sectors for decarbonisation and clean air goals; extending to integration between all three sectors.

4. Fuel cells are an ultra-clean and efficient form of electricity and heat generation involving the safe, electrochemical reaction between hydrogen and oxygen.

5. Hydrogen is a very versatile clean energy fuel which has global applications. Hydrogen can be sourced from natural gas and other fossil fuels (for a low carbon solution) or from water via electrolysis using renewables as primary energy (for a zero carbon solution). Hydrogen can be both *produced* and *used* locally to keep value in the local economy. Hydrogen can be stored at very large scales and seasonally.

6. In transport, hydrogen is a proven fuel for use in cars, vans, buses, lorries, trams and trains. All the transport modes have hydrogen tanks which supply an on-board fuel cell to generate electricity to drive an electric motor. The only emission is water vapour. Batteries are included to boost torque and performance, especially when accelerating from standstill. Such quick response will suit lines which require a high frequency service to effectively meet growing passenger numbers.

7. Fuel cells involve no combustion and therefore emit near-zero air pollution which is a critical public health issue especially in urban areas and which disproportionally affects poorer communities.

8. Fuel cells are also typically twice as efficient as engines at the scale used in transport. Unlike engines, fuel cells are also very quiet in operation which is a further benefit for deployment in urban areas.

9. Hydrogen infrastructure is modular and, as there is only one "grade" of hydrogen, can serve different transport applications. Strategically sited hydrogen filling stations could serve different transport modes and help achieve the required economies of scale to support investment. Hydrogen infrastructure developments are gaining widespread application in many countries, for example:

   Scotland - Aberdeen City Council has a fleet of 10 hydrogen buses together with hydrogen infrastructure
   http://www.aberdeeninvestlivevisit.co.uk/home/H2-Aberdeen-Summit.aspx

   Germany - By 2023, Germany aims to have 400 hydrogen filling stations.
   https://cleanenergypartnership.de/en/home/

   Scandinavia - Developing a multitude of pathways for hydrogen supply using local resources.
   http://www.scandinavianhydrogen.org

   California - Growing hydrogen infrastructure network including a 2.5MW wind turbine to produce 1,000kg of hydrogen per day for cars and buses.
   https://www.gasworld.com/north-americas-largest-100-renewable-hydrogen-plant-ahead/2011670.article.

10. Germany is introducing a fleet of hydrogen trains to its regional rail network over the next few years. Letters-of-Intent were signed in 2014 between manufacturer Alstom and the German Landers of Lower Saxony, North

Rhine-Westphalia, Baden-Württemberg, and the Public Transportation Authorities of Hesse for the development of a new generation of emission-free trains equipped with fuel cells. Alstom's hydrogen train can reach 140 kmh, with a range of 600 to 800 km and accommodate up to 300 passengers.
http://www.alstom.com/products-services/product-catalogue/rail-systems/trains/products/coradia-ilint-regional-train-/

11. China is introducing hydrogen trams to combat air pollution. Initial details have been published by fuel cell developer Ballard and the first trams are expected to go into service during 2017.
http://ballard.com/about-ballard/newsroom/news-releases/news04071501.aspx

12. The electrification costs of the GWR line from London to Cardiff (and on to Swansea at a yet-to-be-determined date) have ballooned from the original 2013 estimate of £874m to over £2.8bn, http://www.bbc.co.uk/news/uk-england-oxfordshire-37908735. Hydrogen trains can avoid the need for expensive, conventional electrification infrastructure (overhead and unsightly catenary, bridge & tunnel upheavals, new power supplies etc). The runaway GWR costs should serve as a caution to the electrification aims of the Rail Franchise and the Metro; especially given the many tunnel, bridge and topography challenges of laying-down electrification infrastructure within Wales' towns and cities, in rural areas and in the Valleys. Lines on the rail and Metro network may be better suited to hydrogen trains than conventional electrification on the grounds of infrastructure costs, civil engineering upheavals, appearance and power-supply constraints.

13. Hydrogen trains may have a cost premium when compared with conventional electric trains but these costs could be more than compensated for by avoiding expensive electrification infrastructure. i.e taking a whole-systems look at costs. Additionally, social, health and environmental costs should be factored-in to the Rail Franchise & The Metro to include air pollution, carbon emissions and noise pollution; all of which can be alleviated by hydrogen trains in common with conventional electrification.

14. Economic opportunities will result from the local production of hydrogen for transport applications, either from water via renewables or from natural gas (both technologies are feasible although renewables are the greenest and possibly highest value route). The cost of the fuel (i.e. hydrogen) would be largely sunk into capital assets for production, storage and transportation, delivering a payback and an economic opportunity; as opposed to paying for external electricity/diesel over which there is less or no control and which may also be less resilient due to power supply issues or weather-related incidents.

15. Such economic opportunities can help spread the wealth of the Rail Franchise and Metro by sourcing hydrogen from e.g. rural areas which have plentiful wind or solar resource, especially when involving community energy enterprises. Wind and solar developments currently face severe electricity grid constraints which can be by-passed by the production of hydrogen, so releasing the full potential of renewables in Wales and as a model which can be replicated elsewhere.

16. Ynni Glan calculates that should the entire Wales rail network be converted to hydrogen trains, the demand for renewably-sourced hydrogen could be met by the output equivalent to a total installed wind capacity of between 100 - 150MW.

17. To put this figure in context, this total wind capacity is approximately 50% of the Pen y Cymoedd wind farm along the Heads of the Valleys. And the capacity could be distributed around Wales in appropriate clusters to spread the wealth of producing hydrogen; also extending to solar and/or other forms of primary renewable generation.

18. Alternatively, stationary fuel cells such as Doosan's can be configured to produce a slipstream of hydrogen for the trains from their input fuel of natural gas or biogas. The fuel cells can therefore be considered as flexible multi-generators - of power, heat/cooling and hydrogen - at the point of need with very low impact; and be suitable for supplying distributed energy for new low carbon developments adjacent to the Metro and also traction power for conventional electrified rail networks as appropriate.

19. The local production of hydrogen could extend to other applications including: injection into and decarbonisation of the gas grid; dedicated hydrogen grids for communities; electricity grid-balancing services; the sustainable production of ammonia (NH3) for agriculture; and for use in industry (chemicals, refineries, steel etc). The Rail Franchise & Metro opportunity could provide the kick-start and at the scale which is required to propel such complementary hydrogen-based innovations to sustainably

grow Welsh the economy.

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Ymgynghorwyr ar ddatblygu ynni glan o Gaerdydd.
Ynni Glan is a clean energy consultancy based in Cardiff.

Llyfr newydd ar William Grove, y Cymro a ddyfeisiodd y cell tanwydd.
New book on Welsh fuel cell inventor, William Grove.
uwp.co.uk/editions/9781786830043

Alstom's zero emission hydrogen train.

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Supporting information from the University of Birmingham website:

Class 156 Fuel Cell Electric Multiple Unit Feasibility Study

Autonomous Power Options for UK Rolling Stock