Written Evidence Submitted by Propulsion Futures Beacon at the University of Nottingham

(HNZ0021)

Executive Summary

We recommend:

- A more ambitious program for example a Hydrogen Innovation Zone based around a city such as Nottingham, rather than a village.
- Much more detail and ambition on the targets that you wish to achieve. The report is ambiguous whether the 5GW hydrogen is green, blue or grey hydrogen. All sources of hydrogen should have their specific targets.
- The hydrogen economy suffers from uncertainty. It is vital that government shows a strong steer and commitment to support industry to make the investment into these new technologies.

About the University of Nottingham Propulsion Futures Beacon

The University of Nottingham is a key player in developing the propulsion system of the future thorough is propulsion Futures Beacon. Launched in 2017, with an investment of £13M by the University it has over 100 academics involved in combined Scientific and Engineering Programmes that integrate activities and expertise across the University supporting:

- transformative research with impact on the aerospace, automotive and marine industries through the demonstrators, industrial buy-in, partnerships and innovative research.

- People: Developing an enhanced and vibrant early career researcher community through PhDs, PDRAs, targeted Fellowships and key appointments. Growing successive cohorts of new Research Leaders to pioneer ground-breaking investigations, knowledge exchange and teaching initiatives that fall under the remit of Propulsion Futures in subsequent decades.

- State-of-the-art facilities: full scale demonstrators and laboratories to push technology forward, and drivers for collaborative research and growing critical mass in the latest technologies. Such as £20m investment through matched funding from government and industry in 5 -20 MW test facilities for electric propulsion systems unique to the UK. Energy devices labs for new materials for energy scavenging and energy storage. Supporting new materials development to targeted challenges to meet the demands of next generation of propulsion units.

The beacon is willing to provide experts from a wide range of related technologies and in particular to the role of hydrogen and its integration into systems. The beacon has an EPSRC Centre for Doctoral Training (CDT) for sustainable hydrogen and a research accelerator building where prototypes and demonstrator hydrogen stores are built through experience of an established hydrogen group. In addition, the planned

integration of these hydrogen demonstrators via fuel cells and electric machines in the new power electronics and machines centre next door offers a important facility. The University is also looking at other important hydrogen carriers such as ammonia for marine and heavy duties vehicles and the conversion of engines. In addition, the Nottingham Energy Institute is linking partnerships with local and regional stakeholders.

Persons contributing to this report

Prof David Grant, Director of Propulsion Futures Beacon, Head of Advanced Materials

Prof Frank Kirkland, Professor of Technology Innovation for Aircraft Propulsion

Dr Simon Gerrard, Corporate Partnerships Senior Executive (and main contact point).

Question 1: The suitability of the Government's announced plans for "Driving the Growth of Low Carbon Hydrogen"

1.1 The announced plan is too vague. The *"5GW of low carbon hydrogen production capacity by 2030"* is worrying in that it does not specify what percentage will be green, blue or grey hydrogen. The type of hydrogen generation is very significant, not least as it links to levels of CO_2 emissions. Too great a focus on grey hydrogen, where CO_2 is emitted, instead of blue or green hydrogen where CO_2 is stored or not generated is a very important consideration for the UK's net-zero 2050 target. The usage of the word *"capacity"* also gives too much wriggle room since you can have 5GW capacity but still deliver 0GW. We need targets of delivered output for grey, blue and green hydrogen.

1.2 **The policy needs to state they will expand the industrial base and be less vague.** For example, there is only one UK electrolyser supplier, ITM who are currently building a factory to deliver 1GW per annum. What plans are there to increase capacity and should the UK have more than one supplier.

1.3 Is this linked to the target *"2025 We hope to see 1 GW of Hydrogen production capacity".* Is this electrolyser from green energy such as wind or is this blue or grey hydrogen from steam reforming? Again, there is too much wriggle room in this, and we cannot *"hope".* We need to deliver.

1.4 Likewise, regarding hydrogen and heating "lower carbon heating and cooking with no change in experience for domestic consumers through hydrogen blends and reducing the emissions of the gas used by up to 7%". This "reducing the emissions of the gas" is too vague. Which gas, which emissions? Does "no change in experience" mean no conversion of cookers and boilers? What plans for conversions. **What targets of blends?** It is all too vague.

1.5 What plans to use the gas network as a hydrogen store and increase the hydrogen content to the extent that you use the gas grid to transport hydrogen around the country?

1.6 How will hydrogen be purified from this route suitable for fuel cells or are you planning to burn the hydrogen in the gas network?

1.7 The target *"2025 Will support industry to begin a large village hydrogen heating trial, and set out plans for a possible pilot hydrogen town before the end of the decade"* is welcome but too small a scale delivering to just heating requirements of 400 homes in a village.

1.8 We propose a Nottingham Hydrogen Innovation Zone: We suggest hydrogen should be integrated with not just one city but two. Namely Nottingham and Derby. It is

perfectly situated for the trial with the largest goods airport in the country (East Midlands Airport), HS2 perfectly bisects the cities, conversion of the Uniper site where the current 2GW coal fired power station is on Ratcliffe on Soar and the site is ripe for redevelopment. Integration hydrogen for industry, homes and transport would be the ambition. The University of Nottingham is already exploring policy papers on this which will be delivered in the next few months and we will work closely with Nottingham City Council, Nottinghamshire County Council and Derby augmenting and solidifying links through a Nottingham Energy Institute (NEI). In addition, we are part of one of the largest Local Enterprise Partnership's (LEP) in the country namely Derby and Derbyshire, Nottingham and Nottinghamshire (D2N2).

1.9 The advantage of this proposal compared with the suggested Hydrogen village trial and then possibly a town is the range of challenges it addresses. It would be difficult for a village trial to address transport and industrial applications so would probably only focus on domestic heating. A large-scale experiment with innovation zone would expose a range of issues and have a higher volume to supply justifying the significant infrastructure required. It is essential that to encourage retraining and skills development sufficient job opportunities are created; only a large-scale trial would be attractive and provide a critical mass for training providers.

Question 2: The progress of recent and ongoing trials of hydrogen in the UK and abroad, and the next steps to most effectively build on this progress

[Answer in numbered paragraphs]

NO ANSWER

Question 3: The engineering and commercial challenges associated with using hydrogen as a fuel, including production, storage, distribution and metrology, and how the Government could best address these

3.1 Breaking down the 5GW target for hydrogen production into what can be practically sustained for each of the production routes for grey, blue and green hydrogen will allow industry to invest.

3.2 Maximising production of green hydrogen from excess wind and integrating that into local and regional communities' infrastructure and gas networks.

3.3 Low pressure storage (ca. 5 -30 bar) using low cost metal hydrides with superior volumetric density allowing or compact safe stores for areas for targeted refuelling stations and built up areas which can be fed directly into fuel cells, gas networks or compressed to higher pressures when needed for transport.

Question 4: The infrastructure that hydrogen as a Net Zero fuel will require in the short- and longer-term, and any associated risks and opportunities;

[Answer in numbered paragraphs]

No answer

Question 5: Cost-benefit analysis of using hydrogen to meet Net Zero as well as the potential environmental impact of technologies required for its widespread use

[Answer in numbered paragraphs]

No answer

Question 6: The relative advantages and disadvantages of hydrogen compared to other low-carbon options (such as electrification or heat networks), the applications for which hydrogen should be prioritised and why, and how any uncertainty in the optimal technology should be managed

6.1 The government must take uncertainty out of hydrogen deployment through investment in infrastructure and incentives that will encourage industry to adopt rather than wait otherwise we will be left behind in the hydrogen economy.

6.2 Hydrogen offers flexibility and another energy carrier that can complement a resilient integrated energy system. The challenge for the government is to take the uncertainty away to build an integrated hydrogen network that can deliver hydrogen for both decarbonising heating and targeted transport such as heavy-duty trucks and fleet vehicles, niche areas such as forklifts and ground transport at airports, remote rail and marine. Where fast replenishing of hydrogen and increased range is advantageous over slower recharging and heavier battery technology.

6.3 For the transport sector a plan relating to cost and availability of hydrogen needs to be established. This supply will initially be to a limited number of locations but this need not be a problem for specific applications. A clear focus where decarbonisation with alternatives are difficult e.g., Heavy Goods Vehicles, Buses and Aviation should be prioritised as these will be most likely to develop further. In step with this investment is required in fuel cell technology to provide propulsion power, either stand-alone or more likely as part of hybrid systems. An opportunity exists for a transitional solution by adapting internal combustion engines with specialized ignition systems; this could accelerate decarbonisation and provide an earlier market for hydrogen. The overall strategy for Investment in Propulsion Systems should be part of the plan.

6.4 Ammonia as a vector to transport hydrogen has many potential benefits in terms storage and could play a role as a fuel in its own right e.g. for shipping. It is therefore potentially complementary to and/or a key enabler to a hydrogen economy. As an example, it is planned to ship ammonia from Western Australia to Singapore and utilise for various applications. An ammonia strategy should form part of the Ten Point Plan

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