Written Evidence Submitted by the Scottish Hydrogen & Fuel Cell Association (HNZ0058)

The Scottish Hydrogen & Fuel Cell Association welcomes this Hydrogen Inquiry into the role of hydrogen in achieving Net Zero by the UK Parliament Science & Technology Committee.

The Scottish Hydrogen and Fuel Cell Association (SHFCA) was formed in 2004 and is recognised as one of the most proactive hydrogen & fuel cell industry associations in Europe. SHFCA has over 120 members, with an increasing number from across the UK, in Europe, and from overseas who want to become more involved with development projects, commercial activities, and research & innovation in Scotland.

Our SHFCA members include Abbott Risk Consulting, Abercus, Aberdeen City Council, Adrian Wilson, Almaas Technologies, Anderson Strathern LLP, Aquatera, Arcola, Areva H2Gen, Arup, ATC (Energy), Ballard Power Systems, BOC Linde, Bramble Energy Ltd, Bright Green Hydrogen, British Geological Survey, Brockwell Energy, Calvera, Ceimig, Cenex, Chesterfield Special Cylinders, Cloffrickford Renewable Energy, CMAL, COFTEC, Comhairle nan Eilean Siar, Connected Places Catapult, Clean Power Hydrogen Group, Cummins Europe, DAK Green Energy, Delta-EE, Deme Concessions, DNV GL, Doosan, DS Consulting GmbH, Dundee City Council, E4tech, Edinburgh City Council, Edinburgh Napier University, Element Energy, Ellis IP, European Marine Energy Centre, Energy Skills Partnership, Energy Technology Centre, Enertek International, ENOCELL, ERM, European Policy Solutions, Expo Technologies, Express Pipework System, Faun Zoeller UK, Fife Council, Frazer-Nash Consultancy, Fuel Cell Systems, Gillespie Macandrew, Glasgow City Council, GM Flow, Green Hydrogen Consulting, Green Knowledge, GreenPower Developments, Hartmann Valves & Wellheads, Haskel Europe, Haskoning DHV, Highlands & Islands Enterprise, Highlands Council, Hillend Engineering, Hydrenor, iPower Energy, ITM Power, JCE Energy Ltd, Jonathan Lewis Consulting, Kerry-Ann Adamson, Kiwa UK, Locogen, Logan Energy, Loughborough University, Marubeni Europower Ltd, Microcab, Nanosun, Nedstack B.V., Nel Hydrogen, Northern Valve & Fitting Company Ltd, Orkney Islands Council, Pale Blue Dot, Perth & Kinross Council, Phoenix Natural Gas, PHY Consulting, Pivotal Management Consulting, PlusZero Limited, Port of Cromarty Firth, Protium Energy, Protium Green Solutions, Proton Motor GmbH, PURE Energy Centre, RDS Energy, Risktec Solutions, Robert Gordon University, Scottish Cities Alliance, Scottish Enterprise, ScottishPower, SGN, Shetland Islands Council, Siggi Huegemann, SSE, Stirling Council, Stream Marine Training, Systeng Consulting, Taylor Construction Plant, Toyota Motor GB, Trilemma Consulting, TUV SUD, ULEMCO Ltd, University College London, University of Aberdeen, University of Edinburgh, University of Heriot-Watt, University of St Andrews, University of Strathclyde, Vivarail, Water to Water, and Wood.

Executive Summary

The last five years has seen a transformation in the awareness for hydrogen as a clean energy vector for the decarbonisation of heat, transport, and industry. For many years our SHFCA events and member networking activities have built up understanding and connections which have helped us to identify and progress opportunities for the development and deployment of hydrogen and fuel cell technologies in Scotland. SHFCA has also engaged with cities and communities across Scotland to support the locations and develop projects which are now leading the way with a 'learning by doing' approach.

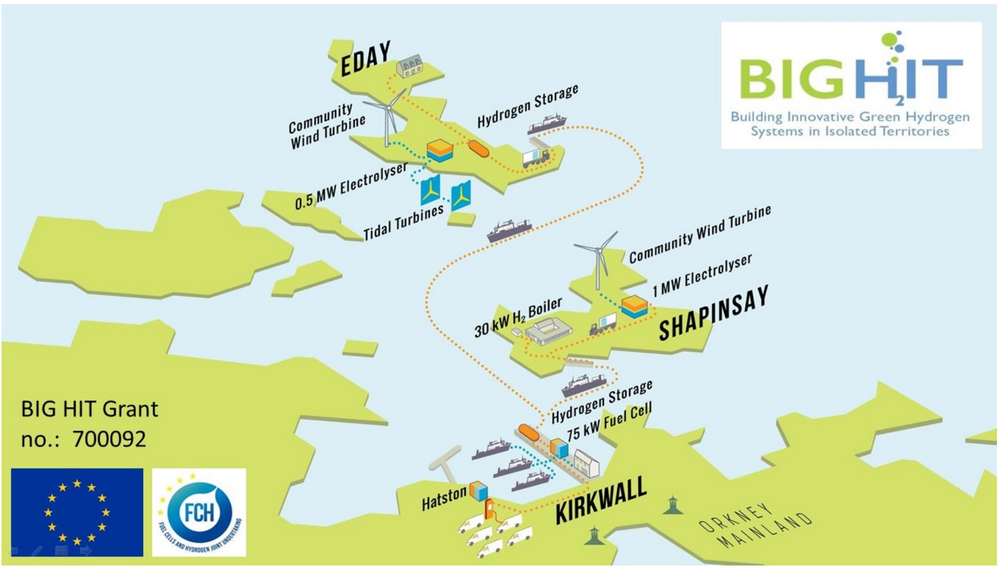
Hydrogen can help reduce the UK's carbon emissions in a timely and cost-effective way, supporting the UK's goal to be Net Zero by 2050 and Scotland's target to achieve Net Zero by 2045. Global atmospheric CO_2 levels reached a record high of 417ppm in May 2020, which together with record high average temperatures for May 2020 clearly shows the increasing impacts of GHG emissions and climate change. There is an overriding need for urgent action to reduce GHG emissions.

Energy production and use account for more than 75% of our greenhouse gas emissions. Significant progress has already been made in Scotland with decarbonising electricity production, and by 2019 the equivalent of 89% of Scotland's gross electricity consumption was from renewables. Progress towards meeting Scotland's renewable energy target is however much slower, with renewable energy at only 20.9% of total energy demand in 2018. Fossil fuels remain predominant in end-use sectors such as transport, industry and buildings. Hydrogen will play a key role in these hard-to-abate sectors where other alternatives might not be feasible or have higher costs, such as heavy-duty or long-range transport and energy-intensive industrial processes.

In December 2017 the Scottish Government released their first Energy Strategy, The Future of Energy in Scotland, which clearly identified the potential for hydrogen as a significant part of fully decarbonised energy system. In May 2019 Scotland announced the ambition to become Net Zero by 2045, and in December 2020 released the updated Climate Plan and the Hydrogen Policy Statement which includes the ambition for 5GW of low carbon hydrogen production to be operational in Scotland by 2030.

This clear and consistent policy approach reinforces Scotland as one of the leading locations in Europe for deployment of hydrogen and fuel cell solutions into developing low carbon energy systems. Recent highlights include the Ofgem approval in November 2020 of the £30M SGN H100 Fife project in Methil, which includes £6.9M of Scottish Government funding, together with other key initiatives such as the expanding hydrogen bus fleet in Aberdeen, hydrogen vehicles in Glasgow, a hydrogen train for COP26, and numerous innovative local energy system projects in the Orkney Islands and the Western Isles.

Innovative hydrogen projects in Orkney such as Surf 'n' Turf, BIG HIT, ITEG, HyDime, ReFlex, HySeas III, HySpirits, and HyFlyer/HyFlyer2 are all helping to build up expertise, skills, and knowledge. This will be key to enabling the replication of hydrogen clusters and the scaling up of localised hydrogen production and demand throughout the UK. The Orkney Islands have been widely recognised as exemplar 'energy islands' which are host for a wide portfolio of renewables and smart local energy projects, including many that involve the use of green hydrogen produced from constrained renewables. One of the important aspects for these projects has been to develop both the hydrogen supply and demand which creates the local market, as well as the infrastructure for transportation of hydrogen.



'Learning by Doing' in Orkney has built a £65M portfolio of innovative H2 projects

Scotland is host to many important demonstration and deployment projects including the Aberdeen hydrogen buses and the largest fleet of hydrogen vehicles outside London. North-east Scotland, particularly at risk from the recent oil & gas sector downturn, are benefiting from a £62M Energy Transition Fund. This fund is supporting industry led initiatives such as the IPCEI Acorn project at St Fergus, which has developed one of the most viable proposals in Europe for H2 production with CCUS by the mid 2020's. These energy transition projects in Scotland are leading the way with a 'learning by doing' approach and are willing to share best practice and experience.

The next five years will require a clear and consistent strategy from the UK government and policy makers if Scotland is to deliver the climate plan target for a 75% reduction in GHG emissions by 2030, which the UK Committee on Climate Change see as essential to the delivery of the Net Zero targets for Scotland by 2045. The combined use of blue and green hydrogen may be required to achieve the scale of hydrogen supply needed to deliver Scotland's 2030 target for a 75% reduction of GHG emissions from the 1990 baseline.

The CCC has also stated that achieving Scotland's 2045 Net Zero target will be essential if the UK is to deliver Net Zero by 2050.

Submission

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

- the focus, scale and timescales of the proposed measures;
- how the proposed measures—and any other recommended measures—could best be co-ordinated;
- the dependency of the Government's proposed plans on carbon capture and storage, any risks associated with this and how any risks should be mitigated; and
- potential business models that could attract private investment and stimulate widespread adoption of hydrogen as a Net Zero fuel;

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;

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;

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

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; and

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.

1. The suitability of the UK Government's announced plans for "Driving the Growth of Low Carbon Hydrogen", including:

The next five years will require a clear and consistent strategy from the UK government and policy makers if we are to deliver the climate plan target for a 75% reduction in GHG emissions by 2030, which the UK Committee on Climate Change see as essential to the delivery of the Net Zero targets for Scotland by 2045 and for the UK by 2050.

The safe production of hydrogen at scale with transportation and end use for industry, commercial, and domestic applications is critical to its adoption and success. SHFCA has recognised the overarching importance of safety, and in 2019 we established the Hydrogen Safety Forum which is also open to non-members with an interest in safety. Hydrogen has the ability to decarbonise large sections of the UK economy, and the approach to safety regulation needs to recognise the potentially wide range of applications which currently crosses several government departments and regulatory bodies.

1a. The focus, scale and timescales of the proposed measures

Hydrogen can help the UK recovery in a fair way from COVID-19's economic impact. An effective hydrogen strategy can strengthen the production and use of clean hydrogen, focusing on the mainstreaming of hydrogen with the repurposing of existing gas transmission and distribution infrastructure. This same strategy can also enable the transfer of jobs and skills from existing high carbon emitting industries to stimulate the rapid growth of a low carbon economy throughout the UK.

In June 2020 the International Energy Agency (IEA) released a Sustainable Recovery Plan for actions that can be taken over the next three years. Their Sustainable Recovery Plan identifies a clear role for hydrogen technologies, with hydrogen is a versatile energy carrier that can be produced from fossil and low-carbon sources. This IEA Sustainable Recovery Plan shows how suitable government policies can provides significant boost to jobs and growth. It is possible to simultaneously spur economic growth, create millions of jobs and rapidly reduce GHG emissions. The focus for governments should be to deliver resilient energy projects that are shovel-ready, and fully meet the requirements for sustainable investment.

1b. How the proposed measures—and any other recommended measures—could best be co-ordinated

A combination of scaled up hydrogen production, together with the enabling hydrogen infrastructure to deliver this low carbon energy where and when needed, can provide the UK with the lasting security of energy supplies for a Net Zero future.

The UK's hydrogen strategy can also be part of an integrated Just Transition approach, such as that currently being developed in Scotland, and provide trans-generational benefits from the legacy of hydrogen production & demand.

1c. The dependency of the Government's proposed plans on carbon capture and storage, any risks associated with this and how any risks should be mitigated

The following comments are focussed on the use of CCS with steam methane reformers, or any other similar process for the production of 'blue hydrogen' from fossil fuels which might use CCS. In addition to the frequently discussed aspects of cost, performance, and long term storage integrity there are two further risks to consider, a climate risk and a finance risk.

There is a climate risk from feedstock production emissions. GHG emissions have global impacts, need to consider full scope GHG emissions, and not just the emissions from the hydrogen production unit. With blue hydrogen the focus has been on the unabated process emissions: with capture levels of 90% often quoted these unabated emissions are relatively small at 10%. There is however a need to take into account the upstream emissions from the production of the fossil fuel feedstock, which are unabated emissions and can vary widely according to the source and subsequent processing such as liquefaction, as well as the distance transported from point of production to point of use. To illustrate the significance, production emissions associated with imported LNG from shale gas are over 6 times those associated with UKCS natural gas (OGA, 2020). Blue hydrogen produced from imported LNG will have a much higher associated carbon footprint, and may not deliver a significant overall reduction in global greenhouse gas emissions. In a worst case scenario H2 production from imported shale gas LNG might only achieve a 25% reduction in GHG emissions compared to using unabated UKCS natural gas.

There is a finance risk for access to sufficient capital at suitable rates for blue hydrogen projects. There is now a strong ESG trend developing in UK and global markets, and as a result investors showing a clear preference for fully sustainable / renewable energy investments. In November 2020 the BSI published PAS 7341 on Sustainable Investment and earlier in 2020 the EU released their comprehensive Sustainable Investment Taxonomy which is establishing clear performance thresholds for investors to use when selecting investments.

Blue hydrogen projects using 'carbon heavy' LNG feedstock may not satisfy taxonomy thresholds. This does not mean these projects will not be able to access private capital, but availability and rates of return could become significantly less attractive. By contrast, other types of CCS projects, such as BECCS or direct air capture CCS, may still be very attractive to sustainable investors.

1d. Potential business models that could attract private investment and stimulate widespread adoption of hydrogen as a Net Zero fuel

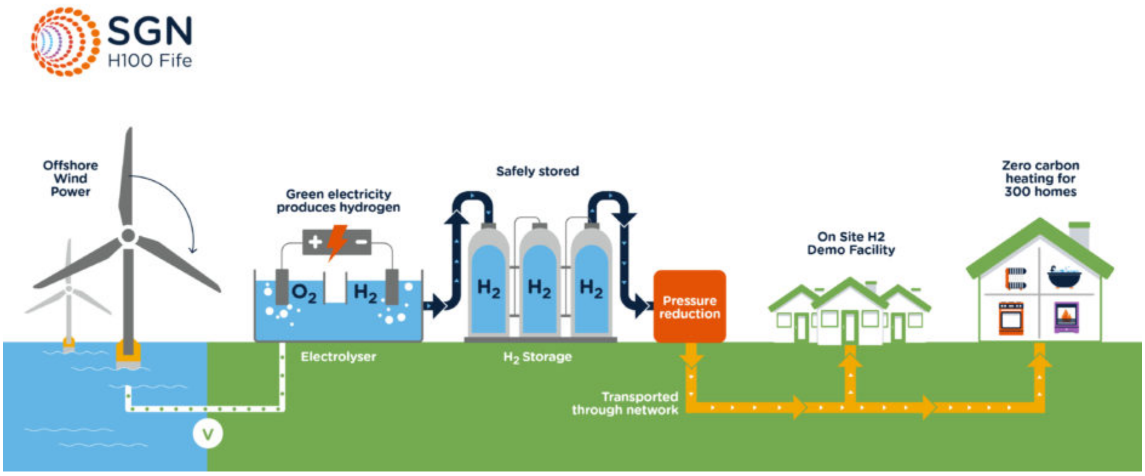
There is now a strong ESG trend developing in UK and global markets, and as a result investors showing a clear preference for fully sustainable / renewable energy investments. In November 2020 the BSI published PAS 7341 on Sustainable Investment and earlier in 2020 the EU released their comprehensive Sustainable Investment Taxonomy which is establishing clear performance thresholds for investors to use when selecting investments.

The production of 'green hydrogen' from sustainable energy sources such as onshore & offshore wind, as well as solar PV, will meet current and foreseeable future requirements for a very low carbon footprint. As the European country with the largest offshore wind capacity and an extensive gas network, the UK has a comparative advantage in distributing and handling gases and producing 'green hydrogen' via electrolysis using electricity generated from offshore wind. Scotland's renewable electricity generation potential from offshore wind has recently been estimated at more than 735GW by the Offshore Renewable Energy Catapult.

The Scottish Hydrogen Assessment project identified the contribution to Net Zero targets from the production of hydrogen from offshore wind in Scottish waters for decarbonising homes, transport, and industry. Moving and storing renewable energy as hydrogen will allow more remote and larger offshore wind projects to be financially viable, enabling the wider uptake of hydrogen across all applications. Hydrogen exports could also make a positive contribution to our balance of trade.

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;

The UK now has a significant opportunity to take a lead on the deployment of hydrogen for the large scale decarbonisation of domestic, commercial, and industrial heat demand, building on the early lead from projects such as Leeds H21, HyDeploy, and SGN's Opening Up the Gas Networks project involving 1100 households in Oban. A combination of technical progress with hydrogen appliances, along with consumer acceptance and positive behaviours will be critical to the successful deployment of hydrogen for heat.



The SGN H100 Fife project will demonstrate safe deployment of H2 for domestic consumers

Projects such as the SGN H100 Fife project will build the UK's first 100% hydrogen network for supply of green hydrogen to households and businesses in Methil. H100 Fife is a critical path project for decarbonising heat the UK (watch the 2 minute H100 video clip here: https://www.youtube.com/embed/z7rlrrxBte8). This H100 Fife project will deploy 100% hydrogen heat in 300 domestic properties, providing critical evidence on the suitability and practical insights for the UK-wide deployment of 100% hydrogen for heating as a key enabler for meeting Net Zero targets.

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;

The UK can benefit from an enhanced collaboration on hydrogen with its international partners, advancing technology breakthroughs with market deployment, together with the development of a well-functioning hydrogen market and corresponding cost-efficient hydrogen transportation infrastructure such as pipelines.

The rapid scaling up of low carbon hydrogen can benefit from shared infrastructure and resources, using physical assets as well as the human capital from the existing oil & gas sector to accelerate the clean energy transition. The pathway to scale and realising the full potential of hydrogen can only be achieved by maintaining a reasonable balance between supply and demand. Effective Government support for hydrogen will recognise this virtuous circle of supply, demand, and economies of scale.

Any lack of standardisation in areas such as hydrogen metrology and certification of hydrogen equipment will lead to significant future barriers for trade and commerce. The issues of post-Brexit accreditation for equipment certification are already causing issues, and this needs to be addressed urgently.

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

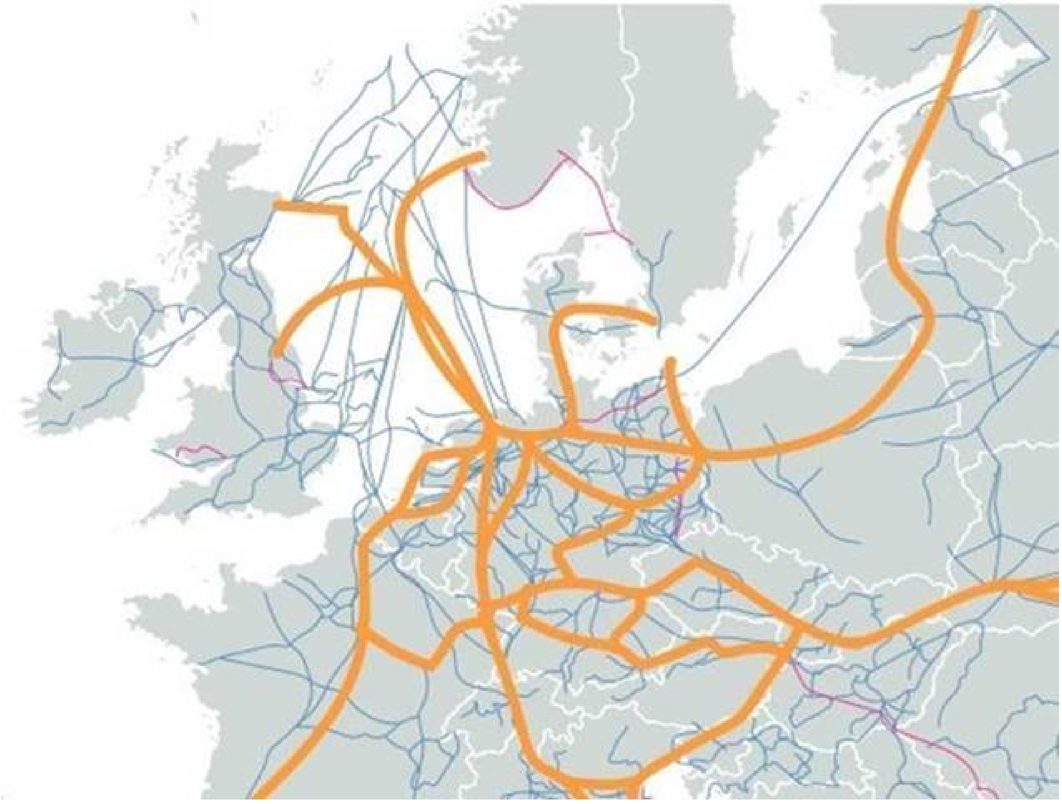
This question about infrastructure should be considered from a local, national, and international perspective. It is also important to take into account the complimentary opportunities from the intelligent use of power transmission/distribution and hydrogen transmission/distribution networks.

The importance of understanding the roles of power and gas distribution networks was highlighted in the Scottish Energy Strategy of December 2017, and one of the first actions undertaken as a result was the 2030 Energy Networks Vision published in March 2019. Based on Scotland's energy strategy, this document looked at the ways in which Scotland's electricity and gas network infrastructure will continue to support the energy transition. The main conclusion was that the most cost effective approach for achieving a decarbonised energy system was through intelligent use of both the power and the gas networks.

The optimum infrastructure for hydrogen will be determined largely by the quantities being moved, and by the distance between source and destination. Gas transmission pipelines and gas distribution networks such as those already used natural gas will play a key role for hydrogen. With the gas distribution networks it is very likely that the existing network can be repurposed to 100% hydrogen, and this could be carried out on a sector by sector approach as used previously for the UK towns gas to natural gas conversion of the 60's and 70's. Transmission pipelines may be more challenging, and some natural gas transmission may need to be retained through to the 2040's.

The deployment of new long distance hydrogen transmission pipelines across the UK may also be achieved through the use of offshore connectors, similar to the approach used by the UK power grids for the east coast and west coast HVDC bootstraps. Although the lengths of offshore pipelines may be more than onshore, there could be significant benefits in terms of timescale for offshore permitting and installation as compared to onshore.

The following schematic map of the European Transnational Hydrogen Backbone is included as Figure 7 in Hydrogen Europe's recently published 2x40GW Green H2 Initiative paper and shows UK land connection points at St Fergus, just north of Aberdeen, as well as Teesside:



Hydrogen Interconnection (yellow) with natural gas infrastructure (blue and red lines)

These pipelines, if deployed at suitable size, would be able to carry very large volumes of hydrogen gas over very long distances. See for example the 600 mile long Air Products Texas-Louisiana hydrogen pipeline, which is onshore, but the same approach would hold offshore. Hydrogen transport cost by pipeline are about 10-20 times cheaper than electricity transport cost by a cable.

A fundamental difference between electricity transport by cables and hydrogen transport by pipelines is the capacity of the infrastructure. An electricity transport cable typically has a capacity between 1-2 GW, while a hydrogen pipeline can have a capacity between 15 and 30 GW. These large pipelines also offer a significant level of energy storage capacity as linepack.

The international dimension of hydrogen infrastructure is of critical importance, with wider geopolitical implications for security of supply and balance of trade. For this reason it will be important to maintain activity at a global level on standardisation of hydrogen quality.

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;

All of the commercially produced hydrogen in the UK is currently from unabated steam methane reformation of fossil fuels such as natural gas. Clean hydrogen (either blue or green) is currently a more expensive alternative than current 'grey' hydrogen supply. Whilst the future cost trajectory for clean hydrogen is looking attractive, there will need to be interim incentives or subsidy schemes to ensure projects are sufficiently bankable for investors, in addition to stable policy frameworks.

Countries such as Canada are already exploring the regulations and policies to support the rapid deployment of clean hydrogen. The Canadian government is boosting the carbon price to $170/tonne by 2030, which should incentivise low carbon hydrogen use by heavy industrial emitters for processing. Canada is also implementing a Clean Fuel Standard which requires a lowering of carbon content in liquid fuels. This will drive low-carbon hydrogen use in refining, plus there are credits for hydrogen as a fuel together with zero emission vehicle mandates in two Canadian provinces (note: SHFCA has reciprocal MoUs in place with over 30 similar associations, including the Canadian Hydrogen & Fuel Cell Association).

Without a solid business case, real change won't happen – and this now requires bold and creative policies to level the playing field and facilitate the clean energy transition.

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

Any prioritisation for hydrogen applications needs to be considered very carefully, and should be made on the basis of the contribution made towards achieving 2030 and Net Zero targets at the overall least cost.

A comparison of the relative advantages and disadvantages of hydrogen compared to other low-carbon options will only provide limited insights. These discussions often take a theoretical approach based on nominal efficiencies of the individual components. This academic approach does have merit but can often overlook many of the factors which are vitally important to the end user. By considering the end user requirements it is often possible to answer the wider question of which technology is best positioned to displace incumbent fossil fuel technologies with high GHG emissions.

For example in transport, the conversion of logistics and commercial fleets to zero emissions has to meet key operational requirements. This would include aspects such as vehicle reliability, availability and speed of recharging or refuelling, and the ability to carry a suitable payload over the required distance. For urban transport applications the availability or ease of access to recharging or refuelling along with cost will be a key factor in any decision to change from the incumbent technology.

For a domestic heating application the thermal characteristics of the building together with the user lifestyle and preferences will play a key part in the decision making process for making (or not making) a significant investment and/or disruption when changing to a low carbon heat alternative.

There are also views expressed such as 'burning hydrogen is a crime against thermodynamics', but whilst the use of hydrogen fuel cells has key advantages in reducing GHG emissions and air pollution, the use of combustion technologies will offer a fast track approach to achieving large scale GHG emissions reduction in heat, power, and industry applications. In making all these comparisons it is important to avoid the search for the perfect answer getting in the way of making pragmatic and effective decisions.

(January 2021)