Written Evidence Submitted by the Department for Business, Energy and Industrial Strategy

(HNZ0090)

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;

BEIS response

Focus, scale and timescales

- There is broad consensus that low carbon hydrogen will be essential to achieving net zero by 2050, with potential to help decarbonise vital UK industry sectors and provide flexible deployment across heat, power and transport.
- The CCC's Sixth Carbon Budget Advice, published in December, considered hydrogen to be a critical technology to meet net zero, particularly in hard-to-decarbonise sectors such as shipping and heavy industry.
- The Prime Minister's Ten Point Plan for a Green Industrial revolution sets out Government's aim, working alongside partners in industry, for 5GW of low carbon hydrogen production capacity by 2030 which could see the UK benefit from around 8,000 jobs across our industrial heartlands and beyond. As we progress towards this ambition, we would hope to see around 1GW of hydrogen production capacity by 2025.
- This is a clear signal to developers, investors, and the broader supply chain, that the UK intends to be at the forefront of establishing hydrogen as a key route to decarbonisation and clean growth.
- Development of a hydrogen strategy is well-underway and a top priority in BEIS and across government – it will be published in the first half of this year.
- We will invest in low carbon hydrogen production with a **£240m Net-Zero Hydrogen Fund (NZHF)** confirmed out to 2025, intended to support both CCUS enabled (blue) hydrogen and electrolytic (green) hydrogen production. Support for different production methods will be an important part of future proofing our energy mix and help ensure security of supply.

Coordination

- BEIS established the Hydrogen Advisory Council in July 2020 as a joint Government-Industry forum to identify and promote concrete actions required to enable the supply of low carbon hydrogen at scale for use across the energy system.

- BEIS officials work across government departments, through formal governance and informal channels, to ensure we work effectively to develop new policy to help bring forward the technologies and supply chain we will need to grow the UK hydrogen economy.

CCUS

- Low carbon hydrogen at scale will be enabled in the near term by carbon capture and storage infrastructure. The Ten Point Plan, Energy White Paper and National Infrastructure Strategy set out the importance of CCUS in reaching net zero. To support deployment the government has allocated up to £1 billion through creation of the CCUS Infrastructure Fund.
- Developing these two new industries together in 'SuperPlaces' will kick start wider decarbonisation of heavy industry, heavy transport, power and over time potentially heating. We will also support scale up of green hydrogen, so that hydrogen production can take advantage of our renewable resources.
- This twin-track approach to policy development will enable production to be brought forward at the necessary scale during the 2020s, to grow the supply chain and build confidence in the sector, whilst scaling up green hydrogen which is likely to dominate the global market in the long term. The levels of green and blue hydrogen production that make up the 5GW will depend on market developments in the 2020s.

Business models

- We are progressing options for low carbon hydrogen business models. In doing so, we are considering the wider value chain, including production, demand and distribution.
- We recognise support is required for hydrogen to be deployed where its costs are currently higher than a high carbon counterfactual. In August last year we published a report by Frontier Economics looking at different business models to incentivise investment in large scale hydrogen production. In December last year we published an update on our approach to hydrogen business models and an update on policy development. We are continuing to engage with industry through the Hydrogen Business Models Expert Group and individually.

We are aiming to:

- consult on a preferred business model in 2021;
- set out details in 2021 on the provision of a revenue mechanism to fund our business models and stimulate private sector investment into low carbon hydrogen projects; and
- finalise a hydrogen business model in 2022.

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

BEIS response

BEIS is supporting hydrogen heating trials and their progress is outlined below:

- The 10 Point Plan announced support for trialling hydrogen heating in homes starting with a Hydrogen Neighbourhood in 2023, moving to a Hydrogen Village by 2025, with an aim for a Hydrogen Town before the end of the decade.

- A first trial of hydrogen heating, the H100 Fife project supplying 300 homes in Fife, was announced at the end of November. Construction is scheduled to begin in 2021.
- BEIS will be looking to the gas industry together with local authorities and communities to put forward proposals for further hydrogen heating trials, and a possible hydrogen town. We will be publishing details on this in due course.

Hy4heat Programme

- A BEIS Energy Innovation Programme project focusing on 100% hydrogen to establish if it is technically possible, safe and convenient to replace natural gas (methane) with hydrogen in residential and commercial buildings and gas appliances.
- Hy4Heat has produced significant evidence to support a hydrogen trial safety case. Safety evidence is being reviewed impartially by the HSE and will form the basis of safety work for future hydrogen trials.
- Hy4Heat has funded appliance development for a range of domestic and commercial appliances which could be used in 100% hydrogen trials – these include boilers, cookers, fires and hydrogen smart meters.
- It will also support the development of a fixed demonstration facility ('Hy4House') to demonstrate domestic hydrogen appliances and meters in a realistic domestic setting and gather evidence of the consumer interaction.
- Hy4Heat intends to showcase appliances developed at COP26 and demonstrate the pathway towards future hydrogen village and town trials.
- Hydrogen blending is being trialled at the University of Keele in the 'HyDeploy' project. HyDeploy is funded by Ofgem's Gas Network Innovation Competition.
- It is now successively mixing up to 20% of hydrogen into the university's gas grid and has demonstrated that it can be used by existing gas appliances without modifying the burners. HyDeploy are currently moving to a larger demonstration on public networks. With HSE approval, and success at Keele, these phases will go ahead in the early 2020s.
- The 2020 Spending Review committed over £280 million in 2021-22 for Net Zero R&D, critically including an £81 million multi-year commitment for the pioneering of hydrogen heating trials. £200 million was also committed for the Net Zero Innovation Portfolio (NZIP).

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.

BEIS response

Engineering challenges

- Decarbonising across the UK energy system – power, heat, transport – with its seasonal demand swings is a significant challenge. Solutions and technology that deliver flexibility will be highly valuable to the low-carbon transition.
- Government is funding a range of projects exploring the potential of low carbon

hydrogen production and use across the value chain. The potential for hydrogen to support a decarbonised energy system is significant. The UK is leading the way in developing production technologies and proving the viability of hydrogen use in industry and the home. The BEIS Energy Innovation Programme (EIP) aims to accelerate the commercialisation of innovative clean energy technologies and processes into the 2020s and 2030s.

- Blue hydrogen production technologies are technically proven and available; the engineering challenge lies in demonstrating the different parts of the system, hydrogen production and CCUS, and increasing efficiency and carbon capture rates. For green hydrogen production, one of the key engineering challenges is the scale up of hydrogen production from electrolysis. These challenges are being addressed by the £33m Low Carbon Hydrogen Supply Competition which supports the development of a range of novel blue and green hydrogen production technologies, such as ITM Power's Gigastack project. ITM Power are developers of world's largest electrolyser manufacturing facility, being built in the UK. We are also supporting Johnson Matthey through the Acorn and HyNet projects.
- The distribution of hydrogen poses engineering challenges, namely understanding if existing gas transmission and distribution infrastructure can be safely used to transport hydrogen, and the requirement for new infrastructure. These questions are under investigation through projects such as H21, H100, and HyNTS.
- The diversity of potential end users of hydrogen is another engineering challenge. To address part of this challenge, we are supporting the development of prototype 'hydrogen-ready' boilers through the £25m BEIS Hy4Heat programme; and world first trials of hydrogen use in a range of industrial sectors through the £20m Industrial Fuel Switching Competition.
- In terms of metering, the Hy4Heat programme has worked with IGEM to create reference standards for the use of hydrogen. This standard covers the different properties of hydrogen and includes practical considerations for the impact on metering. The Hy4Heat programme has two projects to develop 100% hydrogen smart meters suitable for installation into domestic and commercial properties. These projects will result in certified meters suitable for trials and expand the evidence base for the potential cost of hydrogen metering.

Net Zero Innovation Portfolio and Ten Point Plan

- The 10 Point Plan announced a broad set of policy measures to drive the UK to net zero, including a new £1bn net zero innovation portfolio from 2021 to accelerate the commercialisation of innovative low-carbon technologies, including hydrogen production, storage and use.
- The Net Zero Innovation Portfolio (NZIP) will spend at least £1bn over the next 4 years to accelerate the commercialisation of innovative low-carbon technologies, systems and business models in power, buildings and industry. Hydrogen is one of the programme's nine key priority areas. It will decrease the costs of decarbonisation and set the UK on path to Net Zero, create world-leading industries and new jobs, invest in our regions and help make the UK a science and innovation superpower.
- The Hydrogen Advisory Council is also establishing a Research & Development and Innovation working group, to explore key issues with a range of stakeholders across government, industry and academia.

Commercial challenges

The hydrogen business model will address challenges including:

- ***Additional cost of low carbon hydrogen in comparison with high carbon alternative fuels***
  The cost gap between low carbon hydrogen and counterfactual, high carbon alternatives is a significant challenge and that will remain a key focus of our ongoing work on developing low carbon hydrogen business models. The carbon price is unlikely to be sufficient to address the cost gap in the near term.
- ***A complex value chain and policy landscape***
  The value chain for low carbon hydrogen and the associated policy landscape is complex. A single business model is therefore unlikely to achieve our ambitions for deployment of low carbon hydrogen.
- ***Uncertainty in potential demand for low carbon hydrogen***
  The potential demand from different end users of hydrogen needs to be considered in the design of business models. There is uncertainty about the shape and scale of future demand. Key markets are likely to include industry and heavy transport. We also recognise the system balancing value of energy storage.

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

BEIS response

Major infrastructure development is required across the hydrogen value chain, from production, transmission, storage and across its various end uses.

There is a strong view that the UK's combination of domestic electrochemical and regulatory expertise, investment in hydrogen innovation, and geography (with its abundant offshore wind, CO2 storage and hydrogen storage in salt caverns, depleted oil and gas fields and long-established and well-regulated gas system) positions us as a potential leader on low carbon hydrogen.

Some of the key infrastructure requirements are detailed below:

CCUS Infrastructure Fund

- Low carbon hydrogen at scale will be made possible by carbon capture and storage infrastructure. The Ten Point Plan, Energy White Paper and National Infrastructure Strategy set out the importance of CCUS in reaching net zero. To support deployment the government has allocated up to £1 billion through creation of the CCUS Infrastructure Fund.
- Developing these two new CCUS and hydrogen industries together in 'SuperPlaces' will kick start wider decarbonisation of heavy industry, heavy transport, power and over time potentially heating.
- The timelines associated with CCUS-enabled hydrogen production plants are sequenced to the CCUS cluster selection process.

Transport

- Infrastructure requirements for hydrogen for transport include hydrogen refuelling stations (HRS). HRS are the key infrastructure component of the roll-out of fuel cell electric vehicles but the UK hydrogen transport infrastructure is nascent – as of May 2020 there were 11 publicly accessible stations serving fleet of approximately 283 vehicles. Each of these stations has one dispenser, and as such only one vehicle can refuel at any given moment.
- DfT's £23 million Hydrogen for Transport Programme includes £6.3 million of funding for a green hydrogen refuelling station and 19 hydrogen-powered refuse vehicles in Glasgow, a world-first for the size of the fleet. DfT are also supporting a Hydrogen Transport Hub in Tees Valley to bring together representatives from academia, industry and government to drive forward the UK's plans to embrace the use of hydrogen as an alternative fuel.

Hydrogen for heat

- The use of hydrogen for heat – or to replace natural gas in other end uses – will require a hydrogen transmission and distribution network. The 10 Point Plan announced support for trialling hydrogen heating in homes starting with a Hydrogen Neighbourhood in 2023, moving to a Hydrogen Village by 2025, with an aim for a Hydrogen Town before the end of the decade.

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;

BEIS response

- BEIS and CCC analysis show significant amounts of low carbon hydrogen are required in the energy system to meet net zero, which is corroborated by a range of external reports (National Grid, Aurora, Bloomberg, UK Hydrogen and Fuel Cell Research Hub).
- The CCC's Carbon Budget 6 analysis suggests hydrogen demand in 2050 could range from 161 – 376 TWh. Hydrogen appears to be essential for meeting our Net Zero target, but should be focussed on applications of the highest value, where electrification is less feasible. Hydrogen can provide a cost-effective option to displace fossil fuels in applications where emissions reductions would otherwise be impractical or expensive.
- Government is pursuing a twin-track approach, focusing on both commercial-scale CCUS-enabled 'blue' hydrogen and pulling electrolytic 'green' hydrogen projects from demonstration stage to commercial production. This would enable production to be brought forwards at the necessary scale during the 2020s, driving investment across the wider value chain, capture economic benefits of an expanding hydrogen economy including jobs, supply chains and export opportunities and build confidence in the sector, while future proofing our net zero ambitions through a mix of production methods.

- The CCC estimate that 'blue' hydrogen could have lifecycle emissions savings of up to 85% relative to unabated natural gas. 'Green' hydrogen could be zero-carbon if it uses electricity from renewable sources. Hydrogen use in combustion or in a fuel cell does not produce any greenhouse gas emissions.
- BEIS has appointed contractors to gather evidence on emissions associated with different hydrogen technologies and will be working with industry to develop a UK standard that defines low carbon hydrogen. Further details will be provided in the upcoming UK Hydrogen Strategy.

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.

- It is not possible to forecast the exact role for hydrogen across all potential uses in the 2050 energy mix. We will need a number of different production methods to come forward – including CCUS enabled methane reformation and electrolytic hydrogen from renewables. However, action is needed now to give us the option of deploying low carbon hydrogen flexibly in the future.
- While electrification is the leading decarbonisation option for many parts of the economy, there are significant areas where this is not possible or cost effective, requiring a gaseous energy carrier (a molecule) rather than electricity (an electron).
- Hydrogen is well placed to provide this low carbon alternative to natural gas at the necessary scale. As a flexible energy carrier, hydrogen has cross-cutting potential could be used in:
    - Industry – as a feedstock for industrial processes and as a gas for high temperature processes where electrification is not an option (e.g. fuel switching for kilns)
    - Transport – it is expected that a mixture of electrification and low carbon gas will be needed to ensure deep decarbonisation of transport, especially sectors which are hard to electrify, including shipping, HGVs, buses and trains
    - Heat – Hydrogen could play a key role in reducing carbon emissions by 2050, and is one of the options being explored to decarbonise heat in the UK - alongside heat pumps, heat networks and biomethane. However, the safety case for hydrogen for heating is not yet proven - and further work is required to be completed. BEIS regularly engages with Ofgem on a range of issues, including the potential role of hydrogen in the gas network.
    - Power – system-wide benefits, including peak loads and grid balancing. Important for integration of high volume of renewables; potentially allowing the UK to exploit more of its renewable resources, notably offshore wind.

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