Written Evidence Submitted by the British Standards Institution (BSI) (HNZ0048)

1. BSI (the British Standards Institution) is making this submission as the National Standards Body for the United Kingdom. BSI has a public function in support of the UK economy. We bring together stakeholders (including government, industry and consumers) and facilitate the development of "what good looks like".
2. Voluntary standards offer a flexible, adaptive and collaborative alternative to regulation by providing common languages, terminologies, guidelines and good practice developed by and for stakeholders. As the UK's National Standards Body, BSI operates in accordance with an MOU with the UK Government. Our robust standards development process requires open and full consultation with stakeholders to build consensus-based outcomes. This gives standards the legitimacy and degree of market acceptance to be used for public policy purposes.
3. BSI represents the UK within the European Standards Organizations CEN and CENELEC, and International Standards Organizations ISO and IEC playing a major role in the governance, strategy and policy of these organizations. BSI also facilitates access for UK experts to the standards making process, ensuring the maximum influence for the UK over the content of International standards. The UK's ability to influence European standards after withdrawal from the European Union requires BSI's continued full membership of CEN and CENELEC.
4. Standards provide an established mechanism for credible and robust reporting on organizational performance. Whilst standards are voluntary, they can be referenced by policy makers as a means to demonstrate compliance with regulation. Some standards can also be used as a basis for conformity assessment and certification.

BSI's role in support of innovation

5. As the National Standards Body, BSI has extensive experience in bringing together experts in industry, government, academia and consumer representatives to capture what good looks like. BSI provides the infrastructure for over 13,000 experts, who are the voice of UK economic and social interests, to be influential in the international standards organisations. BSI has a public interest responsibility to develop and maintain the standards infrastructure to support UK emerging industries at home and internationally.
6. Standards already exist across a number of related areas that can be utilised to deliver government's objectives. BSI can assist by bringing together key stakeholders to map out the standards landscape and help shape necessary standards revisions, gaps and any new standards development to address requirements. Such research and assessment activities would take into account the UK market drivers whilst building upon existing European and international best practice (through BSI's involvement in CEN, CENELEC, ISO, IEC, ITU and ETSI).
7. There is an increasing body of evidence explaining the role of standards in enabling innovation. Standards are a key component of modern economic infrastructure and play a vital and often invisible role in supporting economic growth. The role of BSI in support of emerging technologies has been acknowledged in HM Government's International Research and Innovation Strategy (IRIS). The report notes that the strengths and global reach of the UK's governance, intellectual property and standards frameworks can support the design of common, global regulatory approaches to support emerging, transformative technologies[1].

[1]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801513/International-research-innovation-strategy-single-page.pdf

BSI’s role in support of a transitioning energy sector and the focus on hydrogen

8. BSI has extensive experience in energy standardization. We maintain vast portfolios of energy, oil and gas standards to support safety, grid stability and security of energy supply. Our stakeholder collaborations support the delivery of government policies and help industry meet regulatory targets. BSI’s strategic standardization programmes for emerging markets and innovations help drive sustainable growth and meet ambitious policy, industry and societal commitments. Working across the energy sector and with its diverse community, we deploy flexible standards development mechanisms to create best practice, keeping pace with fast-changing technology and commercial innovations.

9. BSI manages a vast portfolio of gas and hydrogen-related standards and the communities developing these standards. Key gas and hydrogen related portfolios and committees include: hydrogen technology (PVE/3/8), gas installations (GSE/30), gas supply (GSE/33), natural gas and gas analysis (PTI/15), and gas supply equipment for natural gas vehicles (GSE/40)

10. Hy4Heat’s mission is 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. In support of Hy4Heat, in April 2020 BSI published *PAS 4444, Hydrogen fired gas appliances – Guide*. PAS 4444 provides principles and guidance for appliance manufacturers on the functionality, safety, installation, operating, and servicing requirements of hydrogen-fuelled and hydrogen/natural gas dual-fuelled or converted appliances, including boilers, cookers and fires[2]. In addition, further standards development work in support of Hy4Heat is being carried out by BSI that is supported by BEIS and is a research scoping project to inform the potential development of a PAS for the design, installation and maintenance of low-pressure gas pipework for carrying hydrogen gas.

11. The ‘switch’ to hydrogen or the increased reliance on hydrogen within UK’s energy industry and other sectors of the economy (sometimes referred to as ‘hydrogen transformation’) opens up a much wider decarbonization opportunity and provides a pathway to achieving UK’s net zero ambitions. ‘Hydrogen transformation’ will require concerted effort and collaboration among the many market players, as well as integration of various themes, tools and initiatives. BSI is supporting the effort by engaging with key initiatives and stakeholders, with a view to scoping out the required standardization support. Strategic standardization engagement to date includes: HPDG (and its varied membership), GGG, HAC, Innovate UK/UKRI, IGEM, ENA, gas networks, etc.[3]

12. In our continuous engagement with industry, policy makers and regulators, BSI has observed a growing recognition of the key role hydrogen can play in achieving full decarbonisation of the economy by offering a complementary decarbonisation pathway, alongside electrification, for the UK energy system. As pointed out by the Hydrogen Taskforce in its 2020 report and recommendations to government, this recognition is shared by many other nations and as such the global market for hydrogen technologies is expected to grow rapidly over the coming years.[4] The UK Hydrogen Council estimates that this value could be as much as $2.5tn by 2050.

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[2] https://www.bsigroup.com/en-GB/about-bsi/media-centre/press-releases/2020/may/bsi-launches-the-first-hydrogen-fired-gas-appliances-guide-helping-to-bring-zero-carbon-heating-and-cooking-appliances-to-homes-and-commercial-buildings/

[3] BSI is providing input to the Hydrogen Programme Development Group (HPDG). This BEIS-led government-industry collaboration is aimed at establishing the direction and the operational parameters of a long-term, UK-wide programme in support of UK’s transition from gas to hydrogen.

[4] The Hydrogen Taskforce is founded by UK based companies of different sizes and specialisation – BP, Shell, ITM, BOC, Arup, Cadent, DBD, Baxi, Storengy, and BNP Paribas – that are active across the entire value chain and are at the forefront of hydrogen innovation, globally. The Taskforce’s aim is to convey a coordinated voice which is essential to securing tangible policy support and recognition from the UK Government and the Devolved Assemblies that will culminate in a collaborative and ambitious programme to enable the UK to become world leading in the hydrogen sector.

13. Additionally, the UK's large domestic renewable resources – particularly wind – mean it has an advantageous position for the production and eventual export of green hydrogen.' Furthermore, as outlined in the recently published Energy White Paper[5] 'The production and use of clean hydrogen will be important in achieving net zero emissions by 2050. As a gas that can be used as a fuel without emitting harmful greenhouse gasses, hydrogen will be critical in reducing emissions from heavy industry, as well as in power, heat and transport. When heavy goods transport or a process such as steel production relies on fuel for energy, hydrogen can provide a crucial, low-carbon alternative to fossil fuels.' BSI supports this statement and the net zero aspirations behind it and looks forward to working with government, industry and other key stakeholders on detailing and enabling the UK's future Hydrogen Strategy.

Call for evidence

14. Many of the technical responses and evidence in this section have been provided by BSI's technical experts. For more information and further detail please contact BSI for an introduction to the experts on BSI committees.

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**

15. The short-term ambition of 1 GW by 2025 is a welcome market signal of intent to allow investor confidence. However, the medium-term ambition of 5 GW by 2030 is unlikely to be sufficient to put the UK on the necessary build out rate to achieve the required volumes of hydrogen outlined by the UK on the necessary build out rate to achieve the required volumes of hydrogen outlined by the Committee on Climate Change. A 2030 target of 10 GW would provide a stronger signal of the UK's ambition to become a world leader in hydrogen production capacity.
16. The timescales currently involve the development of a hydrogen village leading into a hydrogen town. This is a welcome development as it provides recognition of the incremental nature of early deployment, in line with the supporting evidence base and regulatory facilitation.
17. The focus of government work is rightly recognised as market regulation, and in particular business model development. The technical challenges of hydrogen deployment will naturally be resolved, if they have not been to date, by the private sector, however a clear understanding of the commercial case for production investment is a foundational step along the hydrogen journey. Hydrogen business model development is currently not committed to any particular period within 2021, given its fundamental importance this should be prioritised and scheduled for 2021.

- **How the proposed measures—and any other recommended measures—could best be co-ordinated**

18. The development of a mature liquid hydrogen market within the UK will involve a number of regulatory developments and coordination. The primary co-ordination effort must be on facilitating the development of the necessary legislation to enable business model development for both hydrogen supply and carbon capture, use and storage (CCUS).

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[5]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf

19. Coordination will be necessary between government departments, regulators and industry bodies to enable alignment of progress. For example, the necessary changes to the current energy billing regime to enable hydrogen to be billed appropriately will require engagement between BEIS, Ofgem, Xoserve and UNC. Any interplay of hydrogen usage for vehicles will require coordination between BEIS and DfT, and finally any necessary changes to gas distribution regulations will require HSE engagement.
20. Alongside the coordination of efforts to review and amend current legislation, it is likely additional regulatory bodies will be required to provide sound governance for CCUS, which will be critical for the development of bulk hydrogen supply capacity.
21. In addition, new or revised industry standards will be required across the use and application of hydrogen. Standards provide the information needed to safely build, maintain and operate equipment and facilities – ensuring uniformity of standards within the domestic market will allow the scaling of technologies nationally. Setting world-leading standards and promoting these internationally (e.g. via BSI's participation in European and international standardization) can enable export to international markets and ensure that the UK has a competitive advantage in exploiting trade opportunities with hydrogen. Setting and upholding standards is in keeping with the UK's commitment to establish, align and uphold international standards and aspirations for the environment, climate change and consumer protection.

- **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**

22. Carbon capture and storage (CCUS) is recognised as critical to the development of low-cost bulk hydrogen production. A commitment has been made by HMG to deliver on multiple CCS/hydrogen clusters, and this commitment is welcome. Given the scale of hydrogen production necessary (ca. 270 TWh/yr which is comparable with the total current UK electricity demand) all four main clusters should be progressed in tandem and supported through FEED stages under the Industrial Decarbonisation Challenge Fund. The UK is fortunate to have favorable offshore geology to create a world leading CCUS infrastructure.
23. At the same time the Energy White Paper recognised that existing oil and gas assets at the end of their existing commercial life could release significant cost savings in the deployment of CCUS and prove instrumental in getting the technology operational by the mid- 2020s. By developing the required standards to deploy CCUS and 'decommission and repurpose' existing oil pipeline there is a strategic opportunity for the UK to become a world leader in the development of this critical technology that will unlock bulk low carbon hydrogen production.

- **Potential business models that could attract private investment and stimulate widespread adoption of hydrogen as a Net Zero fuel**

24. The development of financeable business models to enable investment in hydrogen production is foundational to any hydrogen sector. The development of this should be recognised as the primary regulatory priority. By enabling hydrogen to be sold at the price of natural gas, a market will be created by early adopters capturing carbon benefit through the avoidance of emissions charges. This would create demand from large scale users and provide commercial certainty for the production investors. A CfD market structure is seen as the most appropriate regime, given its familiarity with the financing sector and proven track record of stimulating markets. A CfD structure would also create competition from investors which would allow a reduction in support over time in line with market maturity and technology scale, as has been shown through the development of the wind power market.
25. The interface between hydrogen and CCUS business models must be carefully managed to ensure projects remain financeable in their entirety with appropriate risk allocation.

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;

26. BSI Committee GSE/30 *Gas installations* (see here) has identified a number of activities that may be of interest to the Select Committee evidence[6]. *See Appendix for full list of trials and activities.*
27. Standards play a critical role in supporting government, UK's innovation community and the industry on the path to Net Zero and enabling a concerted energy system decarbonization effort going forward. Multi-stakeholder, consensus-based standardization can further hydrogen innovation and help develop the nascent markets in a safe, consistent, interoperable and secure manner.
28. A key next step of many ongoing activities and initiatives of relevance will require standards to help converge the effort, provide a platform for collaboration, build upon and enhance existing good practice, align with policy and regulation, open doors for UK plc and exert UK influence internationally.
29. A key strategy for government should be to include standardization support within hydrogen-related innovation approaches and UK hydrogen innovation strategy from the outset, and further translated into individual programme deliverables.

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;

30. The production of hydrogen has been supported to date via the Hydrogen Supply Competition, with most recent funding announced in April 2020. Future support has been identified through the £240 million Net Zero Hydrogen Fund; this is a welcome announcement to enable early projects to continue through engineering studies during the current hiatus in business model development.
31. The distribution of hydrogen to major industrial users as well as key nodes of the gas network will be key to unlocking a large demand potential for hydrogen. Gas Distribution Networks have allocated funding for investment in hydrogen distribution within their RIIO GD2 plans and this should be supported by the energy regulator Ofgem and BEIS.
32. Accurate metrology is being assessed by a number of programmes, both for admixtures and the development 100% hydrogen meters. Further work may be required in this area to support changes to gas billing methodologies to ensure any CV implications of hydrogen deployment are accounted for within consumers bills.

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

33. Greater understanding and more investment in research is required on the effects of hydrogen on metrology; the effect of hydrogen on rubber materials for seals and diaphragms for gas appliances and gas equipment; Hydrogen embrittlement; effect of hydrogen on wielding; and the permeability of hydrogen on gas components.

[6] https://standardsdevelopment.bsigroup.com/committees/50000784

34. For FCEVs, other than for heavy duty vehicles, the development of interoperability standards is underway. These support the AFID and AFIR in CEN/TC 268/WG 5 *Specific hydrogen technologies applications* (see here), based upon standards in ISO/TC 197 *Hydrogen technologies* (see here). There are also standards supporting the development of hydrogen refuelling stations and hydrogen vehicles (applicable to FCEV or ICE) in ISO/TC 197, all of which is mirrored by BSI PVE/3/8.
35. PTI/15 mirrors work developing the analytical methods standard for hydrogen analysis under ISO/TC 158 (see here), and GEL/105 mirrors the work of IEC/TC 105 on fuel cells (see here).
36. Work on rail is in its infancy with RAE/1 mirroring CEN/TC 256/WG 43 (see here). Close alignment with current ISO/TC 197 work is expected when it comes to gaseous hydrogen-fuelled trains, but this is yet to be confirmed. Work is also being done by IEC/TC 9 (see here), which is mirrored by BSI's GEL/9.

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

37. A compelling cost-benefit analysis for hydrogen exists within both the domestic and industrial user base. The domestic case is used by way of an example.
38. The capital cost of a hydrogen boiler has been sighted as around £100 more than a standard natural gas boiler. Given a typical boiler lifetime of 15 years with consumption of 8 MWh per annum, this equates to an additional cost of ca. £0.8/MWh. Production of blue hydrogen (e.g. natural gas reformation with CCUS) can produce hydrogen at scale for £20-25/MWh more than natural gas. Therefore, assuming a 90% boiler efficiency, a hydrogen heating system would cost on the order of £23-28 per MWh of delivered heat, relative to natural gas.
39. The comparator within the domestic market is a heat pump, the lowest cost of which is an air source heat pump (ASHP). Typical lifetimes of an ASHP are 20 years and are typically £8,000 more than gas boilers, this accounts for typical heating upgrades such as larger radiators and/or underfloor heating. Therefore, assuming the same heat delivery of 8 MWh per annum, the additional capital requirement of an ASHP is ca. £50/MWh. Domestic electricity prices are £190/MWh, taking a normal coefficient of performance of an ASHP of 3.0, an ASHP would deliver heat at £63/MWh. Given that natural gas retails at £45/MWh with a 90% conversion efficiency, natural gas heat is £50/MWh, therefore the operational costs of an ASHP are £13 per MWh of heat above natural gas. The total uplift in heat delivery costs of an ASHP relative to a natural gas boiler is therefore on the order of £63/MWh.
40. It can be seen that hydrogen offers a significant economic benefit to consumers over ASHPs, a saving on the order of £37/MWh of heat delivered. Any cost differential between natural gas and alternatives would require support to incentivise investment, especially if consumers are expected to cover the cost of the alternative. Therefore, ultimately, any additional costs would have to be borne through general taxation or energy bills. Given that 23 million homes are currently heated with gas boilers, saving £37/MWh of heat, equates to £6.1 billion per annum of cost saving.

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.

41. The gas industry has a vast network of pipes that can store energy that allows both diurnal and seasonal capacity to ensure sufficient energy is available. Currently the electrical network cannot store sufficient reserves of capacity. Hydrogen is a green gas at the point of use with the only product of combustion being water. Hydrogen can be produced by Electrolysis (green hydrogen) and Steam Methane Reforming in conjunction with Carbon Capture and storage (blue hydrogen).
42. The gas network is a large national infrastructure that has to be part of the path to net zero. Currently this network supplies about 80% of the heating load for domestic premises. To transfer the energy provided by the gas network and supply this amount of electrical energy through green or other forms of generation would require considerable investment. Building or upgrading the electricity infrastructure would cause substantial interruption and inconvenience within cities, towns, etc. and properties to supply this increase demand for the power required to heat our homes, commercial buildings and industrial processes and would require a substantial investment.
43. As discussed in the recently published energy white Paper, the production and use of clean hydrogen will be important in achieving net zero emissions by 2050. As a gas that can be used as a fuel without emitting harmful greenhouse gasses, hydrogen will be critical in reducing emissions from heavy industry, as well as in power, heat and transport. When heavy goods transport or a process such as steel production relies on fuel for energy, hydrogen can provide a crucial, low-carbon alternative to fossil fuels.' The Energy White Paper discusses hydrogen as an extra energy vector, source and mechanism for decarbonizing UK's energy system, complementary to, and enabling electrification, and working well alongside heat networks, heat pumps installations, etc.

(January 2021)

APPENDIX - The progress of recent and ongoing trials of hydrogen in the UK and abroad

Admixtures of hydrogen by volume in Natural gas
There are many projects being undertaken at home and abroad regarding the introduction of hydrogen (H_2) into the existing and purpose designed H_2 networks. There are two distinct paths being followed:

a) an admixture of H_2 of currently up to 20% H_2 into a natural gas network,
b) the introduction of 100% H_2 networks. Although many are using the term 100% for H_2, the purity does depend on its application with that used for heating purposes the amount of hydrogen is typically around 98% H_2 with the other 2% containing other gases. If the H_2 is being used in fuel cells, say for mobility then the gas quality needs to be to a higher specification. For H_2 Gas Quality reference is generally made to the international Standard ISO 14687- Hydrogen fuel quality — Product specification.

In Great Britain several projects are being undertaken under the umbrella of HyDeploy. The HyDeploy is a project that is being run by gas distributors Cadent and Northern Gas Networks along with other partners including the Health and Safety Executive (HSE). There is a field trial currently underway at Keele University where an admixture of up to 20% H_2 by volume in natural gas is being distributed within a dedicated network supplying a both domestic and commercial appliances. A further trial is currently being planned to distribute an admixture of up to 20% H_2 by volume in natural gas to 670 homes in a village named Winlnton near Gateshead. This will be the first time an admixture of up to 20% H_2 has been distributed into a public network in Great Britain. One of the main outcomes from the trial at Keele University is that it would appear that appliances would not require any modification or conversion to operate safely with this admixture.

Another distribution company, ENGIE has set up a trial which is being undertaken near Dunkirk in France, named Hythane, again distributing admixtures up to 20% H2 by volume in natural gas. This project is supplying fuel for a Natural Gas Vehicles (NGV) refuelling station for buses as well as space heating, water heating for residential property. The French government is also supporting the GRHYD hydrogen energy storage demonstrator project now being conducted by ENGIE and a consortium of twelve industrial partners.

One of the main issues with injecting H_2 into a gas network is at some point there will be an upper limit to the amount of H_2 that can be injected without the need to undertake a full appliance conversion. Currently the accepted figure is an admixture up to 20% H_2 by volume of in natural gas.

There are several projects being undertaken in Europe. These include the THyGA project (Testing Hydrogen Admixtures for Gas Appliances) sets out to develop and communicate a detailed understanding of the impact of blends of natural gas and hydrogen on end use applications, specifically in the domestic and commercial sector. The main goal of the project is to enable the wide adoption of H_2NG (hydrogen in natural gas) blends by closing knowledge gaps regarding technical impacts on residential and commercial gas appliances. The project consortium will identify and recommend appropriate codes and standards that should be adapted to answer the needs and develop a strategy for addressing the challenges for new and existing appliances.

Allowing an admixture of up to 20% by volume within the domestic market would reduce carbon dioxide emissions by 6 million tonnes per year, which is the equivalent of removing 2.5 million cars from the road.

Distributing gas in a totally hydrogen network
There was also a considerable amount of work being done under the Leeds h_{21} project with the ambitious target of converting the city of Leeds to distribute a hydrogen network starting in the early 2030s. The knowledge gained from the Leeds h_{21} project has now used and morphed into the h_{21} North

of England Project. This project now covers the wider area of the North of England including such major cities as Bradford, Hull, Manchester, Liverpool, etc. See link to film below for further information.

https://www.h21.green/projects/h21-north-of-england/

Its partners in this project now include Northern Gas Networks, Cadent and Equinor (whose previous company name was Statoil). In order to produce sufficient hydrogen this will be produced utilising Steam Methane Reforming (SMR) in conjunction with Carbon Capture and Storage (CCS) where the now redundant oil fields in the North Sea will be used to store this by-product. Electrolysis was not seen as a suitable method of currently producing sufficient hydrogen to meet the expected energy requirements. In order to support the successful rollout of a 100% hydrogen a project has now been started by BIES. This project is named Hy4heat which has 10 work packages covering the associated research required for the safe distribution and use of hydrogen as a low carbon fuel as an alternative to natural gas.

H100 Fife

On the east coast of Scotland, The SGN H100 Fife project is laying the foundations to supply a hydrogen network to residents in the local area. This opportunity is to be at the leading edge of the low-carbon economy.

SGN is developing a world-first hydrogen network in Levenmouth that will bring 100% renewable hydrogen into homes in 2022, providing zero-carbon fuel for heating and cooking. In the project's first phase, the network will heat around 300 local homes using clean gas produced by a dedicated electrolysis plant, powered by a nearby offshore wind turbine.

The project is the first of its kind to employ a direct supply of clean power to produce hydrogen for domestic heating – putting Levenmouth at the forefront of the clean energy revolution.

The system will be designed and built to ensure the same high safety and reliability standards expected from the current gas system. An on-site storage unit will hold enough hydrogen to ensure supply won't be disrupted during even the coldest weather conditions.

European projects

The Netherlands and Germany are also investigating the use of hydrogen as a fuel to heat homes commerce and industry.

In the Netherlands BDR Thermea is undertaking a pilot project in the town of Uithoorn. This pilot project has gone live in the town of Uithoorn, the Netherlands, where 14 vacant houses have been adapted to test domestic heating systems running on zero-emission hydrogen fuel.

The North of the Netherlands' is to be the first region to receive a subsidy for their so-called Hydrogen Valley. The North Netherlands' subsidy application for a Hydrogen Valley has been approved by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) of the European Commission. It concerns a subsidy of 20 million euros with a public-private co-financing of 70 million euros. This brings the total project size to around 90 million euros. This subsidy is intended for the development of a fully functioning green hydrogen chain in the Northern Netherlands. The six-year project – called HEAVENN – was planned to start in January 2020 at the latest.

There are many other projects under the FCH JU Project umbrella. For further information see the link below:

FCH JU PROJECTS | www.fch.europa.eu

Germany has developed a 6 point plan;

1) The German Government expects that around 90 to 110 TWh of hydrogen will be needed by 2030.
2) A domestic market for the production and use of hydrogen has to be established.
3) The industrial sector is well-placed to become one of main factors speeding up the market rollout of hydrogen and a global pioneer for hydrogen technology.
4) Transport applications offer great potential for hydrogen-based or power-to-gas based mobility.
5) Even after the efficiency and electrification potentials for process heat generation and the building sector have been harnessed, there will continue to be long-term demand for gaseous fuels.
6) The German Government is due to appoint a National Hydrogen Council.

General

North West Hydrogen Alliance
The HyNet project is led by Progressive Energy and involves hydrogen production on an industrial scale, using Carbon Capture Utility and Storage (CCUS) to make the gas low carbon and cost effective; the captured carbon would be stored in offshore caverns left empty after oil and gas extraction in the Irish Sea. The locally produced hydrogen would be transported through a newly installed hydrogen pipeline to energy-hungry industries such as glass production and refineries and this would in turn make hydrogen available to provide decarbonised heating for 2 million homes and hydrogen fuel cells for HGVs and other heavy freight transport. The HyNet project received £7.5 million of funding through Phase 2 of the Hydrogen Supply Competition in 2020.

HyNet has also received £5.2m from the UK government to fund live trials of hydrogen fuelling at Dunphy's manufacturing site in Rochdale, Unilever's Port Sunlight manufacturing site, and at Pilkington's Greengate Works glass-making plant in St Helens which will be a world first. The projects will demonstrate that hydrogen can be used as a substitute fuel for natural gas in manufacturing processes, helping industry transition to a low-carbon future and leading the way for others to follow.

Wales and West Utilities – The Freedom Project
The Freedom Project to explore and demonstrate the value of smart hybrid heating. Wales and West Utilities worked with partners Western Power Distribution and PassivSystems on the first gas and electricity network future of energy project, which brought energy network integration into customers' homes.

A Freedom installation – of which there were 75 on trial in the Bridgend 'living heat laboratory' – integrates a small air source heat pump alongside an existing boiler central heating system with smart controls. These smart controls are essential and enable switching between gas and electricity based on the affordability and carbon intensity of each vector. The hybrid installation is retrofitted to the existing system with minimal disruption. In the future it is expected that the fuel supplied to these boilers will be hydrogen.

SGN Real Time Networks
This is an Ofgem Funded Project under the Network Innovation Scheme. This project will consider the rise of data and digitalisation and how it can be used to helped many sectors become more efficient and resilient - and as we move toward a future net zero energy system, the application of these future technologies will become even more important.

Network modelling is just one area where data analysis can help drive efficiencies. It is essential to efficiently and cost-effectively distribute gas – but the gas industries current network model is based on assumptions and techniques developed in the 1980s. While that worked perfectly at that time, decarbonisation is changing where our gas comes from, the types of gas we use, and the way we use it.

Homes and appliances are becoming much more energy efficient, and low-carbon technologies like renewables, hydrogen and biomethane are changing our energy system.

Looking towards net zero and a decarbonised energy system, the traditional methods of energy production are giving way to more agile, decentralised solutions that require a smarter, more flexible grid. By modelling demand in real time, we can better react to meet new and future customer demand. SGN is collecting and analysing live gas data every six minutes as it is distributed through our network in the south-east and used by our customers and using this data to improve network analysis.

SGN Oban Project
A trial in Oban was undertaken by Scotia Gas Networks (SGN) to investigate the supply of gas outside the current UK specification legislated for by Gas Safety Management Regulations (GSMR). This project was funded by Ofgem under the Network Innovation Competition; it sought to provide evidence to support a cost-effective new gas supply solution for the Scottish Independent Undertakings (SIU's) – isolated local distribution networks – following the closure of the LNG storage facility at Avonmouth. Dependant on the results from this project it was also foreseen as providing a potential roadmap for the UK adoption of a widened gas-quality (Wobbe Index) specification.

Requiring a specific exemption from GSMR to be granted by the HSE, the project involved a study of approximately 1100 properties and 2500 appliances fed by the SIU, including identifying and replacing any appliances unable to cope with varying gas quality. Spot-checks were carried out over the project duration to check appliance combustion was acceptable to industry norms, and that there were no other issues apparent.

The decision of whether to expand the Wobbe Number under the GSMR is under consideration by the HSE.

Zero Carbon Humber (ZCH)
Zero Carbon Humber (ZCH) brings together international energy producers, major regional industries, leading infrastructure and logistics operators, global engineering firms and academic institutions in a plan to decarbonise the UK's largest industrial region. This will be enabled by shared trans-regional pipelines, for low-carbon hydrogen and captured carbon emissions, creating the world's first net zero industrial cluster by 2040.

Delivering this is expected to protect 55,000 existing jobs in the Humber and create 49,000 new ones, while supporting skills, apprenticeships and educational opportunities in the region.

HIGGS Project
The Hydrogen in Gas grids (HIGGS) is led by partners from Spain, Germany, Switzerland and Belgium. The project aims to pave the way to decarbonisation of the gas grid and its usage, by covering the gaps of knowledge of the impact that high levels of hydrogen could have on the gas infrastructure, its components and its management.

To reach this goal, several activities, including mapping of technical, legal and regulatory barriers and enablers, testing and validation of systems and innovation, techno-economic modelling and the preparation of a set of conclusions as a pathway towards enabling the injection of hydrogen in high-pressure gas grids, are being developed in the project.

EUROMET, EMPIR Project NEWGASMET
This is a European Funded Project which is investigating the effects of Flow metering of non-conventional gases (biogas, biomethane, hydrogen, syngas and mixtures with natural gas). The overall objective of the project is to increase knowledge about the impact of renewable gases on the accuracy and durability of commercially available meters; it will then disseminate these new data and possible

recommendations into the EN, ISO and OIML standards used for the design of gas meters, for their certification and for their flow calibration in laboratories and in manufacturers' plants.

Norther Light Project
Following a historic vote in parliament, on the 20th December 2020 the Norwegian Government announced its funding decision for the Northern Lights CO_2 transport and storage project. This final investment decision for the Northern Lights project enables the shipping, reception and sequestration of CO_2 in geological strata in the Northern North Sea, approximately 2,600 metres below the seabed.

The funding decision demonstrates the Norwegian government's strong support for the development of a Carbon Capture and Storage (CCS) value chain, which is essential if Europe is to achieve its carbon neutrality targets.

Northern Lights will be the first of its kind – an open and available infrastructure enabling transport of CO_2 from industrial capture sites to a terminal in Øygarden for intermediate storage before being transported by pipeline for permanent storage in a reservoir 2600 metres under the seabed.
Carbon capture and storage (CCS) is important to achieve the goals of the Paris Agreement.

This project is the largest climate project ever in the Norwegian industry and will contribute substantially to the development of CCS as an efficient mitigation measure. Working together with the industry, the step-by-step approach has confirmed that the project is feasible. The Northern Lights project is a partnership between Equinor, Shell and Total.

The Northern Lights project includes the development and operation of CO_2 transport and storage facilities which will be open to third parties. It will be the first ever cross-border, open-source CO_2 transport and storage infrastructure network and offers European industrial emitters the opportunity to store their CO_2 safely and permanently underground. Phase one of this project will be completed mid 2024 with a capacity to store up to 1.5 million tonnes of CO_2 per year.

CEN/TC 237 – Gas meters
This Technical Committee (TC) is investigating the effects of different non-conventional gases on the accuracy and durability of gas meters. This committee has responsibility for the standardization of the requirements for the construction, performance and safety of gas meters, including diaphragm, rotary displacement, turbine, ultrasonic domestic gas meters, thermal-mass flow-meter based gas meters and all associated conversion devices. It is also responsible for the maintenance of this suite of European Standards.

This TC is working closely with the NEWGASMET Project team by supporting them in realising the affect these non-conventional gases will have on this range of gas meters. Mr Sibley is also Chairman of CEN/TC 237.

Danish project
In Denmark there is also a project being undertaken by EUDP titled "Energy Storage – Hydrogen injected into the Gas Grid via electrolysis field test" which was completed in May 2020.

The project has demonstrated transportation of up to 15% hydrogen in natural gas in a closed-loop high-pressure system, consisting of components and infrastructure from both the transmission and distribution grids. The test has shown that there is no increased leakage of hydrogen from the system compared to natural gas and that the tested components from the gas system are capable of handling hydrogen in the tested concentrations without major modifications. The project has also produced detailed knowledge on the effects on electrolysis systems from long-term standby periods.

HSE role**

The Health and Safety Executive are also heavily involved with the transition of the gas industry to provide a low carbon economy. Each gas network operator has to provide a safety case to ensure its network is going to operate safely. The introduction of hydrogen into the network will have a substantial impact of gas operator's safety case and amendments will be required and these will have to be assessed and approved by the HSE.

In preparation the HSE, Science Division in Buxton has been investigating the effects of hydrogen on the gas carrying components used within the gas infrastructure in terms of safe operation.

Institution of Gas Engineers and Managers (IGEM)**
Under the BEIS funded Hy4heat Work Package 2, part of this contact has been awarded to the Institution of Gas Engineers and Managers (IGEM) to develop standards for the installation of pipes, gas quality and associated hydrogen activities.

IGEM are also members of BSI's GSE/30 gas installations technical committee that maintains the National Standards Body programme of standards.

** IGEM and the HSE are members of BSI committees and contributors to NSB-led standardization.

DNV GL
DNV GL has a unique world class test site at Spadeadam in Cumbria where they can perform large scale investigations on safety critical activities on pipe and component failure. DNV GL has also built a street of terraced houses named HyStreet to investigate such safety critical activities such as the effect of dispersion of hydrogen gas leakage or rupture of service pipe entering the property.

This work supports the fact that the gas network in Great Britain is one of the safest in the world and any changes to gas specification have to be robustly tested to ensure safety is not compromised.

Below is a link to a video demonstrating the work that is being undertaking to ensure when hydrogen is distributed it will be at least as safe as the distribution of natural gas.

https://www.dnvgl.com/oilgas/perspectives/heating-homes-with-hydrogen-proving-the-safety-case.html

Work being undertaken by other European Organisations
The following European organisations are supporting the gas industry in working towards a low carbon economy.

> Marcogaz is the Technical Association of the European Natural Gas Industry and has been undertaking studies regarding the introduction of hydrogen into the gas network.
>
> Farecogaz
> Farecogaz is the European Association of manufacturers and is dealing with the gas metering chain, gas pressure regulators with associated safety devices and relevant stations.
>
> GERG
> The European Gas Research Group works with the European energy community to develop innovative solutions that ensure our gas infrastructure remains at the heart of the energy system and integral in our transition to a sustainable energy future. All the projects GERG supports aim to deliver a competitive, secure and low-cost sustainable pathway to Europe's energy transformation.

Draft Standardization Request on hydrogen

A Standards Request Ad-hoc Group Hydrogen (SRAGH) has been formed. This group focusses on the development and/or update of European Standards on interoperability between the power and gas grids, safe admixture of hydrogen to the natural gas grid, gas quality, electrolysers for grid balancing and on compatibility with end-use appliances.

Input was collected from CEN/TC 234 'Gas infrastructure', CEN/CENELEC Sector Forum Energy Management (SFEM) WG 'Hydrogen', CEN/CLC/JTC 6 'Hydrogen in energy systems' and the CEN Sector Forum Gas Sector regarding a future Standardization Request related to hydrogen and power to gas.

This group is supporting the European Commission by identifying what new standards may be required and which may require amendment.

GasNaturally
GasNaturally is a partnership of eight associations that together represent the whole European gas value chain – their members are involved in gas exploration and production, transmission, distribution, wholesale and retail operations, as well as gas in transport. Their members include EUROGAS, European Gas Research Group (GERG), Gas Infrastructure Europe (GIE), International Association of Oil and Gas Producers (IOGP), International Gas Union (IGU), Liquid Gas Europe, Marcogaz and The Natural & bio Gas Vehicle Association (NGVA Europe).

This partnership has produced a report which investigates a carbon neutral future of gas appliances for domestic, commercial and Industrial applications.

Western Australia
Infinite Blue Energy is proposing to build one of the world's largest renewable hydrogen production facilities in Western Australia, with a $350 million plan for the Arrowsmith green hydrogen project that would include 160MW of onsite wind and solar projects and the ability to produce as much as 25 tonnes of zero emissions hydrogen each day.

While Infinite Blue Energy plans to produce more than three-quarters its power needs from the onsite renewable energy projects, the company has secured an agreement to partner with Western Power to undertake initial planning work for an additional 330kV transmission network link to the proposed green hydrogen facility.

Through the cooperative agreement, both Infinite Blue Energy and Western Power will progress early studies into an upgraded transmission link between Eneabba to the site of the proposed Arrowsmith project, to be located around 300 kilometres north of Perth.

Background on BSI

BSI is the UK's National Standards Body, incorporated by Royal Charter and responsible independently for preparing British Standards and related publications and for coordinating the input of UK experts to European and international standards committees. BSI has over 115 years of experience in serving the interest of a wide range of stakeholders including government, business and society.

BSI represents the UK view on standards in Europe (via the European Standards Organizations CEN and CENELEC) and internationally (via ISO and IEC). BSI has a globally recognized reputation for independence, integrity and innovation ensuring standards are useful, relevant and authoritative.

BSI is responsible for maintaining the integrity of the national standards-making system not only for the benefit of UK industry and society but also to ensure that standards developed by UK experts meet international expectations of open consultation, stakeholder involvement and market relevance.

British Standards and UK implementations of CEN/CENELEC or ISO/IEC standards are all documents defining best practice, established by consensus. Each standard is kept current through a process of maintenance and review whereby it is updated, revised or withdrawn as necessary.

Standards are designed to set out clear and unambiguous provisions and objectives. Although standards are voluntary and separate from legal and regulatory systems, they can be used to support or complement legislation.

Standards are developed when there is a defined market need through consultation with stakeholders and a rigorous development process. National committee members represent their communities in order to develop standards and related documents. They include representatives from a range of bodies, including government, business, consumers, academic institutions, social interests, regulators and trade unions.

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