Written Evidence Submitted by Glass Futures and British Glass (HNZ0035)

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Introduction

This is a joint response from British Glass and Glass Futures, separate organisations, but working very closely to lead the UK glass sector to meet its 2050 net-zero decarbonisation targets.

British Glass Manufacturers Confederation (BG) is a not-for-profit company limited by guarantee, owned by its members from the glass supply chain and exists for the benefit of the glass industry. BG vision is to support and build a strong, successful, and sustainable future for glass.

BG aim is to ensure that the glass sector has the knowledge, influence and skills to be commercially successful, innovative and sustainable. By working with the full glass supply chain and its stakeholders to enable collaboration, information sharing and action in areas such as technology, innovation, safety, skills and the environment.

Glass Futures Ltd (GFL) has been created to be the Global Centre of Excellence in Glass for R&D, Innovation and Training and its members GFL's mission is to drive research and innovation across the glass sector to make glass the low carbon material of choice and increase its use throughout society.

GFL is creating a new glassmaking Pilot Plant facility in St Helens, United Kingdom, to provide a Global Centre of Excellence for sustainable manufacture of glass. This facility will have full plant utilities and services, a full-scale Batch Plant, initially a 30 tonnes per day furnace complete with abatement and heat recovery. The glass output can also be processed by an IS machine and cold end container process coating, inspections, and packing line. This line will be designed to trial hydrogen fuels throughout the glass manufacturing process.

GFL is also working closely with a number of leading research groups in hydrogen technologies across the UK and EU, including Progressive Energy, CelSian, DNV-GL, Linde-BOC, Glass Service and the Universities of Leeds, Sheffield, Sheffield Hallam, Cambridge, Liverpool and Aachen (Germany).

Reason for submitting evidence.

Over the last two years, the Glass Industry, led by Glass Futures Ltd. (GFL) and British Glass Manufacturers Confederation (BG) and supported by several industry partners and academics, has undertaken extensive studies to assess the feasibility of hydrogen to replace the use of fossil fuels within the glass sector.

In 2019, Glass Futures published their findings from the IFS Phase 3 project into alternative fuels for the glass sector, which highlighted that, although hydrogen has potential to replace fossil fuels, there are many unknowns, both technical and economic, that need to be understood and addressed before the industry could commit to switching to hydrogen. A summary of these findings can be found in the following report:

Alternative Fuel Switching Technologies for the glass sector (publishing.service.gov.uk)

In 2020, Glass Futures secured £7.1m grant to run a follow-on project under the BEIS Industrial Fuel Switching Phase 3 funding scheme to run a series of practical demonstrations and economic studies into the viability of low carbon alternatives to fossil fuels within the glass sector. This project is due to finish mid-2022 and will provide greater insights into the technical and economic viability for the use of hydrogen fuel in glass manufacturing.

Evidence

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

- **the focus, scale and timescales of the proposed measures;**

The BEIS funded Industrial Fuel Switching programme has been very welcome, bringing together the glass sector and its supply chain for the first time to explore low carbon technologies such as hydrogen and playing a vital role in shifting the industry opinion towards the consideration of hydrogen as a potential future fuel for the industry. It is worth noting that the BEIS funding has enabled GFL to secure significant in-kind industry investment from the industrial partners involved in the project.

As such, with further investment along similar lines to the IFS scheme, it is believed that there is a realistic chance that a hydrogen glass furnace could be possible by 2030 (within the clusters), and so align with the UK Government's planned time-frame for roll-out of hydrogen. However a significant investment in R&D and plant infrastructure is required to realise this timeframe.

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

GFL's remit is to help the glass sector develop and de-risk technical solutions for employing hydrogen technologies within the glass sector. GFL is in close contact with other parts of the hydrogen supply chain (such as Progressive Energy, Cadent) to understand how the hydrogen might be delivered to glass plant and what the quality of this fuel will look like. GFL is also working with these groups to ensure knowledge exchange across common technological challenges, to avoid duplication of R&D efforts. It is recommended that future funding be made available to encourage such collaborations and knowledge-sharing activities to maximise the speed of new developments, as well as identify any new arising challenges as early as possible.

GFL has been working closely with a number of organisations across the other Foundation Industries (Steel, Cement, Ceramics, Paper, Chemicals) and has found there to be a number of common challenges that each sector needs to address in order to switch to hydrogen fuels at scale for high temperature processes such as burner designs, furnace control systems, new refractory technologies and waste heat recovery systems.

As such, GFL recommends that the concept of creating a national industrial hydrogen combustion centre should be considered, to develop and demonstrate new combustion technologies specifically for hydrogen fuels. Such a facility would be a good fit alongside the current GFL Pilot Facility being built in St Helens, especially given this site is likely to be connected up to the HyNet hydrogen network as early as 2026 and so be one of the first sites in the UK to have access to a piped hydrogen supply.

- **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;**

Due to the composition and volumes of the exhaust gases produced in the glass furnace, carbon capture at the glass plant will be a challenging and likely to be costly. As such, use of low carbon fuels such as hydrogen is an essential route to decarbonise glass melting processes. Many sites will not have the space requirements for CCUS or be situated near to CO2 pipelines.

The glass sector has no preference for how the hydrogen is made but would support CCUS technologies if essential to decarbonise hydrogen as a fuel.

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

As part of the IFS Phase 3 project, GFL and BG are working with Element Energy to develop an economic model that will benchmark the economics hydrogen fuels against natural gas and other green fuels, covering all CAPEX and OPEX implications. This model will provide a valuable tool to help glass manufacturers identify the costs and timings involved in switching to hydrogen.

Preliminary findings suggest that, although industry is likely to be willing to make some investment into infrastructure and systems changes, significant government support will be required to help manufacturers transition to hydrogen fuels whilst remaining competitive in the global market place. The glass sector is classed as at risk of carbon leakage and is on the EU list of industries exposed to carbon leakage and must be protected from increases in compliance and energy costs.

The glass manufacturing process does produce a significant amount of waste heat, so GFL is currently working with partners to explore how this could be used to generate low cost hydrogen which could be used to power the furnace. Some glass plants have a large footprint and there is scope to use this to install low carbon technologies to produce hydrogen.

There is an opportunity for the UK to become a leader in hydrogen technologies for the glass sector, which would provide a knock-on boost to the wider UK supply-chain within the hydrogen economy and that is likely to subsidise R&D efforts (demonstrated by the fact that the GFL IFS Phase 3 project has been able to secure in-kind support from over-seas partners such as Guardian Glass).

GFL also offers opportunities to provide training on the use of new hydrogen technologies to a global market, which could attract further investment, revenues and talent into the UK economy.

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;**

Within the IFS Phase 3 project, GFL is leading a series of lab studies exploring the dynamics of hydrogen combustion and how to address issues such as the low emissivity, NOx creation and foaming. These studies are due to be complete by the end of 2021. GFL is also liaising closely with other research groups investigating the use of hydrogen in glass making, including:

- IFS Phase 3 project led by Progressive Energy, looking to trial hydrogen fuels on a float glass furnace owned by NSG Pilkington (also a member of both GFL and BG).
- Lab studies at Aachen University into effects of hydrogen fuels on the glass chemistry.

However this work will only scratch the surface in terms of providing the necessary technical understanding to fully de-risk this technology. Significant further R&D funding is required to address the many challenges hydrogen poses.

Discussions with industry partners (manufacturers and the supply-chain) indicate that they are willing to cover some of the costs, but are unable to cover the full costs of this research and so subsidised government funded R&D programmes will almost certainly be a necessity to drive these developments at the necessary pace.

GFL and its globally unique pilot facility provide the UK with an opportunity to develop and trial new hydrogen technologies at an industrially relevant scale. With suitable government support, this facility can attract significant in-kind investment from glass manufacturers across the world to collaborate in developing the technologies required to make hydrogen fuels viable.

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 following section outlines some of the key challenges, identified within GFL studies, that will need to be addressed if hydrogen is to be adopted by the UK glass industry:

Technical Challenges

There are a number of unknowns that will require significant further work beyond the scope of the current GFL IFS Phase 3 project, including:

- Optimising the emissivity of hydrogen combustion flame to ensure efficient transfer of heat into the glass
- How the hydrogen combustion products will affect the glass melting process and the final chemistry of the glass (such as melting rates, glass colour, foaming)
- Techniques to address the likely higher NOx associated with hydrogen combustion due to the higher flame temperatures
- Refractory solutions that can cope with the higher moisture content of the combustion products
- Improving the efficiency of the hydrogen furnaces compared to carbon-based fuels with higher flame emissivity

There is a general consensus within the industry partners of the Fuel Switching project that the above challenges can be addressed with sufficient investment into R&D efforts, although there is a possibility that other fuels (e.g. bio-fuels) may need to be blended into the hydrogen supply for certain parts of the glass manufacturing process to achieve the required combustion dynamics and furnace atmosphere.

Engineering Challenges

Hydrogen gas behaves very differently to natural gas. As such, a switch to hydrogen from natural gas is likely to require changes to site infrastructure, including:

- Upgrading gas handling and furnace infrastructure to be ATEX rated
- Installation of hydrogen monitoring equipment around the site
- Upgrading pipework (to avoid the risk of hydrogen embrittlement and leaks)

Larger volumes of hydrogen gas are required to deliver the same thermal energy. As such modifications to the furnace and associated infrastructure will be required to manage the implications of this, likely to require a full furnace rebuild.

Furnace operators will need to be trained to operate a furnace with hydrogen effectively and safely. New Health and Safety measures and procedures, with associated training, will also need to be developed.

Commercial Challenges

Although this is an areas still under investigation, the provisional version of the GFL economic model indicates that significant CAPEX investment will be required to address the above technical and engineering challenges associate with switching to hydrogen. Sites may also have to invest in oxygen generation equipment, given the likelihood of having to operate oxy-fuel furnaces to mitigate issues with NOx.

The additional H&S measures are expected to increase OPEX.

There may be issues with hydrogen roll out as sites situated within clusters will have access to low carbon energy and potentially CCUS which could give them a competitive advantage over those sites outside clusters.

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

The site infrastructure changes required to transition to hydrogen have been discussed above.

Due to the volumes of hydrogen required by a glass furnace (which can require upwards of 750GWh of fuel/year), a glass plant would require a hydrogen gas pipeline to deliver the fuel to the site, as supply by truck will not be viable at this scale. A glass furnace must operate continuously, any disruption to the fuel supply for more than a few hours risks causing irreparable damage to the furnace. If there is any risk to the supply of hydrogen during the transition period, glass plants will need to have both hydrogen and natural gas supplied to site, which may required two separate pipelines.

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;**

The provisional economic model being developed within the IFS Phase 3 project is still under development and so it is not possible to draw definitive conclusions on the relative cost-benefit of hydrogen.   Needless to say, if a glass manufacturer is to be persuaded to switch, the cost of hydrogen fuel needs to be equivalent to natural gas plus carbon costs. If not, the glass sector will not be able to adopt this technology and still remain competitive in the global market place.

Although there is a high probability that the technical and engineering challenges can be addressed, it is expected that significant investment will be required to switch a glass manufacturing site from natural gas to hydrogen, likely requiring a furnace rebuild. As such, without suitable financial support/incentives, many sites will only switch when an existing furnace is replaced, which could delay the switch to hydrogen technologies. Typical glass furnace lifetime is 15-20 years, if hydrogen cannot be retrofitted to existing furnace the industry may benefit from a scrappage scheme to compensate writing off the asset.

There is a possibility that use of hydrogen could increase NOx emissions, but these can be largely be mitigated through use of oxy-fuel furnaces or additional abatement systems, albeit with an increased associated CAPEX and OPEX.

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.**

A comparison between hydrogen and other low-carbon fuel options can be found in the GFL IFS Phase 2 report: Alternative Fuel Switching Technologies for the glass sector (publishing.service.gov.uk)

At present it is not possible to say for certain which, if any, of the low carbon fuel options will be viable and which might be most cost-effective. In practice the most attractive fuel may well very depending upon location and plant size.

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