



Hydrogen ready appliances- the pathway

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Outline

The UK Government has committed to cut UK Green House Gas emissions to a Net Zero level by 2050. This will mean that all sectors of the economy will need to decarbonise at a faster and deeper rate than had previously been modelled for. In some sectors this is already well underway such as for electrical power, although gas still supplies a significant proportion of the demand at peak times. For other sectors the pathway to decarbonisation appears to be clear, such as utilising electric vehicles to decarbonise domestic transport. However, no single solution offers a simple route to decarbonisation and a mixture of technologies are likely to be required.

Heating sector

Decarbonising heat remains less clear. There are a number of technologies available, though all face significant barriers and complexity. Trying to mitigate costs is also a challenge, especially as millions of households in the UK are living in fuel poverty. The energy trilemma is at its most acute when it comes to decarbonising heat.

Currently there are broadly two main strategies for decarbonising the majority of homes in the UK; expansion of the electrical network with installation of heat pumps, or changeover to a low carbon hydrogen gas grid for properties on the existing gas network.



To meet our Net Zero 2050 targets, the Committee for Climate Change has suggested that both technologies will need to be employed in the future. However, neither direction has a mass market pathway established, and several trials are underway exploring each approach.

Decarbonising heat

For the roll out of hydrogen gas compatible appliances there are broadly two routes:

1. Installing hydrogen-ready appliances that work on natural gas and then, using a conversion kit, are modified to use hydrogen gas at a future date.
2. The other is that during the switch over to hydrogen gas, new hydrogen gas appliances are installed at the same time, which have left the factory configured and tested to burn hydrogen gas.



Hydrogen-readiness has been demonstrated in gas boilers, but this is more complex for domestic cooking appliances where a large variety of appliances are currently installed in UK homes. However, initial designs of hydrogen ready cooking appliances are now available.

This paper will not explore which option is best or even which is most desirable. The purpose of this paper is to establish the definition of hydrogen-ready domestic appliances that would be supplied with a 100% hydrogen gas concentration and includes boilers, cookers and gas fires. Any costs in this paper are assumptions based on industry information and use of available data.

Hydrogen Blend Projects

In the UK and Europe projects such as HyDeploy and THyGA are assessing the potential to add hydrogen to the current gas networks to reduce carbon emissions and introduce a greener gas.

HyDeploy is based at Keele University in Stoke-On-Trent and aims to prove that blending up to 20% volume of hydrogen with natural gas is a safe and greener alternative to the gas we use now. It is providing evidence on how customers do not have to change their cooking or heating appliances to use the blend, which means less disruption and cost for them. It is also confirming initial findings that customers do not notice any difference when using the hydrogen blend. It is anticipated that no changes to products in people's homes, commercial and process plants are required. In addition, there will be no changes to current working practices.

In addition to the consumer aspects, the project allows the industry to learn more about the distribution and working practices associated with hydrogen, along with production using electrolysis.

Note - these gas products are currently on the market and should be able to burn natural gas with a blend of up to 20% hydrogen and are not of the hydrogen-ready type discussed in this paper. Other projects in Europe are exploring the potential for gas appliances to burn a hydrogen blend, but these products are not of the hydrogen-ready type (100% hydrogen) discussed in this paper.

Hy4Heat – Hydrogen Appliances (100%)

The Department for Business Energy and Industrial Strategy (BEIS) has set up the Hy4Heat Research and Innovation Programme to explore a transition from natural gas to hydrogen gas for cooking, heating and hot water in the UK.



The programme is intended to establish if it is technically possible, safe and convenient to use zero-carbon hydrogen gas in residential and commercial buildings and gas appliances. This will enable the UK

Government to determine whether to proceed to a community trial phase.

Hydrogen ready product definitions (100% concentration)

Domestic Hydrogen-Ready Appliance

A gas appliance that “out of the box” is designed and approved to be installed for use with natural gas and, following a conversion and re-commissioning process in situ, can then operate safely and efficiently using hydrogen.

Hydrogen-Ready Boiler

A boiler of any type (Regular, System or Combination) that “out of the box” is ready to be connected to the Natural Gas Network and following a conversion and re-commissioning process in situ, can then operate safely and efficiently, maintaining equivalent comfort levels and providing a sufficient supply of heating and hot water using hydrogen.

Hydrogen Ready Local Space Heater

A gas fired local space heater of any type (Flue-less, Conventional or Balanced-Flue) that “out of the box” is ready to be connected to the Natural Gas Network and, following a conversion and re-commissioning process in situ, can then operate safely and efficiently using hydrogen.

Hydrogen Ready Domestic Cooking Appliance

A gas cooker of any type (Free-standing or Built-In cooking appliance) that “out of the box” is ready to be connected to the Natural Gas Network and, following a conversion and re-commissioning process in situ, can then operate effectively, safely and efficiently using hydrogen.

Note: - The hydrogen-ready appliance would initially be installed, commissioned and serviced exactly like a typical Natural Gas-Fired model and the normal British Standards, Building Regulations, Gas Safety Installation and Use Regulations would apply, as would the normal Gas-Safe Registration requirements with which installing engineers are required to comply.

When converting to hydrogen gas, the Hydrogen-Ready appliance can be converted using a small kit of components and a fast, simple procedure to burn hydrogen gas. The appliance would then be recommissioned by a suitably qualified, competent engineer. There is no need to exchange the appliance for a new version. For boilers, no re-plumbing work and the flue system, controls, heating system and pipework would all be retained.

Hydrogen-Ready Approval and Safety Testing

Each appliance manufactured and sold today is approved and tested to the Gas Appliance Regulation. In conjunction with other regulations and harmonised European and British standards, this allows manufacturers to apply the CE mark. CE marking is a certification mark that indicates conformity with health, safety, and environmental protection requirements for products sold within the European Economic Area. These requirements apply only to placing the product on the market, and thereafter the safe installation and commissioning of those appliances are the responsibility of the installer (Gas Safety Installation and Use Regulations GSIUR).

Note: -At time of writing, details of the UKCA mark have recently been published.

Supporting Standards

Currently, installation standards for appliances are the responsibility of the British Standards Institute and IGEM. These standards will require updating to include hydrogen gas.

PAS4444

BSI has developed a new specification, PAS 4444, to be used primarily in the Hy4Heat programme. The aim is that, along with the current European and British Standards, it forms the basis for wide-scale standardisation of hydrogen-fuelled appliances. It is an additional guide to be followed by appliance manufacturers and Notified Bodies regarding functionality, safety, installation, operating and servicing requirements for hydrogen-fuelled and dual-fuel hydrogen/natural gas convertible appliances.

All aspects of gas appliance manufacture currently require 3rd party certification, currently by an EU Notified Body. This includes any hydrogen gas conversion kit. This same arrangement would continue and encompass all aspects of the convertible appliance.

Hydrogen Gas Conversion Kit Approval

It is suggested that, as part of the approval submission of a Hydrogen-Ready Appliance, manufacturers would include in their risk assessment the hydrogen gas conversion kit and procedure, with instructions as per the Gas Appliance Regulation. The Notified body would assess the suitability and safety of the conversion kit along with the risk assessment. Approval of the Hydrogen-Ready appliance including the conversion kit would be obligatory to allow the use of the Hydrogen-Ready label, and the appliance would be registered in a suitable product data base.

Quality Control Example

Hydrogen-Ready appliances will be tested using current working practices for natural gas before leaving the factory. It is envisaged that, as part of the Quality Audit process, a number of hydrogen-ready appliances will be converted to the hydrogen mode and tested using a hydrogen supply. The audit plan will be based on a suitable Acceptable Quality Level (AQL).

Availability of Conversion Kits

Manufacturers would be responsible for approval and provision of the conversion kits. Providing details on which conversion kit fits a particular appliance along with the necessary conversion kit instructions. Suitable quality plans should be in place for suppliers of components included in the conversion kit.

Identification and Location

Information is required by gas distribution networks (GDNs) regarding which properties have Hydrogen-Ready appliances installed in order to know if the appliance installed in a home can be converted. For this, it would be beneficial for a label to identify a hydrogen-ready appliance to the end user, and include make, model and serial number.

A centrally-held database that links each hydrogen-ready installation location with the manufacturer and part number of the required conversion kit would assist with the conversion process.

Decision 1: The first decision is to agree a formal definition of a Hydrogen-Ready appliance. The challenge is to ensure that it remains simple and cost effective to install but also does not limit innovation or become anti-competitive.

Example

Currently, the industry definition of a hydrogen ready boiler is:

- Category II appliance (Cat II2H4(x))
- Conversion kit availability assured (by manufacturer) for product lifetime
- Conversion kit cost capped with reference to the product cost (under review)
- Total duration of conversion process, including commissioning, less than or equal to approximately 1 hour
- Conversion process requires standard skillset

Decision 2:

- i) Decide who will administer and manage the product database for all Hydrogen-Ready appliances along with details of the conversion kit.
- ii) Decide who will administer and manage the data base detailing location of the installed Hydrogen-Ready appliances.

Nationally Accredited Certification Scheme (ACS)

The conversion of individual appliances and the whole house gas system to hydrogen must be carried out by an appropriately qualified Gas Safe registered fitter working under the direct supervision of the Gas Distribution Network Operator that is undertaking the wider conversion. This is essential to ensure safe conversion. Upon conversion to hydrogen, the appliance must be re-commissioned to reflect the new gas qualities and the commissioning engineer must hold relevant qualifications in both Natural Gas and Hydrogen Gas.

Energy & Utility Skills will support the Hy4Heat programme to put in place the appropriate foundations and develop a “Competence Framework” for the training, accreditation, and registration of gas engineers working with hydrogen.

The framework will enable personnel working with hydrogen-burning gas appliances to acquire the required knowledge and skills to operate in a competent and safe way. This framework will address the gap that currently exists within the gas industry in relation to the training and registration of professionals to work with hydrogen in the domestic environment, and for a limited scope of non-domestic installations.

References

- <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law>
- <https://hydeploy.co.uk/>
- <https://www.hy4heat.info/>
- THyGA project <https://thyga-project.eu/>
- [euskills-new-competency-framework-for-hydrogen](#)
- [BSI PAS4444](#)
- <https://www.bsigroup.com/en-GB/iso-9001-quality-management/>