Institution of Gas Engineers & Managers

Resilience in our Future Energy Mix

IGEM Policy Position Paper
May 2022

About IGEM

The Institution of Gas Engineers & Managers (IGEM) is the UK's Professional Engineering Institution, supporting individuals and businesses working in the global gas industry. IGEM was founded in 1863 with the purpose of advancing the science and relevant knowledge of gas engineering for the benefit of the public.

As a not-for-profit, independent organisation IGEM acts as a trusted source of technical information, guidance and services for the gas sector. In today's net zero context, IGEM is focused on engineering a sustainable gas future – we do this by:

- Helping our members achieve and uphold the highest standards of professional competence to ensure the safety of the public
- Supporting our members in achieving their career goals by providing high quality products, services and personal and professional development opportunities
- Acting as the voice of the gas industry when working with stakeholders to develop and improve gas policy

Key messages

- In support of a resilient, flexible and secure future energy system, a mix of low carbon energy vectors and technologies must be harnessed.
- Hydrogen, biomethane, heat pumps, hybrid technologies, and to some extent heat networks, all have a role to play in the decarbonisation of heat.
- A 100% electrified energy system is impractical, due to the challenges of energy storage, intermittency, peak energy demand and the scale of infrastructure required by 2050.
- 8-12m homes are unlikely to be suitable for heat pumps, due to affordability, insufficient exterior space and/or the thermal properties of the building fabric.
- Which low carbon technology is used should be based on a local/regional as well as national level assessment, looking at factors such as local infrastructure/supply, building type and fabric, carbon savings potential, consumer preference and costs.
- An energy system based on hydrogen and biogases, alongside electrification, could save around £13bn a year by 2050 compared to an alternative pathway that relies on electricity alone.

Current context

The recent energy cost crisis, coupled with extreme weather events, have emphasised the importance of UK energy security and resilience. Storms, flooding and gales have caused devastation across the UK during the Autumn/Winter period, with many living without power to their homes. Those with gas fires, gas ovens and wood burners were able to continue heating their homes and cook, however those that were completely dependent on electricity were not able to do so. This serves as a vital lesson for our Net Zero energy policy makers considering how we heat our homes and businesses by 2050.

The current high cost of electricity and gas, driven by growth in global gas demand, poor weather conditions and ultimately higher wholesale gas prices[1], puts a greater emphasis on securing the UK's long term energy supply – relying less on imports and increasing UK based energy generation. This is in addition to the challenges presented by periods of low wind, the extended winter period for heating and the reduced storage capacity for gas since the closure of the UKs largest gas storage plant in 2017.

The recently published British Energy Security Strategy includes very encouraging commitments to wind and solar generation, an accelerated role for nuclear and a much amplified role for hydrogen for homes, industry and transport[2]. This approach suggests that the Government is embracing a multi vector energy future to achieve Net Zero.

The future energy mix

IGEM supports an integrated, 'whole-system' approach to meeting the energy transition challenge and welcomes UK Government support for a portfolio of low carbon technologies and projects. A portfolio with major roles for hydrogen, wind, nuclear, energy efficiency and demand response, that are optimised for lowest total system cost and balanced across local, regional and national levels.

A range of solutions for low carbon heating should be embraced, including proposals to use the existing network of gas pipelines to carry low carbon gases, such as biomethane and hydrogen blends, working towards the eventual use of 100% hydrogen. Recognising the role that heat pumps, hybrid gas/electric solutions and to some extent, heat networks, also have to play in the technology mix.

Natural gas should be replaced with a combination of hydrogen and biomethane, working in partnership with an increased use of electricity[3]. Analysis shows that a balanced combination of low carbon gases and electricity is the optimal way to decarbonise the UK energy system[4].

A 'Balanced Net Zero Pathway' is one also supported by the Climate Change Committee (CCC) as part of its Sixth Carbon Budget[5], where contributions to Net Zero by 2050 comes from a balanced mix of demand-side action, electrification, hydrogen, and natural and engineered greenhouse gas removals (GGRs).

[1] House of Commons, Research Briefing 9340 – The energy price crunch, January 2022
[2] HM Government, British Energy Security Strategy, April 2022
[3] ENA, Gas Goes Green Programme, www.energynetworks.org/creating-tomorrows-networks/gas-goes-green
[4] Navigant, Pathways to Net-Zero: Decarbonising the Gas Networks in Great Britain, October 2019
[5] Climate Change Committee, The Sixth Carbon Budget: The UK's path to Net Zero, December 2020

Electrification of heat

Using electrified technologies such as heat pumps, powered using renewable electricity, is a strategy that the UK Government is embracing as a way of making near term reductions in carbon emissions. However, IGEM's view is that heat pumps should not be the UK's only route to heat decarbonisation.

Those championing large scale electrification across the UK are urged to consider the risks and challenges associated with a predominantly electricity dependent energy system, and the opportunity that green gases offer in support of a flexible, secure and resilient energy portfolio.

With the phasing out of fossil fuels for road transport to make way for electric vehicles, considerable scaling up of electricity infrastructure is required. With a wide scale adoption of electrification of heat measures, the UK will see significant additional strain on electricity capacity. Analysis shows that a fully electric heating scenario will require approximately 314GW additional electricity generation capacity and will cost £123.8bn/yr from 2019 to 2050 (based on low levels of system flexibility)[6].

The characteristics of electricity have resulted in a sustained reliance on gas supplies. The variability of renewable generation, for example when wind levels are low, can result in insufficient electricity supply, particularly during periods of peak energy demand such as during cold winter spells. The often promoted pairing of heat pumps with solar PV presents anti-correlated supply and demand across seasons, and does not present a well thought-out solution that takes the dynamic energy system into account. Electrical infrastructure is also vulnerable to damage from extreme weather events.

Unlike the gas network, the electricity system has significant storage limitations. Although battery technology has advanced considerably, batteries alone will not be able to meet the scale of seasonal storage needs in the UK[7]. It is reported that replacing gas system flexibility (daily gas storage of 3.5 TWh) with batteries, would cost £1 trillion.

Heat pumps are an effective technology to heat buildings that have sufficient exterior space and/or have good thermal properties in the building fabric. Recent research suggests that out of the 22.7m homes assessed, 7–10m of homes are heat pump-ready – i.e. there are no limiting factors with minimal/no upgrade requirements, and 3-4m homes could be made suitable following energy efficiency improvements. However, this leaves 8-12m homes (37% to 54% of the sample group) that are deemed unlikely to be suitable for heat pumps. This is due to characteristics such as, solid brick walls, inadequate insulation and/or space constraints; qualities typical of flats and mid-terrace houses[8].

There are also cost implications to consider, for the installation of heat pumps and associated retrofit and energy efficiency measures. Research commissioned by the Department for Business Energy and Industrial Strategy (BEIS) reported that costs to install an air-source heat pump varied between £8,750 and £21,550 depending on factors such as heat pump size and interventions needed[9]. This does not include the additional costs associated with building fabric retrofit, which could include wall insulation, loft insulation and double glazing in those buildings with poor thermal properties.

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[6] Carbon Trust, Flexibility in Great Britain, May 2021
[7] Climate Change Committee, Hydrogen in a Low Carbon Economy, November 2018
[8] Energy & Utilities Alliance, Decarbonising Heat in Buildings: Putting Consumers First, April 2021
[9] Delta-ee, The Cost of Installing Heating Measures in Domestic Properties, July 2018

The need for green gases

One of the advantages of gas is its storability and capacity to balance daily and seasonal demand variations and provide flexibility in electricity supply. Approximately 40% of electricity supply in the UK is regularly being accommodated by gas generation[10]. Observations of live statistics from the national electricity grid has shown that this can flexibly range from 5-70% at any one time[11].

Since the decline of coal-fired power generation, gas has performed an increasingly important role in ensuring both the flexibility and security of UK energy. Research by the Carbon Trust, in their Flexibility in Great Britain report, evidences how crucial flexibility is for the security, agility and resilience of our future energy system – as well as minimising the cost of the energy transition[12]. The infrastructure supporting this flexibility comprises 1.44 billion m3 or ~15TWh of storage, eight interconnectors, four liquefied natural gas (LNG) terminals, as well as the inherent flexibility provided by line-pack (the ability to store gas within the transmission and distribution system itself)[13]. Each year the gas network provides around 100 TWh of cumulative daily linepack flexibility, offering a method of storing energy that is very low cost compared to other options, such as batteries and pumped storage[14].

The eventual replacement of natural gas with low carbon hydrogen presents the opportunity to decarbonise our gas network, whilst preserving the inherent flexibility and security that gas offers for heating and minimising the cost of the energy transition. An energy system based on hydrogen and biogases, alongside electrification, could save around £13bn a year by 2050 compared to an alternative pathway that relies on electricity alone – supporting lower energy bills[15].

A role for hydrogen

IGEM supports the application of hydrogen for heat, as well as back-up power generation, industrial processes and a range of transport applications. A position acknowledged by the CCC in its Sixth Carbon Budget, where hydrogen is seen as having the potential to play a material longer term role in buildings, certain industrial processes and heavy transport, in addition to providing flexibility with intermittency in the power system[16].

A crucial step towards this hydrogen ambition is the plan to blend hydrogen into the existing natural gas network, a commitment echoed in the 2020 BEIS Energy White Paper. The successful conclusion of the BEIS Hy4Heat project has laid the groundwork for the Government's plans for hydrogen neighbourhood and village trials, and indicates that the UK is one step closer to a hydrogen conversion of the gas grid[17].

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[10] Energy Trends and Prices statistical release: 27 January 2022

[11] http://www.gridwatch.templar.co.uk/download.php

[12] The Carbon Trust, Flexibility in Great Britain report, May 2021

[13] Institution of Engineering & Technology, Transitioning to hydrogen: Assessing the engineering risks and uncertainties, June 2019

[14] Dr Grant Wilson; University of Birmingham, Estimated cost of Great Britain's linepack flexibility per kWh of natural gas, January 2022

[15] ENA, Britain's Hydrogen Network Plan, January 2021

[16] Climate Change Committee, The Sixth Carbon Budget: The UK's path to Net Zero, December 2020

[17] Hy4Heat, Final Progress Report, April 2022

As part of the Gas Goes Green programme, Britain's Hydrogen Blending Delivery Plan sets out how the gas networks are readying to blend up to 20 per cent hydrogen on the gas distribution networks by 2023. This would result in 6m tonnes of carbon dioxide being saved per year, the equivalent of 2.5m cars being off the road. IGEM are actively supporting this programme of work through its technical leadership on gas safety and quality.

From a consumer perspective, the application of hydrogen for domestic heat offers minimal disruption to homes and businesses. No prerequisite building retrofit would be required and consumers would be able to continue using their heating and cooking appliances as they do currently. The UK's major boiler manufacturers have also made a price-promise that hydrogen-ready boilers will cost no more than natural gas equivalents. Crucially, hydrogen offers consumers choice in which energy vector they use in their buildings. These are factors overwhelmingly supported by the general public, as evidenced through the work of Climate Assembly UK[18].

Concluding points

Building energy resilience, flexibility and security must underpin how the UK decarbonises its energy system in the lead up to 2050. This can only be achieved through the use of a balanced mix of energy vectors and technologies.

Choosing the right low carbon technologies should be based on a range of carefully assessed factors depending on the application. For the decarbonisation of heat, IGEM rejects calls for the full electrification of heat across the UK. An assessment should be made at a local/regional and national level based on what local infrastructure/supply is in place, a building's type and fabric, carbon savings potential, consumer preference and costs.

Testing and trials of hydrogen are ongoing, overseen by the Health & Safety Executive and BEIS. As the conclusions of these trials continue to emerge, industry experts and policy makers must work together, with urgency, to articulate hydrogen's long term role in the energy mix and implement the policies required to develop a flourishing hydrogen economy.

[18] Climate Assembly UK, The Path to Net Zero – Full Report, September 2020

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