Manchester Metropolitan University

Manchester Fuel Cell Innovation Centre

Greater Manchester Hydrogen and Fuel Cell Strategy 2021–2025

How clean energy can help deliver Greater Manchester's 2038 decarbonisation ambition

GMCA GREATER MANCHESTER COMBINED AUTHORITY

Contents

Foreword

The analysis in this strategy was conducted in close collaboration with government, industry and academia and led by Manchester Metropolitan University's Fuel Cell Innovation Centre and MetroPolis think tank.

Our analysis has identified the most promising immediate opportunities to provide a view of the near-and long-term landscape and to mitigate the need for more widespread infrastructure change that a wholesale shift to alternative low carbon energy sources would require. It also builds on the work of the Greater Manchester Hydrogen Partnership (GMHP) which was founded in 2013 at Manchester Metropolitan University to develop and support hydrogen technology projects and embed a successful hydrogen economy in the wider North West region.

Hydrogen and fuel cells have the potential to help deliver very low emissions pathways. As a low carbon energy source, increased use of hydrogen and fuel cells can have a noticeable effect on carbon emissions simply by providing a cleaner alternative and at a scale far greater than any other potential route. There is recognition in the region of the importance of hydrogen and fuel cells and what they bring to the decarbonisation route for Manchester, with its ambition of being net zero carbon by 2038.

The Manchester Fuel Cell Innovation Centre (MFCIC) at Manchester Metropolitan University is a regional hub for research, innovation and economic growth in the hydrogen and fuel cell technology sector in the North West and beyond.

The Centre is part-funded by the European Regional Development Fund (ERDF) and is crucial both environmentally and economically for the region, as the UK focuses on increasing its use of renewable energy and lowering carbon emissions.

Executive Summary

To deliver the 2038 net-carbon-zero Greater Manchester target, full decarbonisation of all sectors is necessary.

This report highlights the activities and policy initiatives taking place across the Northern Powerhouse to position the North for the introduction of hydrogen as a component of the decarbonised energy mix.

The state of readiness of current technologies is assessed. A number of short-term, no-regrets recommendations are made to position the Greater Manchester region for the arrival of large volume hydrogen supplies in the late 2020's.

To make widespread use of hydrogen a reality in the future, government, local authorities and academic institutions can take a positive lead in directing the way forward. Cooperation and support from central government is crucial in order to facilitate changes towards new carbon free energy and unlock business opportunities and on scale deployment. This can be achieved by providing financial schemes to support demonstration projects, regulation/incentives on clean fuels, and emission penalties to make end users and industries desire environmentally friendly solutions. This would drive the demand and change social perception making new and high-risk technologies seen as accessible and risk-free, a reliable clean-swap solution.

The report focusses on delivery in 3 phases:

- Phase 1 2020–2025: Establish Transport Supply Chain and Build Confidence in Wider Hydrogen
  - Recommendation 1: Use public sector HGV vehicle to lead FCEV switch
  - Recommendation 2: Utilise air quality policy to drive uptake by HGVs and Buses
  - Recommendation 3: Planning for wider hydrogen refuelling station deployment
  - Recommendation 4: Evaluate hydrogen as replacement for diesel rail.
  - Recommendation 5: Support innovation and demonstration of hydrogen for heat.
  - Recommendation 7: Utilise academic expertise and facilities to support innovation.
  - Recommendation 9: Support educational institutions to develop courses that deliver skills for the hydrogen economy.
- Phase 2 2026–2030: Prepare for the availability of large volume hydrogen supply
  - Recommendation 6: Prepare for the availability of large volume hydrogen supply.
  - Recommendation 8: Support reskilling of those already in the labour market.
- Phase 3 2031–2028: Establishment of a CO_2-free hydrogen supply system. This phase will focus on wide scale deployment to support the move to a hydrogen economy.

Introduction

As the challenge of climate change grows, the search for low carbon energy sources has become critical. The interest in hydrogen and fuel cells is now gaining an unprecedented momentum around the world as a clean solution which meets multiple needs. Whilst initially for domestic energy, public transport and private vehicles, the potential uses of the technology are enormous.

Like cities across the UK and all over the world, Manchester faces the challenge of reducing emissions to limit the impact of climate change and meet the targets set out by the 2015 Paris Agreement.

To seize this opportunity, government and the private sector need to take ambitious and real-world actions now. This important strategy, which has been prepared with a number of stakeholders under the guidance and support of the Greater Manchester Combined Authority, provides an extensive and independent assessment of hydrogen and fuel cells. It lays out where things stand now; the ways in which hydrogen and fuel cells can help to achieve a clean, secure and affordable future energy; and how we can realise its potential in the region and beyond.

Greater Manchester does not have a single plan setting out how it will meet its climate change targets. However, widespread adoption of hydrogen and fuel cell technology offers a potential route.

The high-level objectives driving this strategy are as follows:

- To align to the wider North West region and Northern Powerhouse agenda
- To support the North West in becoming the UK's first Low Carbon Industrial Cluster. Government wants this to be in place by 2030 and is looking at mobilising £500m of investment in the low carbon industry to facilitate that goal
- To integrate with the Greater Manchester Environment and Whole System Smart Energy Plan[1], the focus of which is energy generation and storage, decarbonisation of heat and low carbon transport
- To act as a realistic roadmap to defining a comprehensive research programme that will bring stakeholders together and ensure Greater Manchester's growing clean energy strengths play a part in the global movement to mitigate climate change.

1 Energy Systems Catapult 2019 SSH Phase 2 D40: Whole System Smart Energy Plan Greater Manchester

The Challenges

Despite significant advances in the decarbonisation of the electricity supply system at both the national level (18% of energy consumption) and local Greater Manchester level (23% of energy consumption), electricity represents only a small part of the overall energy supply (Figure 1[2]).

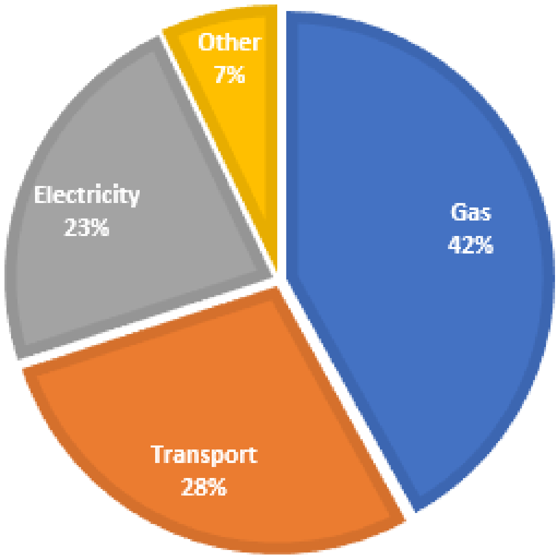

Figure 1 GM Energy consumption

The carbon intensity of electricity generation in 2018 had fallen to 32% of the level in 1990[3]. In contrast, there has been little progress in the decarbonisation of the heat sector, which is mainly delivered by natural gas, and the transport sector.

For the transport sector, the Government's Committee on Climate Change[4] stated that battery electric vehicles (BEV) are well placed to deliver the bulk of decarbonisation for cars and vans. However, of the 1.3 million cars and vans registered in Greater Manchester at the end of 2018, only 3,200 (0.24%) were plug-in vehicles.

Domestic, commercial and industrial heating is responsible for around a third of the UK's overall emissions, which is unchanged from 2009.

There are two basic technical ways to reduce the carbon emissions associated with heating – either by reducing demand through energy efficiency measures or by replacing fossil fuel heating systems with less carbon-intensive versions.

The UK Context

Policies implemented worldwide to reduce our carbon footprint make the move to renewable and clean energy sources inevitable. This is especially the case in the UK, which has committed to zero carbon by 2050.

There are already hydrogen refuelling stations and fleets of Fuel-Cell Electric Vehicles (FCEVs) trucks, buses and taxis running on hydrogen on Britain's roads. There are projects that support further hydrogen network development: focusing on fuel station deployment, looking into the way we heat our houses and assessing how much carbon is generated by UK industry.

Hydrogen offers a unique opportunity to decarbonise across the heat and transportation sectors, as well as providing a long and short-term storage option for electricity generation.

Whereas the supply and demand of electricity must be matched with second-by-second response times at the site of power generation, hydrogen can be supplied from a store, meaning that the investment required in hydrogen production does not need to meet peak demand – as long as there is sufficient capacity to maintain the stores.

National Grid has identified that "green gas" has a major role to play in decarbonisation across heat, transport and industry when supported by approaches that address:

- Whole energy system approaches
- The development of new products and services
- The use of Carbon Capture Usage and Storage (CCUS).

Hydrogen has the potential to meet the majority of these "green gas" supply stipulations. Its production potential is not limited by the availability of feedstock. This contrasts with biomethane where national domestic feedstocks, food and agricultural waste, and would be limited to circa 100TWh/y which represents around a third of domestic gas demand and a tenth of total natural gas demand[5].

2 Source Greater Manchester Spatial Energy Plan Evidence Base Study
3 Data provided by Committee on Climate Change
4 Committee on Climate Change: 2020 Reducing UK Emissions – Progress report to Parliament
5 T Isacc 2019 Why Hydrogen – The Chemical Engineer www.thechemicalengineer.com/features/why-hydrogen

The opportunity for Greater Manchester

The North of England is poised to be the primary region for the development of a decarbonised, hydrogen-based energy market for the UK. It already features all the necessary components to develop a hydrogen economy – thriving industrial and manufacturing base, the capability to address the re-skilling of an existing workforce, city regions that collaborate, and natural assets.

The North has infrastructure advantages in key areas, such as hydrogen, tidal and marine energy, and energy storage capability with the potential for further scaling up. It is leading the UK's transition to renewable energy with nearly half of the UK's renewable energy being generated in the North England.

However, to become the leading low carbon energy region, Local Enterprise Partnerships (LEPs), local and combined authorities and academic institutions must take the lead in working collaboratively and directing the way forward together.

It is important for key stakeholders in the North to set their own vision and priorities for action, based on regional strengths, in order to equip local businesses and industry sectors with the necessary technological know-how and equipment to succeed in the new clean and renewable energy landscape. Central government, regulators and other national bodies must, however, support these efforts to enable opportunities to be seized, ensure a level playing field for northern businesses and unlock investment and positive change[6].

A number of northern local authorities have already demonstrated commitment to local energy strategies and initiatives. They acknowledge the importance of hydrogen and its economic value and understand the opportunities it could bring to their region. Examples of northern local energy strategies include:

- Liverpool City Region H2 Project – a pipeline £6.4 million project funded by the government's Office for Low Emission Vehicles (OLEV). The project aims to:
    - create a new hydrogen refuelling station at the BOC plant in St Helens that will initially deliver 500 kg of hydrogen per day
    - deploy up to 25 hydrogen-powered buses on the streets of Liverpool[7].
- H21 Leeds City Gate – a demonstration project converting Leeds' natural gas network into 100 % hydrogen. The project aims to:
    - determine the feasibility of converting from an economic and technological point of view
    - minimise disruption to existing customers
    - deliver heat at the same cost currently incurred by natural gas[8].
- HyTees – UK Research and Innovation project that focuses on the production, industrial use and storage of green hydrogen in Tees Valley and the transition of domestic gas in Leeds City Region to hydrogen. The project aims to:
    - deliver whole energy systems
    - provide demonstration, skills and training support to industry
    - provide equipment and machinery to support the transition by the associated manufacturing sector[9]
    - promote hydrogen vehicles and refuelling infrastructure through a £1.3 million grant from OLEV that will deliver five new hydrogen-refuelling stations, 73 fuel cell passenger vehicles and 33 fuel cell buses across the UK[10]

These projects are supported by wider Local Enterprise Partnership projects:

- The North West Energy and Hydrogen Cluster covers the industrial powerhouses of the Liverpool and Manchester City Regions as well as Cheshire and Warrington. It has a low cost and low risk approach to carbon capture utilisation and storage (CCUS). This project meets Government policy objectives for industrial decarbonisation to be both low risk and low cost and will secure and grow high value manufacturing jobs. The vision is to reduce carbon emissions by over ten million tonnes per year and create in excess of 33,000 new jobs by 2030[11].
- The North East Local Enterprise Partnership's Energy for Growth strategy aims to drive economic growth in the North East while also bringing sector partners together to deliver at scale on national energy strategy. It has a target of 100,000 more and better jobs by 2024[12].

Implementation of a hydrogen energy supply deployment strategy would contribute to a number of the priorities in the Greater Manchester 5-year Environment Plan (Figure 2).

6 Northern Energy Taskforce, 2017
7 LCR LEP, 2015
8 H21, 2017
9 Mark Lewis, 2019
10 TVCA, 2019
11 (NWEHC, 2019)
12 (NELEP, 2019)

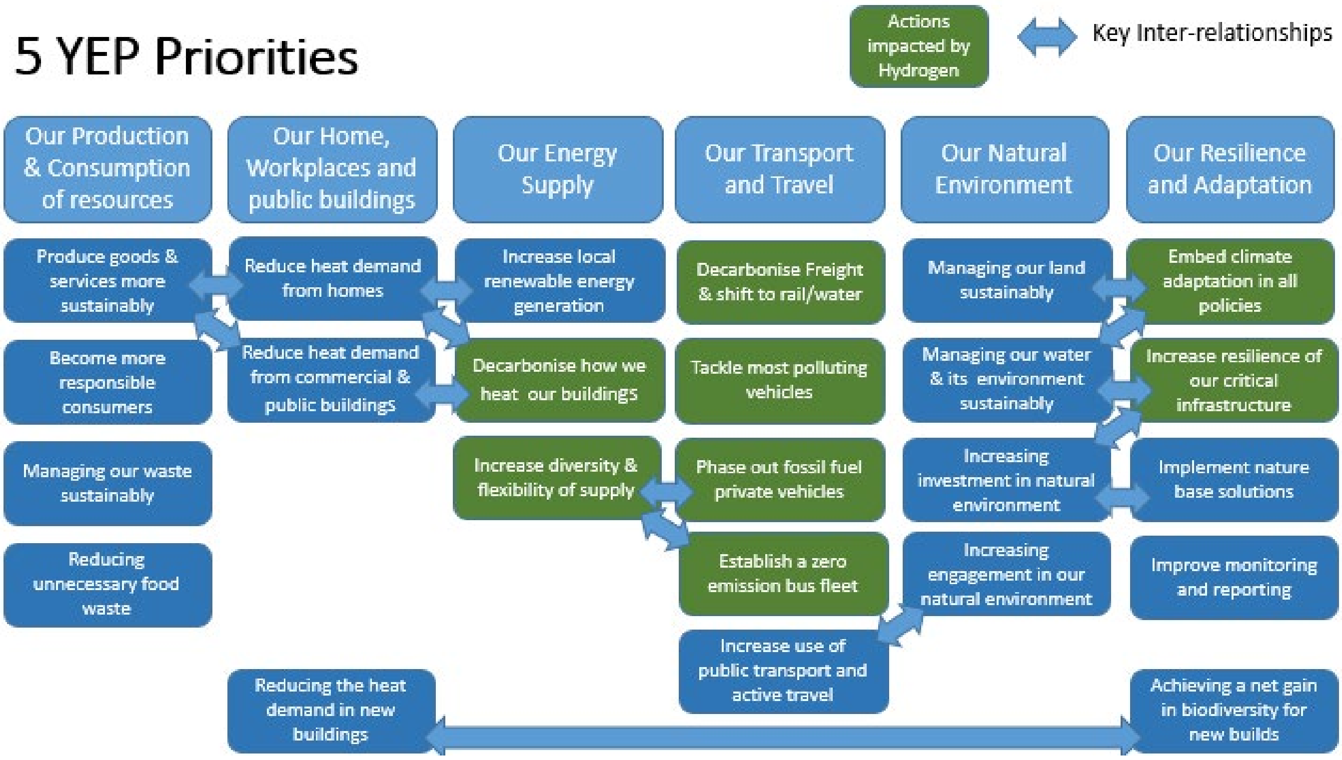

Figure 2 Hydrogen Impact on GM Environment Plan Priorities

European City Region Opportunities

The EU Fuel Cells and Hydrogen Joint Undertaking launched the region's initiative in 2017. It attracted 89 regions and cities from 22 countries and more than 55 industry partners. The Greater Manchester city region was represented in the study by Manchester Metropolitan University. The report identified the important role regions and cities can play in creating a future fuel cells and hydrogen (FCH) market in Europe by channelling public investments into the sector and supporting the build-up of a European FCH value chain.

As Figure 3 shows, there is the potential for multiple additional benefits for cities and regions beyond decarbonisation and these include economic growth, job creation and workforce skills, and environmental benefits[13].

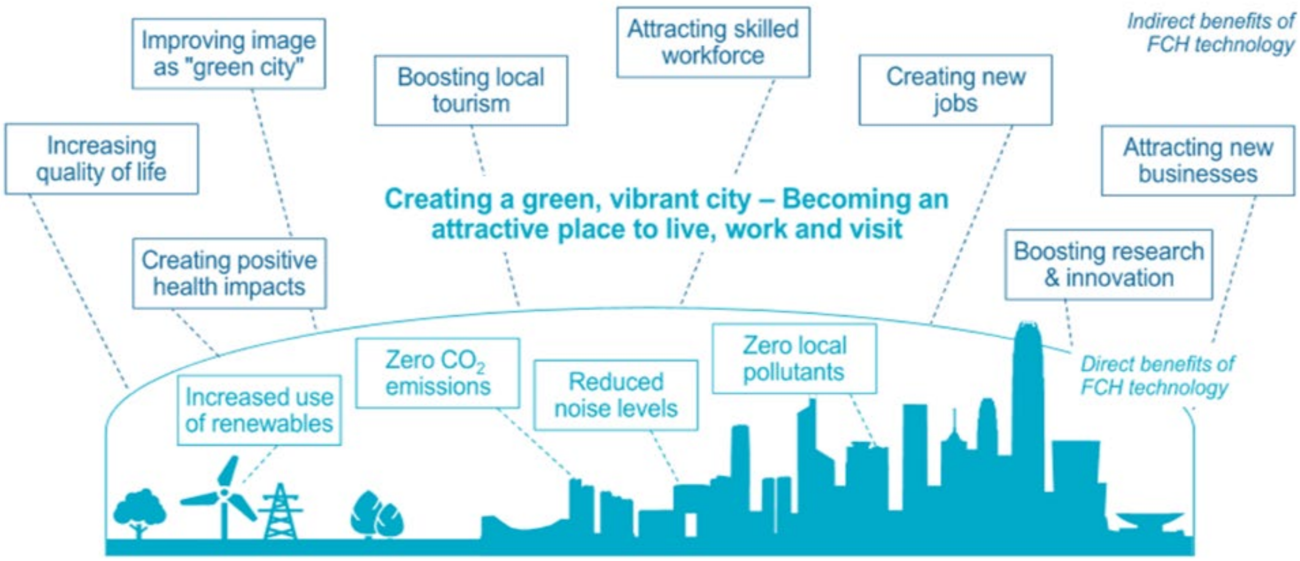

Figure 3 Local Benefits of hydrogen and fuel cells for cities and regions

13 (Roland Berger, 2018)

Gaining the Benefits of Hydrogen and Fuel Cells for Greater Manchester

Phase 1 2020–2025: Establish Transport Supply Chain and Build Confidence in Wider Hydrogen.

In this phase we seek to take advantage of existing hydrogen and fuel cell technologies to establish demand and build business and public confidence in the move to hydrogen as part of the energy supply mix.

During this phase the following recommendations should be delivered:

- Recommendation 1: Use public sector HGV vehicle to lead FCEV switch
- Recommendation 2: Utilise air quality policy to drive uptake by HGVs and buses
- Recommendation 3: Planning for wider hydrogen refuelling station deployment

In addition, work should commence on the following recommendations:

- Recommendation 4: Evaluate hydrogen as replacement for diesel rail.
- Recommendation 5: Support innovation and demonstration of hydrogen for heat.
- Recommendation 7: Utilise academic expertise and facilities to support innovation.
- Recommendation 9: Support educational institutions to develop courses that deliver skills for the hydrogen economy.

Phase 2 2026–2030: Prepare for the availability of large volume hydrogen supply.

With the planned delivery of large volume hydrogen supplies anticipated in the late 2020's this phase will prepare the businesses and the work force for the new opportunities this will offer.

Recommendations commenced in phase 1 should continue to be delivered.

In addition, during this phase the following recommendations should begin delivery:

- Recommendation 6: Prepare for the availability of large volume hydrogen supply.
- Recommendation 8: Support reskilling of those already in the labour market.

Phase 3: 2031–2028 Establishment of a CO_2-free hydrogen supply system.

This phase will focus on wide scale deployment to support the move to a hydrogen economy.

Recommendations commenced in the previous phases will have provided the foundations for this deployment and the focus will therefore be on their commercial uptake.

The Technology

Hydrogen Supply

Although hydrogen (H_2) production is a mature technology with over 70 million tons produced worldwide per year, nearly all hydrogen is currently produced from fossil fuels.

For hydrogen to become a viable decarbonised energy vector, low and zero-carbon hydrogen production will need to be deployed using one of the four established technologies:

- steam reformation of methane (SMR) with carbon capture, utilisation and storage (CCUS)
- auto-thermal reforming (ATR) of methane with CCUS
- electrolytic production of caustic soda which produces hydrogen as a by-product
- electrolysis of water (H_2O) using alkaline electrolysis for bulk supplies or proton exchange membrane (PEM) electrolysers for smaller or local supplies.

The purity of the delivered hydrogen is an important consideration for selecting hydrogen generation technology. The semiconductor industries require extremely pure hydrogen (>99.9999%) for technologies such as chip fabrication but petroleum refining processes require only 80–90 % purity. Hydrogen fuel cell technologies are currently rated for <0.2 ppm CO and 1.0 ppm CO_2 impurities under operating conditions.

Large scale production of hydrogen (SMR and ATR) is located close to disused off-shore gas fields to provide the necessary long-term stores for carbon dioxide.

The Institution of Engineering and Technology (IET) has estimated that to produce sufficient hydrogen to heat Greater Manchester's 1.2 million homes would require electrolyser capacity of 140GW. This would have an estimated footprint of 1,000 hectares and a water demand equivalent to 0.3 million homes[14].

In the short term, the use of PEM electrolysers to service transport demand for hydrogen is the most likely mechanisms to provide a hydrogen supply. This scalable technology is well established and widely deployed both in the UK and internationally for on-site hydrogen generation.

Two of the UK's potential hydrogen production projects, HyNet and H21 North of England, propose the construction of hydrogen supply pipes to service Greater Manchester.

HyNet, with production on the Wirral, would service the Greater Manchester and Liverpool city regions with an anticipated supply from 2026. The estimated price for heat delivery using hydrogen from HyNet is currently£38/MWh, which represents a £23/MWh uplift on today's natural gas price of around £15/MWh.

H21 North of England envisages a trans-Pennine link between the Tees-based hydrogen production facilities that will supply Leeds and HyNet. Estimated timescales are 2028-2035. Indicative prices are not yet available.

Supply Options 2021–2026

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Supply Options from 2026

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14 IET 2019 The Future of Hydrogen

Fuel Cell Types

Fuel cells come in two basic types: polymer electrolyte membrane fuel cells (PEMFC) or solid oxide fuel cell (SOFC). PEM fuel cells are primarily used for transport applications and SOFC for stationary applications.

Today's PEMFCs have an efficiency rating of approximately 60 %. A PEM-FC unit of 25 kW costs ~$1,350/kW in CAPEX (total capital cost, assuming 50,000 units). This is expected to fall dramatically as the scale of production ramps up, driven largely by the take-up by vehicle manufactures, for example, the Toyota Mirai, Honda Clarity and Hyundai Nexo.

Unlike batteries, fuel cell technologies decouple storage from the power-generating portion of the device. So in terms of volume and weight, these two energy storage technologies scale very differently from each other. In the case of a battery, to double the capacity (energy stored), one must double the volume of the module. Conversely, to double the capacity of a hydrogen fuel cell, the volume of the storage tank is doubled, not the fuel cell.

Today, hydrogen fuel cell technologies are used predominantly in the transportation sector, although stationary backup power generation fuel cells are also available commercially and deployed in a few locations.

One important note regarding PEM-fuel cells is that this technology cannot tolerate >0.2 ppm CO concentrations in the hydrogen streams.

SOFC systems, which run on natural or bio-gas as well as hydrogen, are replacing diesel generators as backup and stand-by emergency power generators. While these systems are largely solid oxide fuel cells, some manufacturers already sell backup PEM-FC generators tailored for micro-grid applications, as well as baseload power rated at 1 MW.

Beyond power generation, fuel cells also generate heat during their operation. This offers the opportunity for combined heat and power (CHP) applications, particularly for heating residential and commercial buildings, due to their high electrical efficiencies and lower power-to-heat ratio.

Use of Hydrogen

Hydrogen Use for Road Transport

Two technologies are currently available for the use of hydrogen by the transportation sector:

- Partial decarbonisation can be achieved by adapting diesel engines to operate as dual fuel hydrogen-diesel internal combustion engine. Ultra-low emissions vehicle conversion company, ULEMCo, based in Liverpool, are a leading supplier of this technology.
- Complete decarbonisation can be achieved using proton exchange membrane fuel cell (PEMFC) in Fuel Cell Electric Vehicles.

Hydrogen produced by electrolysis is perfect for transport fuel as it produces hydrogen at the very high levels of purity required by PEMFC. The use of electrolysers also provides an additional “demand side management” balance resource for the electrical power system.

Recommendation 1: Use public sector HGV vehicle to lead FCEV switch

Build on the leadership of Manchester City Council in the switch of refuse collection vehicles to low-carbon technology project to identify a location for investment in hydrogen refuelling infrastructure. Encourage the wider use hydrogen fuelled vehicles that operate in return-to-base fleets of vehicles, for example: emergency services, public buses, refuge collection trucks.

Air Quality

Focusing initial transport decarbonisation on heavy vehicles has a disproportionately positive impact on air quality (Table 1).

HGVs as % all vehicles	2%
HGV miles as % of all miles	6%
HGV GHG emissions as % all roadside GHG	16%
HGV NOx emissions as % all roadside NOx	21%

Table 1 HGV Contribution to GHG and NOx Emissions

While decarbonisation is the longer-term driver for the deployment of hydrogen fuel cell transport, the more immediate driver is likely to be the need to address NOx pollution levels Data shows that Greater Manchester has been in breach of its legal limits for nitrogen dioxide every year since 2011[15]. New diesel road vehicles are required to meet Euro 6 emission levels while diesel rail is still at Euro 3 emission levels.

A policy focus of switching HGV and diesel rail to hydrogen fuel cell will therefore have a more immediate impact on the levels of air pollution while also contributing to the longer-term decarbonisation objective.

Recommendation 2: Utilise Air Quality Policy to Drive uptake by HGVs and Buses

In the short term to 2026, hydrogen policy should focus on the air quality benefits that can be achieved by deploying low carbon transport actions including the use of hydrogen for HGVs and buses.

Hydrogen Fuel Cell Fuelling Stations

Deployment “at scale” of hydrogen fuel cell vehicles is often described as a chicken-and-egg situation. Without the infrastructure to refuel, who will buy fuel cell vehicles? With few fuel cell vehicles on the road, who will fund the refuelling infrastructure?

Typical refuelling of light weight FCEV requires 4–5kg of H_2 at 700 bar, taking 3–5 minutes to refuel. HGVs and Buses, wth their larger size, can be refuelled at 350 bar.

The NW based HyNet project has estimated likely pump prices for hydrogen (Table 2). For comparison, 1kg of hydrogen is roughly equivalent in mileage terms to 1 litre of diesel.

Hydrogen source	£/Kg of H_2
On-site Electrolysis	£11.40
Off-Site Electrolysis	£6.40
Within 1km of HyNet Pipeline	£3.60

Table 1 Cadent's Estimated Fuel Pump Price for Hydrogen (without tax)

15 Source TFGM

The UK Hydrogen Mobility Committee, representing companies in the hydrogen and vehicle supply chain, has submitted a proposal to the Department for Transport to establish an industry support programme in phases, according to financial stability:

- Phase 1: 2019 – capital support for 250 cars, 100 buses and 20 hydrogen refuelling stations (HRS) with fuel subsidy to bridge the cost between on-site electrolysis and the current price of diesel
- Phase 2: 2023 – capital support for 600 new vehicles including buses and trains and an increase in the number of HRS plus fuel subsidy to the off-site electrolysis price
- Phase 3: 2025 – capital support for a further 4,000 vehicles and fuel support until pipeline supply established.

This would be part-funded via the renewable transport fuel obligation on fuel retailers.

The Institute of Engineering and Technology has concluded[16]: "The development of hydrogen infrastructure is slow and holding back widespread adoption. Hydrogen prices for consumers are highly dependent on how many refuelling stations there are, how often they are used and how much hydrogen is delivered per day. Tackling this is likely to require planning and coordination that brings together national and local governments, industry and investors."

Recommendation 3: Planning for Wider Hydrogen Refuelling Station Deployment

Review the capacity in the local electrical network for supporting the installation of hydrogen electrolysers for transportation use alongside the growth of Battery Electric Vehicle (BEV) recharging infrastructure.

Hydrogen for Rail Transport

The Institute of Mechanical Engineers (IMechE) has studied the options for decarbonisation of the rail system in the light of the Government announcement of the elimination of 2,400 diesel trains by 2040. While the preferred option would be electrification, a significant part of the network is unlikely to be electrified for both technical and economic reasons and in these cases, hydrogen powered trains are identified as the best option[17].

Greater Manchester lies at the heart of a largely non-electrified network (Figure 4) and is therefore ideally located for the deployment of hydrogen powered trains.

However, current rail operator franchises do not allow for the costs of the introduction of hydrogen-powered trains. Local political support would be required to enable the companies to re-negotiate their franchise agreements with the Department for Transport.

Alstom estimate that the lead time to the delivery of the first hydrogen trains at 40-50 months because of the need to establish regulatory approvals.

Fuel prices continue to be an issue for rail as rail currently uses red diesel.

Recommendation 4: Evaluate hydrogen as replacement for diesel rail.

Work with Network Rail and local train companies to evaluate those lines that are not economic to electrify and support any required change to franchise agreements to allow investment in hydrogen powered trains for these lines.

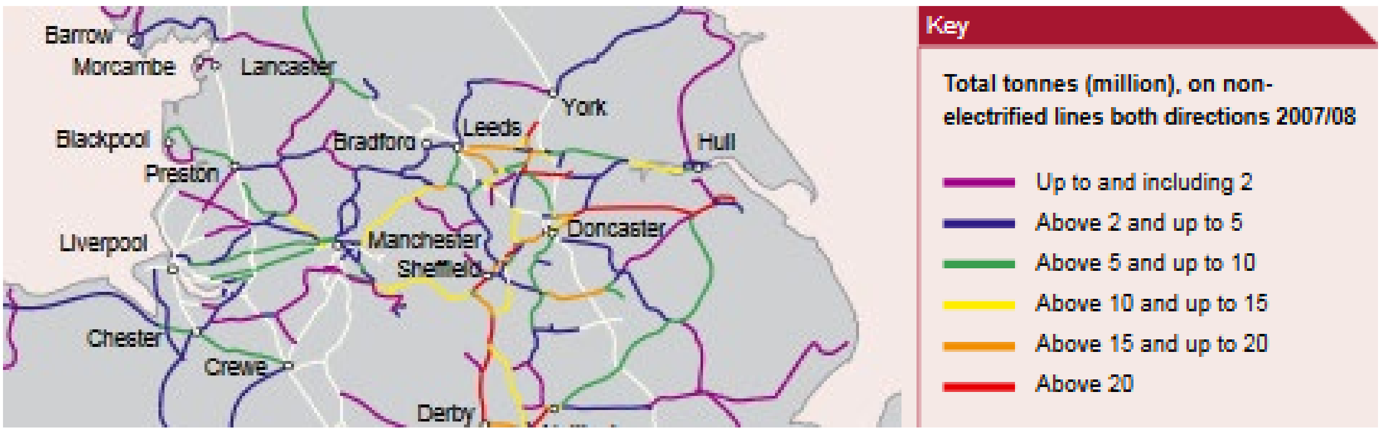

Figure 4 Non-Electrified Rail Network

16 IET 2019 The Future of Hydrogen
17 "The future for hydrogen trains in the UK", IMechE

Hydrogen Use for Heat

95% of postcodes in Greater Manchester are connected to the gas grid. Gas is primarily used for space and water heating and in 2017 it totalled 42% of the total energy consumption, contributing 34% of total CO_2 emissions[18].

The challenge for decarbonising heat is not only this total energy consumption, but the very high peak demand and daily and seasonal variability which does not easily lend itself to being met by an energy vector without high levels of built-in storage (Figure 5).

Peak gas demand in winter is typically 2–3 times peak electrical demand but on very cold days it can reach 3.5 times. Hence, a very significant investment in electrical generation and supply infrastructure, combined with extensive retrofit, would be required to bridge this energy gap.

The Institute of Engineering and Technology have analysed the decarbonisation of heat and shown that only hydrogen and district heating are able to provide similar heat performance to natural gas (Figure 6).

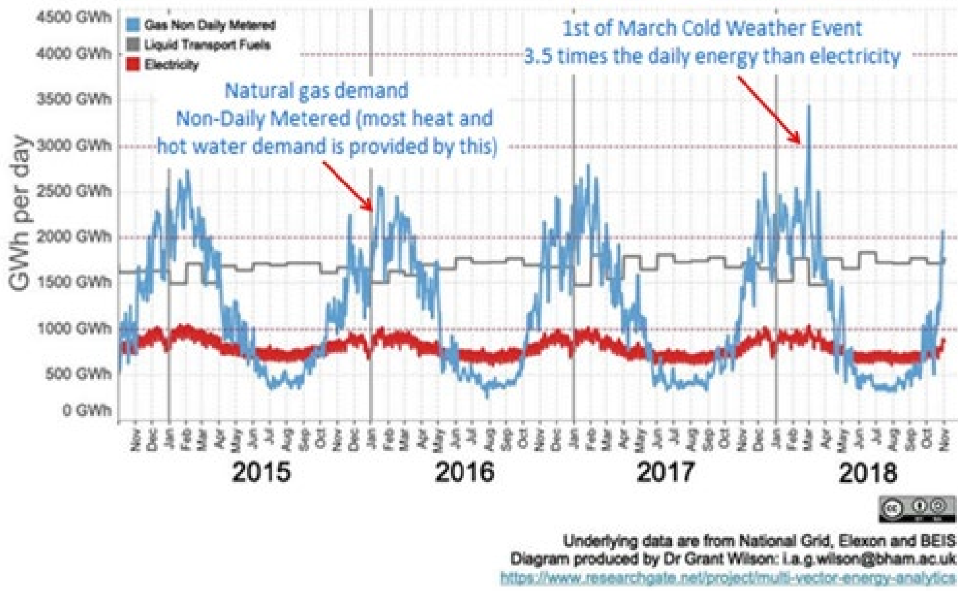

Figure 5 Great Britain's Energy Vectors – daily demand for energy in GWh per day courtesy of Dr Grant Wilson University of Birmingham (Wilson, 2018)

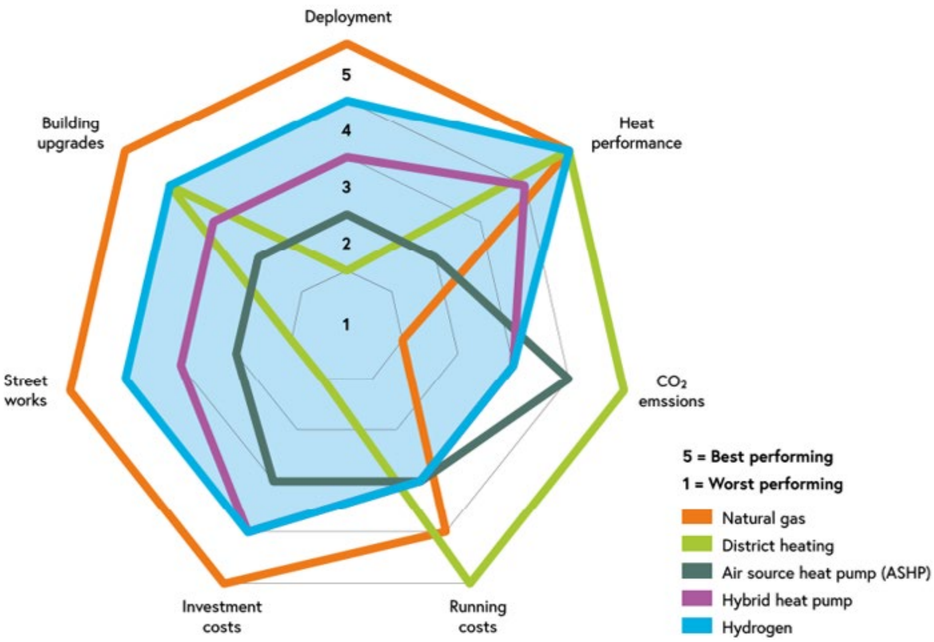

Figure 6 Comparison of Natural Gas and Low Carbon Heating Systems for Mass Retrofit in Domestic Properties

18 UK local authority and regional carbon dioxide emissions national statistics: 2005–2017

Safety and environment

A number of projects are working to establish the safety of hydrogen within the gas system. This is complicated as blends of hydrogen with natural gas fall within the Gas Act while pure hydrogen supply does not, although this is under review.

The Health and Safety Executive, which has responsibility for enforcing Gas Safety Management Regulations within the Gas Act, has stated that approvals will only be given where it is demonstrated that the proposed change is “no less safe” than the current situation.

Recommendation 5: Support Innovation and Demonstration of Hydrogen for Heat.

Prior to the availability of large volume hydrogen supplies innovation and demonstration projects for the delivery of heat using hydrogen will build confidence to building owners.

Hydrogen and Natural Gas Blending

Ofgem, the government’s regulator for UK gas and electricity markets, funded the HyDeploy project which is being conducted by Cadent and Northern Gas Networks and which is exploring the injection of up to 20% by volume into the normal gas supply. The project is predicated on the standard certification of gas appliances which, since 1996, have involved testing with 23% hydrogen. If the project is successful deployment will be possible without any change to existing appliances.

The project is currently being run on the private gas network at Keele University and will then be tested on parts of the public network in the North East and North West.

The objective of the project is to ensure that the regulatory package required to enable this technique to be used is in place as soon as pipeline hydrogen is available post 2026.

Pure Hydrogen

Burning pure hydrogen in current household appliances is not possible without redesign of the appliances. The Department for Business, Energy and Industrial Strategy is currently funding the Hy4Heat project to examine the changes needed to develop new appliances and establish the likely conversion costs to burn pure hydrogen in existing appliances.

Initial prototypes are anticipated by 2021. Further work will be required to establish the practical use of such appliances. Pure hydrogen burning for heat cannot be successful unless concerns regarding NOx emissions are resolved because of the higher flame temperature relative to natural gas when hydrogen is burnt.

Recommendation 6: Prepare for the availability of large volume hydrogen supply.

Current large volume hydrogen supply projects predict availability of supply from the late 2020’s (Supply Options from 2026 page 3). Policy and publicity should be linked to the availability of such supplies.

Research, Skills and Innovation

There is a substantial increase in research and demonstration activities visible worldwide in transport, infrastructure and heat sectors.

Fuel cells have found applications in power units, the automobile industry, residential builders and electronics. The Greater Manchester Universities are a regional hub for research innovation and economic growth in many areas that are complementary to the developing market for Hydrogen and Fuel Cell technologies.

The specialism of the research at the Manchester Fuel Cell Innovation Centre is on making use of advanced materials such as Graphene within both Fuel Cell and Electrolyser design. The Centre is a regional hub for SMEs and industry to develop products in the Hydrogen and Fuel Cell sector by utilising the range of equipment in the facility itself or by the research expertise the centre's academic and team can provide.

Academic expertise both regionally and across the UK is detailed within a capability document that was commissioned by the UK Hydrogen and Fuel Cell (H2FC) SUPERGEN Hub to create a database of researcher capability on hydrogen and fuel cells in the UK.

Recommendation 7: Utilise academic expertise and facilities to support Innovation.

Developing a research and skills base that can help achieve the net zero carbon targets, like the 2038 target for Manchester, and align to the Local Industrial Strategy by exploiting and the expertise offered by academia in developing the supply chain of regional businesses contributing to sector.

The shift to carbon neutrality will mean that some firms, particularly those that have carbon intensive operations, will need support to speed up their progress towards carbon neutrality without constraining growth. Certain skill sets will be required if we are to accelerate the implementation of energy and material efficiency measures in the design and production of green products and services.

Businesses and policy makers have a key role and need to respond to this agenda to put pressure on educators to develop the courses that they require. The region can use its networks to make the benefits of investment in green skills clear and the opportunities this provides in terms of innovation, sustainability, efficiencies and productivity.

Recommendation 8: Support reskilling of those already in the labour market.

Commit to working with skills development leads in growth and development teams within each applicable Local Authority as they already have a policy framework for education and skills in progress to support workers already in the labour market, or those with transferrable skills valuable in a zero carbon economy, who need to upskill in order to adapt to the range of projects offered either by the cluster or arising as a result of policy or technological developments in the ambition for clean

The skills system already faces challenges to meet the demand for future skills e.g. those required by digitisation and automation.

The long-term skills demand projections are uncertain for key emerging technologies such as Hydrogen and Fuel Cells so further phased research is needed in this area. This is being developed through academic institutions and educators. However, we know that education and skills will underpin our ability to reach our ambition of a zero-carbon economy and achieve the social and economic drive; by ensuring our residents and students are equipped with the necessary skills to fill these roles.

Recommendation 9: Support educational institutions to develop courses that deliver skills for the hydrogen economy.

Schools, Colleges and Universities must deliver the right courses so that employers can find people with the skills they need. Individuals need to be able to make better-informed choices in order to develop their careers in the emerging economies.

Conclusion

In recent times a lot has been said about The UK's need to set out a hydrogen strategy as part of its commitment to net-zero carbon emissions by 2050. Greater Manchester has a clear role to play within the context of the UK and the strategy we present is a starting block on which to build back better in our region and is one that fully supports the regional 5 year environment plan to adopt an approach that mobilises various actors across traditional sector boundaries to come together in new ways.

The global hydrogen economy is estimated to be worth $2.5 trillion by 2050, supporting 30 million jobs. The European Commission is also creating an EU hydrogen strategy, which includes plans for multi-billion euro investment in hydrogen projects, and schemes to boost sales of hydrogen electric vehicles.

As demonstrated by campaigns such as UK Hydrogen Strategy now there is a fundamental need for a national hydrogen strategy to really develop the UK strengths around a recovery mechanism post COVID that is economic, green and clean. We all really need to take advantage of the natural environment of the UK with the potential that hydrogen can bring through many areas of generation.

The benefits of having a strong hydrogen economy are clear – it will drastically reduce carbon emissions, improve air quality, and create new, green jobs across the country. It can help usher in a new era of zero-carbon transport as well as zero-carbon heating. It will also provide a huge boost to manufacturing in this country and give the UK the opportunity to lead the world in an exciting renewable and low-carbon technology

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