Establishing a Regional Hydrogen Roadmap in Derby and the Wider Region

Findings and Recommendations Report

Rev 3s Stakeholder Issue | August 2021

ARUP

Derby City Council

Foreword

It is incredibly exciting to see hydrogen shift from future fuel status to being recognised as an energy vector that can play an integral part in creating a resilient, low-carbon energy system for the UK, helping transition the nation to achieve its net zero-carbon commitments before 2050.

Derby and the wider D2N2 region is strongly positioned to spearhead this change and is dedicated to becoming the UK's centre of excellence for future fuel technologies. From our unrivalled concentration of manufacturing and advanced engineering companies, world-class universities and research institutions, power station infrastructure and network of engaged stakeholders, we have the right energy eco-system to develop a hydrogen-based economy.

With developments such as ZERO (the proposed new exemplar energy innovation cluster at Ratcliffe Power Station, and the only inland Freeport designation) in which East Midlands Airport's position as a centre for logistics will be further strengthened, it is also an opportune time for the region to explore the potential of hydrogen.

In addition, given the region's strong industrial legacy tied to carbon-intensive methods, developing a hydrogen economy will ensure we achieve our aspiration to lead the most ambitious carbon turnaround in the country.

Hydrogen is not a silver bullet to achieving net zero emissions but an exciting energy vector that accelerates multiple energy related initiatives. As a region we must also assess systemic change in our consumptive behaviour and our treatment of the natural world to ensure a just transition. Hydrogen need not conflict with these wider aims and in fact accelerates these conversations.

With two of the last-standing coal fired power stations in the country, alongside our concentration of cement producers, transport equipment manufacturers, food manufacturers and distribution sectors, delivering a hydrogen-based economy in the region will be critical in meeting the net-zero carbon challenge, as well as protecting and bolstering the region's economic strengths so they have a leading role in a low-carbon future.

Derby City Council has commissioned this project, led by Arup and in partnership with key stakeholders, to understand how existing and new assets in the region could be leveraged to support the region on its transitional pathway to decarbonisation and economic growth to 2050, through hydrogen.

The work draws on conversations with over 40 stakeholders to understand the scale of the hydrogen opportunity which could be unlocked and provides a critical first step towards establishing a deliverable pipeline of hydrogen focused projects in the region.

This report presents an invitation from Derby Council to industry, government, academia and society in general, to explore and take advantage of the hydrogen potential in the region. Derby City Council can't achieve this alone. We will need a coalition of the willing to help us use hydrogen to bring about the green growth and resilient net zero future that future generations are calling for.

Councillor Chris Poulter
Leader of Derby City Council and Cabinet
Member for Strategy and Policy
Derby City Council

In October 2020, Derby City Council declared its future fuels ambition, stating its aim to become the UK's centre of excellence for future fuel technologies, using the city's advanced manufacturing expertise to revolutionise the way low-carbon energy is used to power businesses, transport and homes in the region.

This report seeks to set out a 5-year road map to support the development of a regional hydrogen economy and consider the potential further impact a hydrogen economy could have over the next 15-20 years.

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Executive summary

The next five years represent an opportune time for Derby and the wider D2N2 region to utilise its unique energy eco-system to grasp the full potential of the hydrogen opportunity, delivering decarbonisation, green growth and skills development benefits.

Hydrogen is increasingly recognised as a viable and low carbon future fuel that can help the UK meet its net zero commitments by 2050. It has potential across five main areas: (1) production, distribution and storage, (2) heating, (3) transport (4) industry and (5) jobs, skills and research.

Derby and the wider D2N2 region is particularly well-placed to be a national front-runner for establishing a hydrogen economy, given its strong cluster of advanced manufacturing and engineering excellence, its wealth of large scale sites with high development potential as green energy hubs, its network of research institutions and collaborators and large potential users with strong transport infrastructure.

Through engagement with over 40 stakeholders in the region, we have been able to identify the region's multiple assets and infrastructure, as well as opportunistic synergies, to understand the full potential of a hydrogen economy in Derby and the wider region.

There are on estimate 30,000+ jobs related to industries which burn hydrocarbons including their supply chains, a high proportion of which are of high productivity with good pay and make an impact on average income in the region.

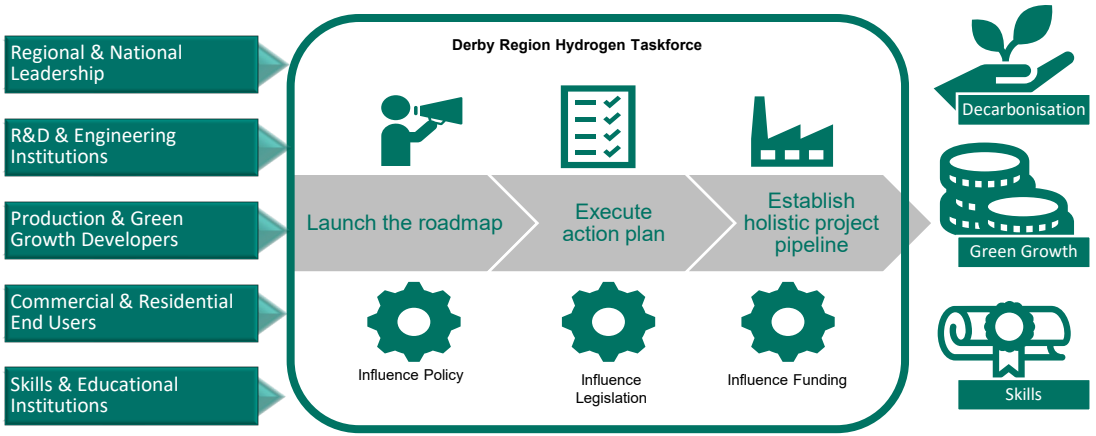
Hydrogen will be a critical driver in both retaining and upskilling the region's substantial and aligned workforce and supply chain in its productive advanced manufacturing, engineering, and energy sectors, and could account for at least 800 new jobs in the D2N2 area by 2030.

It is imperative that the region acts now to ensure it stays relevant to existing large employers such as Toyota, Rolls Royce, Alstom and others in order to benefit from investments made when transitioning their businesses to becoming net-zero carbon. In the short term, projects within the influence of Derby City Council such as the Confidential Site and hydrogen bus fleet should be supported by well-defined briefs and studies.

Private sector opportunities should be further explored with owners.

There is also significant opportunity for secondary industries associated with the region's growing focus on clean growth industries, notably around East Midlands Airport and Ratcliffe Power Station, to benefit from a hydrogen economy.

Furthermore, hydrogen could help to solve the challenge of decarbonising the region's highest carbon emitting sites (power stations, cement & lime production, gas engine manufacture and transport logistics); without which such industries could be forced to move overseas in the context of the UK's net zero goals. In short, hydrogen ensures the region can achieve the mutually reinforcing goals of decarbonisation, economic growth and skills development.



Infographic shows the proposed process to establish hydrogen in the region

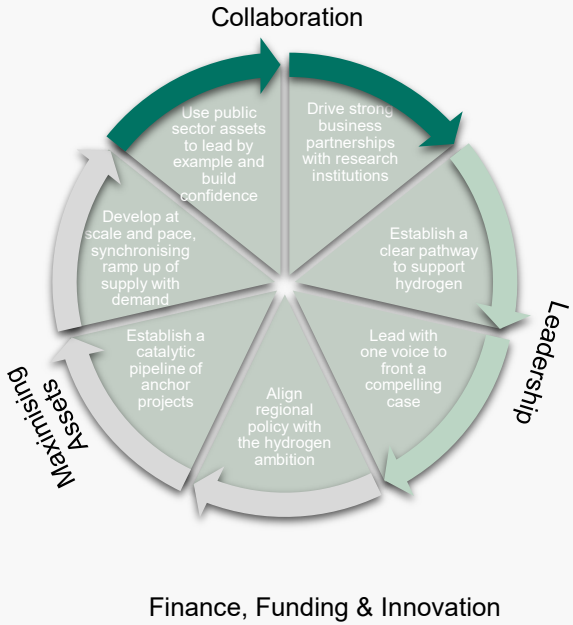
Executive summary

In terms of demand, it is estimated that 8.5 Twh of hydrogen could be consumed in the Derby and D2N2 wider region by 2050, largely through industry but also by transportation, and that by 2030, local demand could exceed what can be produced locally. The region has at least 16 sites with high potential for hydrogen production and/ or end-use capability.

A roadmap has been created which sets out recommendations up to 2035 and beyond in terms of establishing a regional hydrogen economy, with 'quick wins' identified for the next five years, and 40 detailed action steps outlined to take forward. Some key recommendations to come out of the roadmap include:

- Setting up a Derby region hydrogen taskforce;
- Focusing on vocational skills training and educational outreach programmes related to hydrogen;
- Establishing a hydrogen supply, initially through blending;
- Implementing hydrogen bus schemes, introducing hydrogen passenger trains and dispensing infrastructure, with aviation potential to be explored in the longer term;
- Exploring domestic hydrogen potential through a heat trail in Derby;
- Exploring hydrogen in industry, through an exemplar energy innovation site at Smart Parc and establishing a hydrogen and carbon capture industrial cluster in North West Derbyshire.
- Incorporating the findings of this study into Derby and D2N2 LEP's inward investment strategy.

It is clear there is a crucial 'coalition of the willing' in the region, as evidenced through the engagement informing this report, who are primed to take ownership of the proposed roadmap and drive forward the required actions in the short, medium and long-term. However, buy-in from government and better policy and funding alignment is needed to strengthen this process. This will enable Derby and the wider region to be at the forefront of hydrogen development and innovation, and maximise the decarbonisation, green growth and skills development benefits the hydrogen opportunity has the potential to deliver.



The infographic shows the key actions required around collaboration, leadership and assets to establish a regional hydrogen economy.

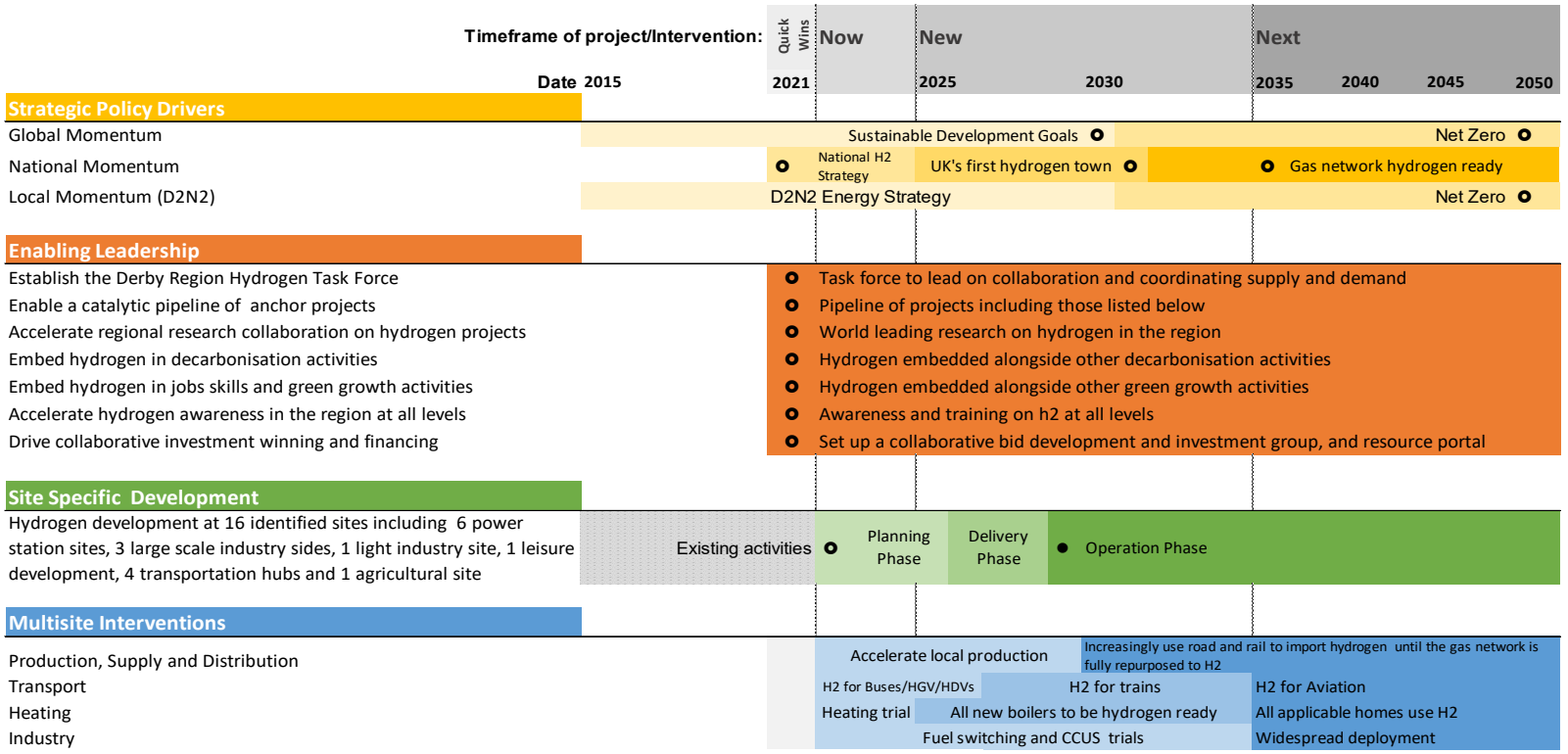
Key findings

We summarise the findings and next steps that have been identified for key groups of stakeholders in the region which have been used to develop our regional hydrogen roadmap.

Strong Leadership & Policymaking	High Skills & Research Potential	Production, Storage & Transfer Readiness	Committed Manufacturers & End Users	Next Steps
Region's stakeholders are primed for action and look to its **strength in regional leadership** to help support a collaborative roadmap	**Strong advanced manufacturing heritage** can be reskilled to ensure growth and job retention	**16 sites** identified with strong hydrogen growth potential, several former power station sites already available	**Large global manufacturers are already engaged** in hydrogen activities in the region and seeking to develop synergies	Establishment of a **Derby Region Hydrogen Task Force** to drive collaboration, and action across the **project pipeline**
The **region has all the pieces of the puzzle** to establish a hydrogen economy and could rely on its own production potential till at least 2030	The region must look to move from long term research and **move towards business partnerships**	**2 coal fired power stations closing** by 2025, which opens new hydrogen opportunities on prime brownfield development sites	**Successful freeport bid** by East Midlands Airport creates renewed potential for hydrogen in production, logistics and aviation	Create a web-based platform to **launch the roadmap** and enable discussion forums and collaboration
Leadership have an important role in matching supply and demand so that stakeholders have the confidence to **jump together**	Vital to develop how industrial operators will **transition skills** e.g. how power station engineers retrain to electrolyser operators	Hydrogen ready boiler, gas cylinder, fuel cell and electrolyser manufacturers **already exist within the region**	There is a potential need to initiate a **North West Derbyshire Industrial Cluster** to collaborate on hydrogen and carbon capture	**Update regional policy** to reflect the unique potential and benefits of hydrogen
Existing **policy landscape supports hydrogen** but requires updating to bring hydrogen and future fuels into focus	More **hydrogen awareness** is required in educational institutions at all levels	**Centrally placed, well connected region** for hydrogen distribution and supply hubs	**Strong positive engagement from advanced manufacturers** committed to developing low carbon solutions	Continue to develop a roadmap for hydrogen to present to BEIS to **unlock support for a regional delivery pathway**

Proposed roadmap

The proposed roadmap has been summarised as below:



Benefits Realised

Introduction and Approach

Project rationale

In October 2020, Derby City Council declared its future fuels ambition, stating its aim to become the UK's centre of excellence for future fuel technologies, using the city's advanced manufacturing expertise to revolutionise the way low-carbon energy is used to power businesses, transport and homes in the region.

Hydrogen is specifically seen as a critical opportunity to contribute to the region's decarbonisation aims, with the added benefit of driving jobs and green growth. This has led to this work being commissioned by Derby City Council as an initial step towards understanding how existing and new assets and infrastructure in the region could be leveraged to develop a hydrogen economy, as part of its transitional pathway to decarbonisation and economic growth up to 2050.

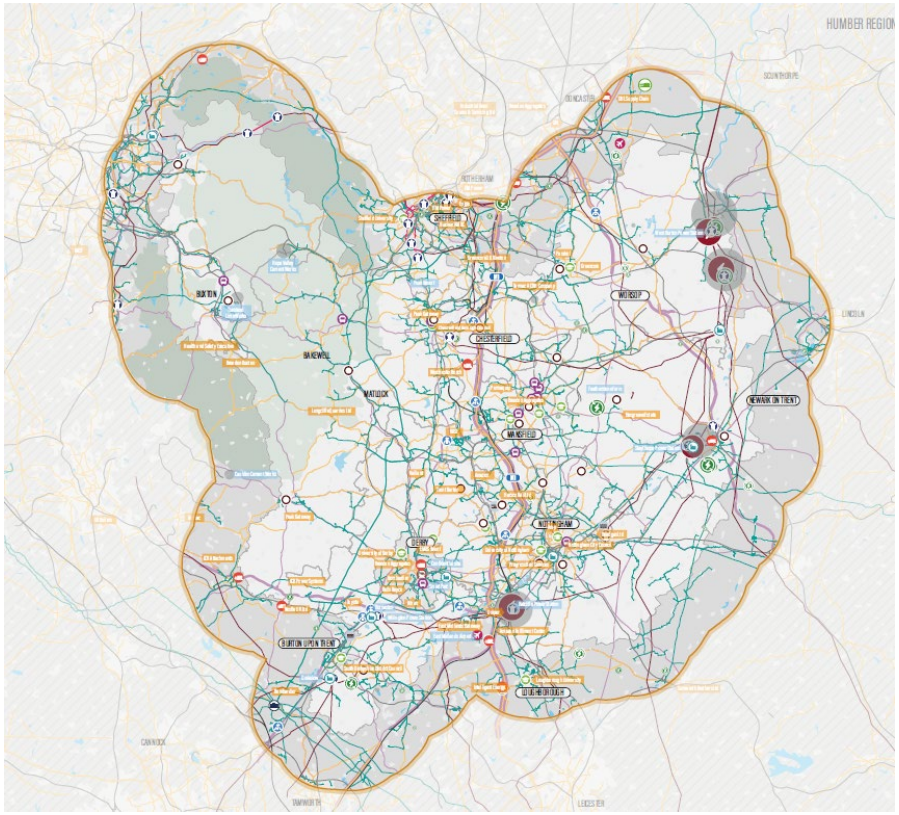
This work aims to build on and complement existing ambitions and policy such as D2N2 LEP's declaration to lead the most ambitious carbon turnaround in the country to provide some initial clarity on the scale of the hydrogen opportunity which can be unlocked in the region.

This work recognises from the outset that it must serve two purposes:

1. To inform and engage a rich mix of crucial stakeholders in the region to develop collaborative thinking and support around the hydrogen opportunity; and

2. To build upon our desktop studies and stakeholder engagement findings to produce a high-level, credible and region-specific pathway which can serve as the basis of future project development and delivery activities.

The report ultimately seeks to set out a 5-year road map to support the development of a regional hydrogen economy and consider the potential further impact a hydrogen economy could have over the next 15-20 years.



Our study focuses on the *Derby Region* which refers to the D2N2 LEP boundary, with an additional 5-mile buffer added, to capture all potential opportunities in the area.

Approach and methodology

This is the first piece of work commissioned in the region to understand the collaborative hydrogen potential that can be unlocked. The methodology has been designed to be informative and gather support whilst also acting as a platform for bringing new ideas to the fore. The process allows feedback at a number of stages to ensure a holistic and credible roadmap is developed.

Project steps:

Our project approach develops a potential roadmap for a hydrogen economy across five exciting thematic opportunities:

1. Production, Distribution & Storage
2. Hydrogen for Heating
3. Hydrogen for Transport
4. Hydrogen for Industry
5. Hydrogen for Jobs, Skills & Research

The following methodology was designed to assess these and has been explained further in the next slides:

Step 1: Understanding the Region & Stakeholders

- Review of existing and planned policy landscape.
- Identify crucial representative stakeholders.
- Collate and map stakeholder, assets, infrastructure, policy and any quantitative data to build a picture of the strengths, weaknesses and opportunities within the region.

Step 2: Assessing Opportunities

- Initial engagement via introductory workshop to present project objectives and achieve stakeholder support.
- Run five smaller focused action sessions aligned to the hydrogen themes to identify and assess potential opportunities.

Step 3: Developing a Road Map

- Collate learnings through follow-up engagement and critical analysis to develop a preliminary road map.
- Assess high-level economic potential of hydrogen in the region.

Step 4: Funding Options & Next Steps

- Assess local, national and private funding opportunities available for hydrogen and carry out a gap analysis.
- Identify practical next steps to unlock delivery and funding.
- Produce a high-level action plan.

Step 5: Feedback & Refinement

- Share findings and incorporate feedback
- Road map is shared with stakeholders for feedback so that recommendations can be incorporated for further development.

Approach and methodology

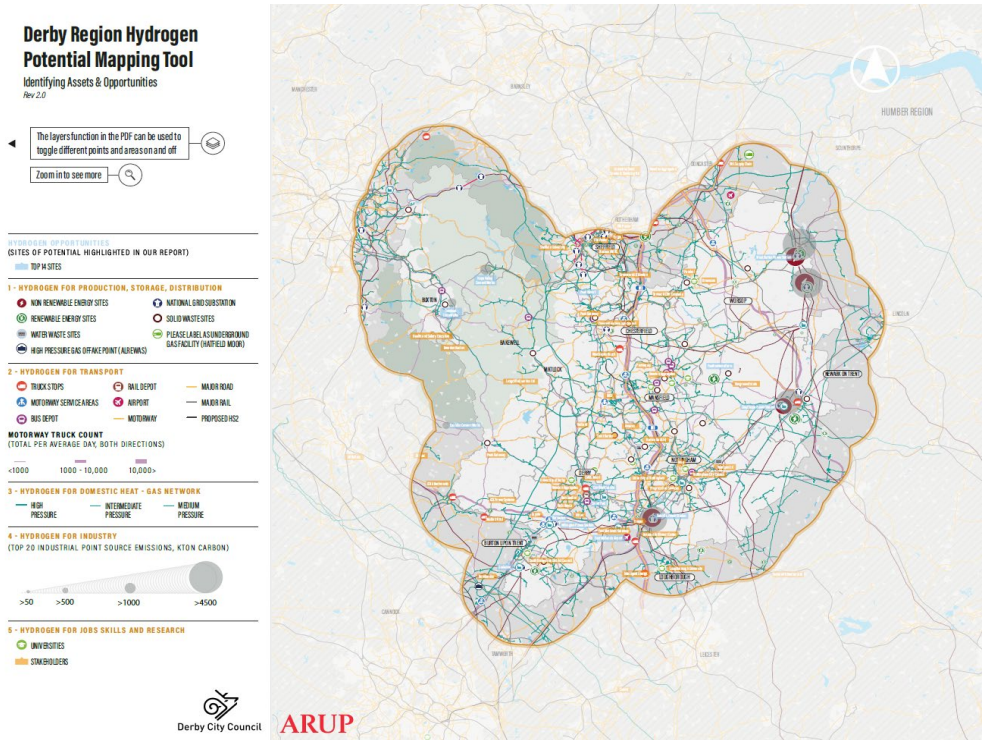
Step 1: Understanding the region and its and stakeholders

Developing a hydrogen economy to meet regional demand requires strong regional knowledge and a coordinated and holistic approach across the five hydrogen opportunities.

This begins with understanding where the relevant supply chain assets and infrastructure currently exists and could potentially be developed in the future, allowing new site opportunities to be identified. By mapping regional stakeholders, potential synergies can be explored, to form projects and enabling interventions.

A detailed mapping exercise was carried out from a number of data sources across all five hydrogen themes. By creating an easily accessible layered PDF showing existing assets, infrastructure and stakeholders, a visually engaging tool was developed and used for stakeholder engagement.

This tool became a crucial platform for identifying opportunities and synergies with the region's stakeholders. (please see Appendix A).



Interactive Derby Region Hydrogen Potential Mapping Tool with switchable layers used to engage stakeholders. To see the full map and interact with its layers please see Appendix A.

Approach and methodology

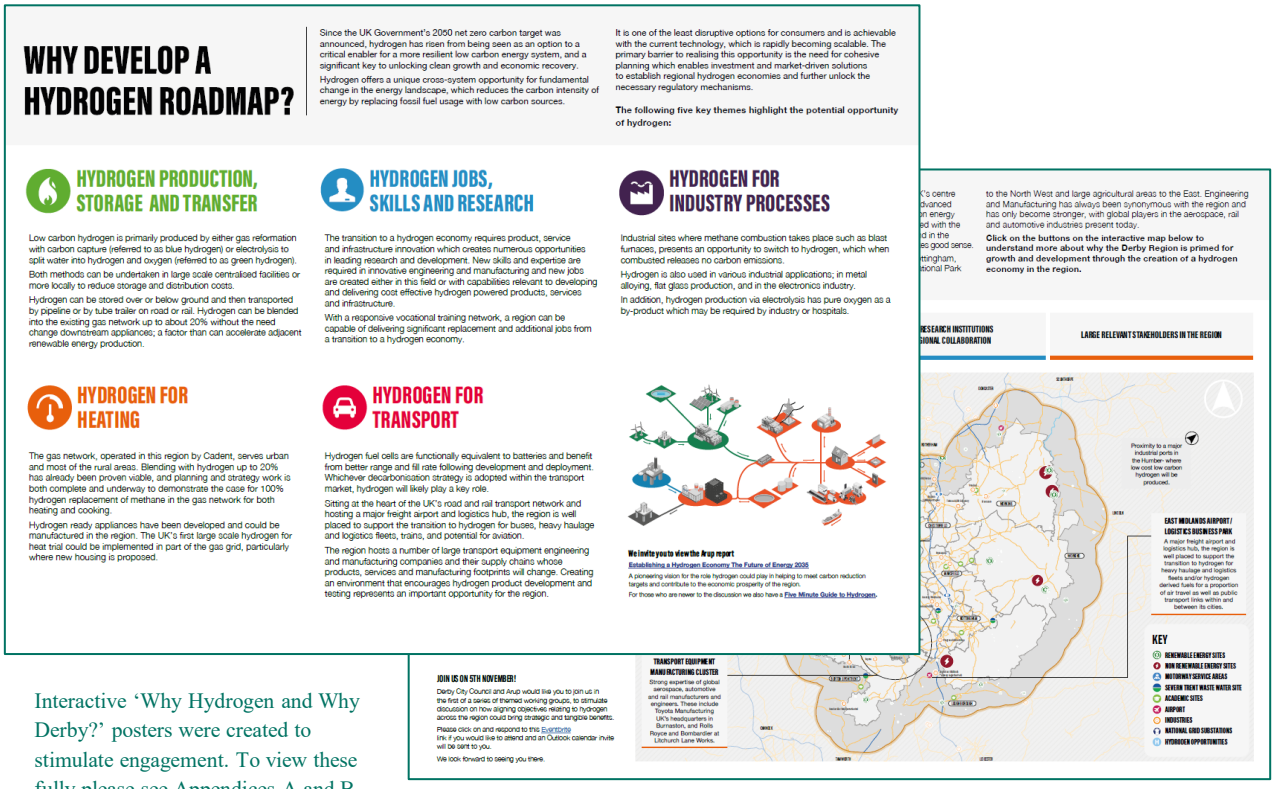
Step 2: Assessing the opportunities

Stakeholders are crucial to understanding the existing opportunities and their involvement underpins the design, deployment and overall success of any road mapping exercise, becoming the owners of any subsequent action plan.

Early engagement and buy-in from critical stakeholders across the five themes is key to unlocking a credible, holistic and deliverable pathway for hydrogen.

An exhaustive list of stakeholders was defined and matched against their stake within the five hydrogen themes. Pre-existing hydrogen activities were identified to form a tracker and an engagement plan drawn up. (please see Appendix C). These documents become an invaluable resource for future engagement within the region.

An invitation to join a collaborative engagement process was initiated through an interactive 'Why Hydrogen and Why Derby?' poster, along with the interactive Derby Region Hydrogen Potential Mapping Tool and an invite to the introductory workshop event (please see Appendix A and Appendix B).



Interactive 'Why Hydrogen and Why Derby?' posters were created to stimulate engagement. To view these fully please see Appendices A and B.

Stakeholders we engaged with

Step 2 and beyond

Engagement with the right stakeholders has been critical to producing a representative and credible roadmap for the region, as each brings a piece of the puzzle to the discussion to eventually create the region's hydrogen vision.

These stakeholders will go on to inherit the actions that are proposed from this work and have a vested interest in securing the benefits of a hydrogen economy.

The following diagram shows the myriad of stakeholders engaged for this project, and whose valuable inputs have been critical in understanding the potential of the hydrogen economy in the Derby and D2N2 region.

Councils & Authorities:

Derby City Council, D2N2, Derbyshire County Council, South Derbyshire District Council, Nottingham City Council, Chesterfield Borough Council, HSE, Derbyshire Dales District Council, East Midlands Chamber

Manufacturers & Users:

Rolls-Royce, Toyota, Hyundai, porterbrook, Longcliffe Calcium Carbonates, Breedon, strawson limited, derby homes, SmartParc, Intelligent Energy, trentbarton, PEAK

Production, Distribution & Storage:

ITM POWER Energy Storage | Clean Fuel, Cadent Your Gas Network, uniper, ENGIE, BAXI, Worcester Bosch Group, Vaillant, roadgas Fuelling Greener Futures

Universities:

University of Derby, The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA, NTU Nottingham Trent University, Loughborough University, University of Birmingham, The University Of Sheffield.

R&D & Engineering:

ARUP, Belcan, BASF We create chemistry, Fisher German, altran Part of Capgemini, Far, NUCLEAR AMRC, ERA Energy Research Accelerator

Stakeholder engagement process

Step 2 and beyond

Six virtual events were held between November and December 2020, attracting over 40 regional stakeholders from across local authorities, industry and research institutions, each bringing their unique insights and opinions to the discussion with a strong sense of common purpose and collaboration.

The process stimulated significant input which demonstrates the commitment in the region to decarbonise, whilst also highlighting the wealth of benefits that can be realised in terms of green growth and skills, through the establishment of a hydrogen economy within the region.

Follow-up sessions were also held to further discuss specific opportunities as well as to develop the roadmap and funding options.

Details of the stakeholders engaged and provocation outputs can be found in Appendix C and Appendix E respectively.

Virtual stakeholder events

Introductory Workshop	Production, Distribution & Storage Action Session	Hydrogen For Heating Action Session	Hydrogen for Transport Action Session	Hydrogen for Industry Action Session	Hydrogen for Jobs, Skills & Research Action Session

Three provocations were proposed to the stakeholders at the Introductory Workshop (outputs can be found in Appendix E):

1. "What are the most important opportunities and threats to your organisation and this region from a transition to a 'net zero' economy, including significant adoption of hydrogen energy?"
2. "What sites, assets and capabilities are missing to enable a hydrogen transition and what support do you require to make it happen?"
3. "What hydrogen and hydrogen derived fuels activities is your organisation involved in and what are your barriers to progress?"

Key findings of the stakeholder engagement process

Due to positive local and national drivers, the region feels that **now is the right time** to tap into the hydrogen potential to solve decarbonisation and growth challenges

Regional stakeholders are **highly ambitious** and **welcome a collaborative approach** to establishing hydrogen in the region

There is **strong hydrogen potential** across the supply chain and **all key challenges can be addressed** by the region's stakeholders

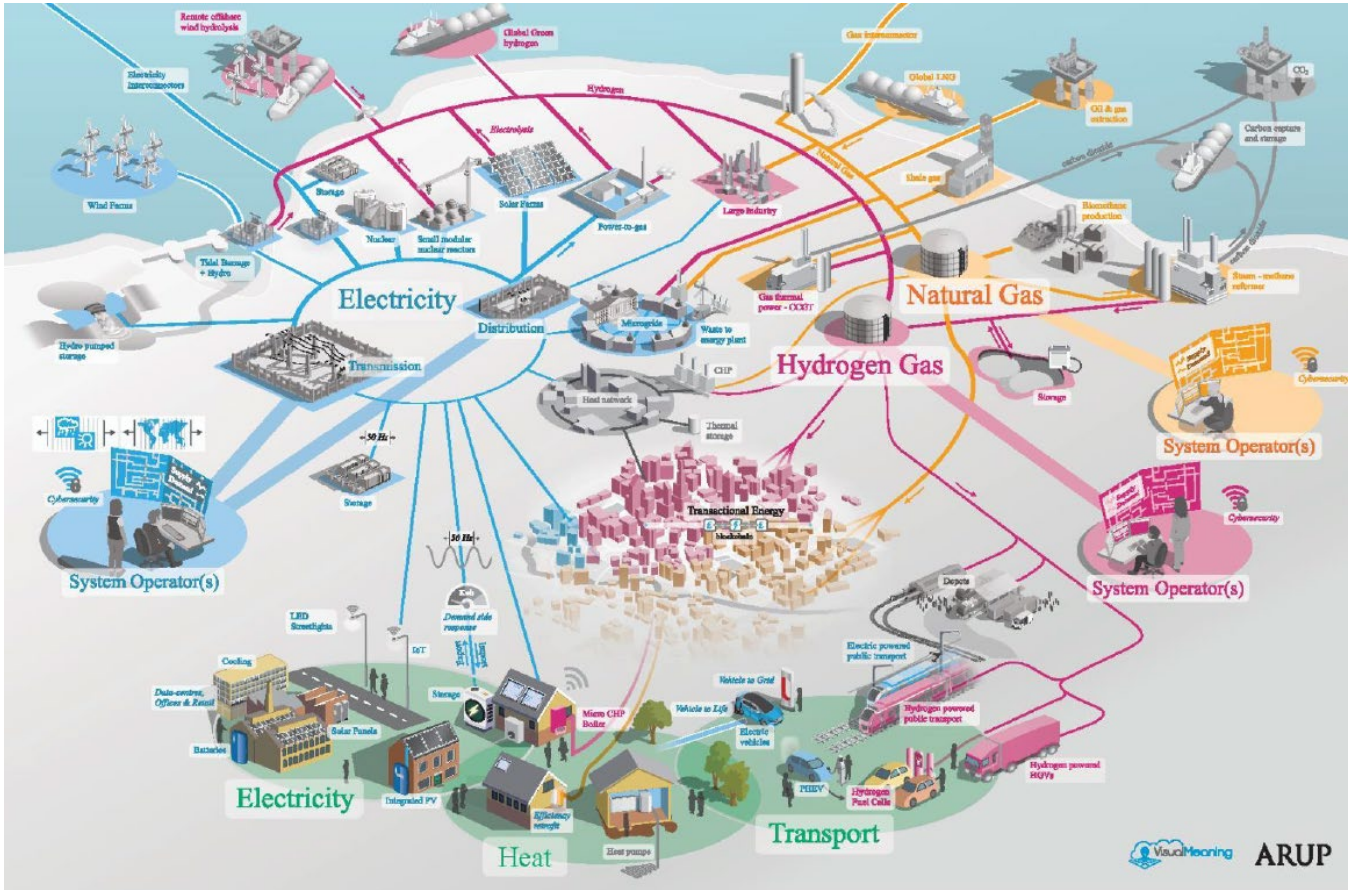
The region must **jump together** and **go large** to benefit from economies of scale and aggregation of demand

Understanding the Region

Is there a case for hydrogen in the region?

The following section of the report explores the benefits and challenges exploiting the hydrogen potential and looks at the strengths within the Derby region which can be harnessed to enable the accelerated development of hydrogen as part of a collaborative regional effort.

The infographic to the right shows the role that hydrogen is likely to have by the mid 2035s in national energy systems. In this report we turn the tables on conventional thought which states that hydrogen is only an applicable energy vector in coastal industrial cities. Instead, we explain how the Derby region, being landlocked, could be a centre of large scale hydrogen demand, with hydrogen initially supplied from local sources and later supporting large scale hydrogen supply in coastal regions. In this section we set out the scale of the potential hydrogen demand as well as its regional economic impact as we strive to achieve net-zero emissions by 2050.



This infographic shows Arup's vision for national scale future energy systems in 2035. Hydrogen is shown in red and is part of a whole-energy system required to meet societal needs whilst getting to net zero 2050. Energy demand is highlighted at the bottom of the diagram in the form of Electricity, Heat and Transport. For more information see: www.arup.com/hydrogen2035.

Why hydrogen?

Hydrogen as a future fuel

Hydrogen is increasingly being recognised as a viable and indeed prominent option to delivering an affordable, reliable and sustainable energy solution for the UK that can help it transition to a low carbon future and ensure the government meets its net zero commitments by 2050.

Hydrogen is light, storable and energy-dense. It produces no direct emissions of pollutants or greenhouse gases when combusted and, given its ability to store and transport energy, is a catalyst for accelerating renewables. Hydrogen can have a significant impact across five main opportunity sectors:

1. Production, Distribution & Storage
2. Heating
3. Transport
4. Industry
5. Jobs, Skills & Research

Additionally, it is one of the least disruptive options for consumers as it is achievable with current technology, which is rapidly becoming scalable.

Hydrogen is of particular interest in those sectors that are proving difficult to decarbonise, as well as proving valuable as a means of energy storage in a world increasingly reliant on intermittent renewable energy.

There are significant challenges before hydrogen's full potential can be realised however. We need to increase and aggregate demand so new production is stimulated, we need investment in new supply infrastructure, and we need a clear and coordinated national and local policy landscape to helps underpin the business case.

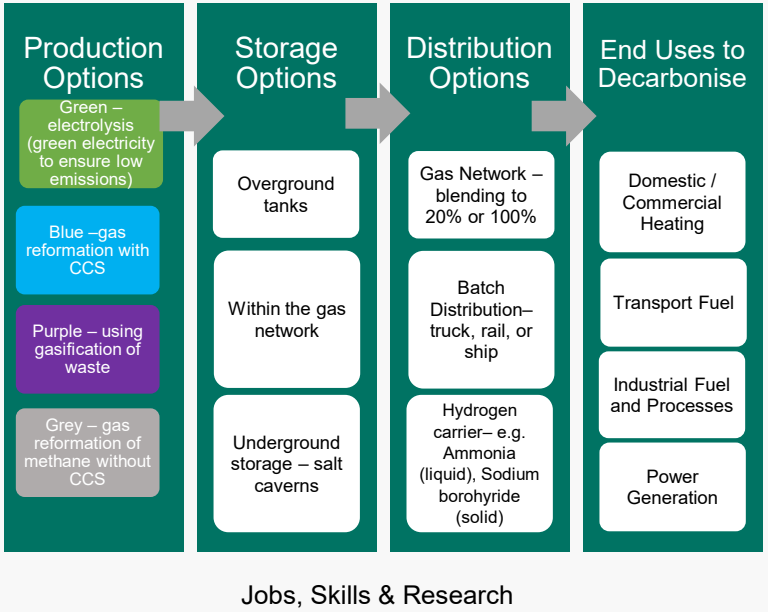
Colours of Hydrogen

Green Hydrogen refers to electrolytic hydrogen, i.e. hydrogen that has been produced using an electrolyser which uses electricity to split water (H20) to produce both hydrogen (H) and oxygen (O). Green electricity refers to that which is either renewable or 'sleeved' using a renewable tariff.

Blue hydrogen refers to when natural gas is split or reformed into hydrogen and CO2 either by Steam Methane Reforming (SMR) or Auto Thermal Reforming (ATR), but the CO2 is captured and then stored (CCS). Without CCS it is refer to as Grey or Brown hydrogen and is not advocated in this report.

Other colours are also referred to (Purple –from gasification from waste) and Yellow – from nuclear power).

The fundamental strategic consideration is not the colour categorisation but the carbon intensity of hydrogen. Other considerations include price, volume, purity, redundancy/security of supply and safety.



Hydrogen as a highly versatile energy carrier. Across its supply chain from production through to end use, hydrogen promises to provide a solution to tough decarbonisation challenges whilst stimulating new jobs, skills and research in the region.

Hydrogen uses

End uses

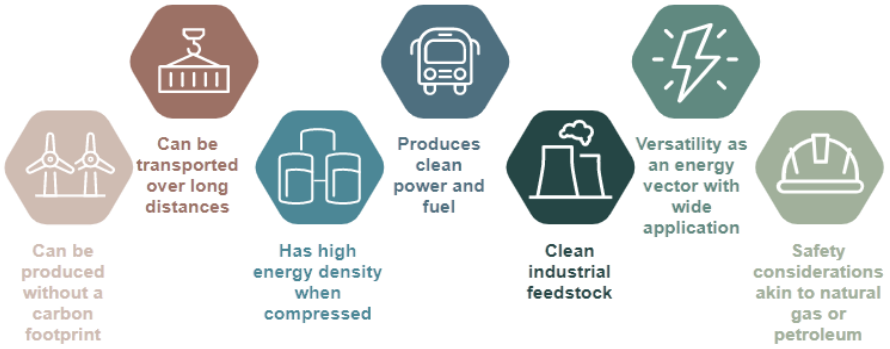
This diagram illustrates the end uses which exist in each opportunity sector and what is required to establish it.

Opportunity Sector	End Use	Main Low Carbon Alternative	Requirements
Industry	Chemical productions and refining	None – hydrogen needs to be used in these processes.	This market already exists – it is just a matter of replacing grey hydrogen with blue or grey. Could be connected to a grid or provided via tanker.
	Heavy industry	Natural gas with post combustion - carbon capture. Challenge here would be building a CO_2 network to dispose of the CO2 produced.	Large quantities of hydrogen to be provided at a constant rate. Provided by high pressure pipelines.
Transport	Back to base fleet transport	Electric battery vehicles – range and refuelling time a major obstacle.	Hydrogen to be delivered to central distribution centres. High hydrogen purity needed for hydrogen fuel cells – blue hydrogen and network transportation problematic without cleaning.
	Long distance heavy vehicles	Electric battery vehicles – struggle with the size and range requirements. Refuelling time also a hurdle. Electric Road Systems were trialled in Europe but found to be problematic.	Hydrogen needs to be distributed to refuelling centres around the country (could potentially be limited number of strategic locations). High hydrogen purity needed for hydrogen fuel cells – blue hydrogen and network transportation problematic without cleaning.
	Personal transport	Battery Electric – market already well developed with expanding charging infrastructure. Less of an opportunity for hydrogen unless high mileage or operational issues dictate hydrogen as being necessary.	Hydrogen needs to be distributed to many refuelling centres around the country. High hydrogen purity needed for hydrogen fuel cells – blue hydrogen and network transportation problematic without cleaning.
	Rail	Overhead Electric – the process of electrifying rail lines is underway. Installing overhead electrification on existing lines can be challenging at bridges and overpasses.	Initially a back-to-base passenger service is required for a trail that can be expanded later to cover a wider network. The rail network is also a means of delivering hydrogen to refuelling locations from production sites.
	Shipping	Battery electric for short distances. Bio fuels are a solution but come with sustainability related land management issues	Growth of hydrogen for shipping is likely to expand alongside the growth of the shipping of energy in the form of hydrogen, or hydrogen carriers transported by shipping.
	Aviation	Battery electric for short haul flights, bio fuels are a solution but come with sustainability related land management issues. Demand management, carbon price and hydrogen derived fuels with carbon capture are necessary for decarbonising aviation.	Further research is underway into the technology, safety case and logistics for the development and implementation of synthetic hydrogen derived aviation fuel.
Heating	Heating & Cooking	Electric cookers, heat pumps and boilers - technically efficient but significant practical challenges including space requirement and the need to upgrade electricity network.	Conversion of hydrogen distribution network and gas appliances. Sufficient hydrogen storage or production capacity to ensure that winter peak demand can be met. Government policy decisions will be required.
Power Generation	Power Generation	The range of renewable sources directly connected to the grid and nuclear energy - most likely hydrogen would work alongside these technologies rather than competing as an alternative.	Investigation into infrastructure associated with existing gas power generation sites required. Unabated gas fired power generation will likely be phased out by 2035, this will lead to the closure of sites, post combustion CCUS or power generation from hydrogen supplied via a repurposed gas network.

Benefits of hydrogen

Core benefits of hydrogen

Hydrogen is an energy vector that has a versatility across its supply chain. From production through to end use, its zero carbon credentials, ability to be produced using renewable sources, distributed via existing repurposed gas infrastructure and stored in large quantities,, makes it a disruptive technology which can accelerate three core regional scale benefits outlined below (right).



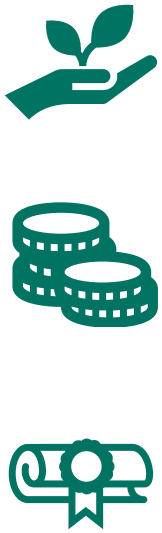
High Decarbonisation Potential	Green Growth Acceleration	New Skills Development
Reduction of dispersed emission source and large emissions point sources by switching to hydrogen which produces zero emissions when used in a fuel cell or when combusted. Ability to accelerate renewable energy by providing power balancing and storage.	Fosters economic growth and development in the region by creating new supply and demand opportunities, as well as stimulating new services relied upon as part of a net-zero future.	Stimulates a need for new skills which is a key factor required in supporting innovation and growth, alleviating poverty and social disparity and tapping into a productive regional workforce.

Core regional benefits of hydrogen across its uses

Benefits of hydrogen

Hydrogen – Core benefits across the opportunity sectors

The following table shows how the three core benefits map across four of the central hydrogen opportunity sectors investigated in this work. The fifth sector, jobs, skills and research is cross cutting and is included as such. There are few alternative fuels which can match the wealth of benefits realised at a large scale.



		Hydrogen Uses			
		Production, Storage & Distribution	**Hydrogen for Heating**	**Hydrogen for Transport**	**Hydrogen for Industry**
Benefits	**Decarbonisation**	• Clean energy store for grid balancing and peaking • Similar storage and distribution properties to natural gas	• Grid network supply possible for widescale distribution • Can be a cheaper energy source than electricity	• Tackles power and range issues found in EVs using a clean energy source • Provides a solution via new vehicle uptake and retrofit of existing vehicles • Provides a solution for the challenging aviation sector – a massive polluter	• Scaled up production of cheap hydrogen promotes switch to cleaner raw material for industrial processes
		• Environment and wellbeing is improved significantly over time and at pace • Replacement of carbon, Sox and NOx emitting fuels e.g. natural gas, petrol, diesel, especially HGVs			
	Green Growth	• Jobs retained as energy industries switch to meet net-zero targets and tackle resource scarcity • New above and below ground storage facilities created to meet increasing demand	• New jobs in boiler manufacturing and installation • New jobs in pipe manufacture and civils for national gas network repurposing programme to replace with compatible pipework	• New and retained jobs in automotive industry due to increasing uptake of hydrogen vehicles and ban on ICE vehicles • New and retained jobs in refuelling infrastructure	• Export potential of hydrogen related manufacturing components e.g. hydrogen rolling stock
		• New jobs creation as new hydrogen market and supply chain emerges from green production hubs • Region attracts complimentary industries such as advanced manufacture and electrolyser components e.g. compressors • Region attracts complimentary industries such as advanced manufacturing and large users e.g. food			
	Skills Development	• Adoption of new versatile, non-disruptive fuel vector opens up R&D and funding in new clean energy uses e.g. hybrid hydrogen boilers, potentially creating new industries • Green hubs and R&D centres attract new skills and talent	• Region becomes a centre of excellence for boiler design, manufacture and service • Region becomes an early adopter for network sourced hydrogen for heating	• Region develops skills base in hydrogen vehicle manufacture, servicing and repair • New skills in hydrogen gas engine manufacture • Region develops skills in setting up refuelling infrastructure and storage	• New industries create new skills and import skills internationally to the region
		• Region develops thought-leader credentials in low carbon production adoption • Region and its leadership develop lessons learnt in this field attracting R&D funding • Live assets in the region stimulate apprenticeship schemes and tackle unemployment and act as a route to higher education			

Core regional benefits of hydrogen across its uses

Challenges of hydrogen

Overcoming the challenges of hydrogen

There are large challenges to overcome to mitigate climate change, build strong communities and achieve a resilient net zero future. The tragedy of the commons (climate risks are someone else's problem) and the tragedy of the horizon (climate risks are too far in the future) are, in the UK at least, being overcome where there is increasing collaboration between government and the private sector around tightening legal obligations. Hydrogen is one of a number of significant strategic levers to pull to reach a resilient net zero future, although it is by no means a 'silver bullet'.

There are specific challenges to the exploitation of the hydrogen potential in a region. The challenges below are the ones most often cited and have been touched upon below:

Challenge	Mitigation
Challenge 1: Hydrogen is too complex	Unfortunately all genuine resilient decarbonisation options are complex and require an appropriate use of technology that is underpinned by, or leading to behavioural change. Planning for hydrogen does require energy systems thinking and collaboration and coordination between supply and demand.
Challenge 2: Hydrogen is too costly	Hydrogen may not be the most cost effective solution even in the long term. However the price of hydrogen is closely linked to the volume required and paying off the capital expenditure required to produce it. Green electrolytic hydrogen depends on the price of electricity which, if generated from onsite renewables, is free (other than the cost of potable water).
Challenge 3 : Hydrogen is too energy inefficient	Energy efficiency at a micro scale is important when comparing low carbon technologies but cannot be simply multiplied up to provide a macro energy efficiency picture. Other social, environment and economic aspects need also be factored in to determining the most efficient route pathways to net zero. See page 19 for alternative low carbon technologies, each major intervention needs to be viewed in a whole system lens.
Challenge 4: Hydrogen is too reliant on government and big industries	This is not necessarily the case, hydrogen is also an off grid solution. Major large scale interventions such as repurposing the gas network for 100% hydrogen are required but prior to that there is still the case for hydrogen, and manufacturing the components for hydrogen, including in inland regions such as the Derby & D2N2 Region.

Why Derby and the wider region?

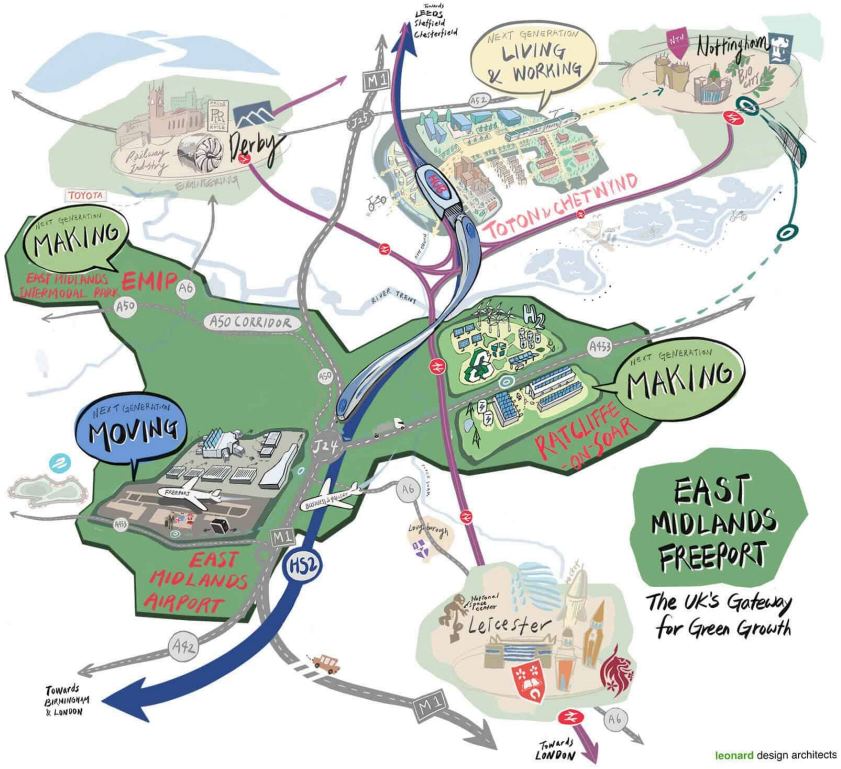
Derby and D2N2 as a centre of innovation and excellence at the heart of the country

Derby has a rich history of making, inventing and innovation. The city continues to be built on the strength of its advanced manufacturing and engineering businesses and associated high skilled workforce this attracts. Derby also sits within the wider D2N2 region, itself steeped in industrial heritage, and with a strong track record in sustainable transport and ambitious zero-carbon plans.

The D2N2 region is also the current focus of significant government investment, with a proposed East Midlands Development Corporation, Freeport and Toton HS2 hub station. It benefits from proximity to assets such as East Midlands Airport, the M1 and fast rail links, with almost 90% of the UK within a four hour drive.

Although landlocked and away from coastal production or imports of hydrogen, Derby's central location and network of industrial clusters give it a unique proposition: it can focus on smaller scale production without being bound to wait for large-scale coastal hydrogen projects or imports to develop on the coast. It can take a more decentralised approach, deploying smaller production sites of green hydrogen to provide a more flexible and responsive approach to meeting demand as it grows.

Not only will this improve resilience in the transition from fossil fuels, it will also ensure the region has developed the level of demand required to benefit from economies of scale when large scale coastal production comes to fruition in the 2030s.



Above: Graphic showing the benefits of the successful East Midlands Freeport bid
Above Left: The former Rolls-Royce Works in Derby, first opened in 1908 to produce aircraft engines

Why Derby and the wider region?

Derby and the D2N2 region hold four core strengths which create the right ecosystem upon which to develop a hydrogen economy:

1. Advanced Manufacturing and Engineering Excellence

Porterbrook

Rolls-Royce

Bombardier

With multiple large businesses in operation in the region e.g. Rolls Royce, Bombardier, Toyota, the region benefits from a nationally significant engineering and advanced manufacturing cluster. It is the only location in the UK where rail technology is still designed, and the city's aerospace and rail sectors alone produce approximately one third of the city's GVA and 12% of its total employment1.

It is also home to Porterbrook, who have introduced Hydroflex, the UK's first hydrogen powered train. The region area is also home to a significant national cluster of activity in boiler manufacturing, accounting for 45% of UK jobs in that sector, as well as fuel cell manufacture e.g. Vaillant Group, Worcester Bosch and Intelligent Energy.

2. High Development Potential Sites for Green Energy Hubs

Ratcliffe Power Station

Willington Power Station

West Burton Power Station

The region has two of the last-standing coal-fired power stations that will cease to use coal by 2025 (Ratcliffe and West Burton) as well as numerous other former power station sites that are available for development. This gives rise to new opportunities to develop innovative low carbon hubs that speak to the region's strong ambition to lead a dramatic carbon turnaround.

With the benefit of national grid connections and through the initiative of forward thinking site owners, these sites hold significant potential to become green energy hubs: leading clean energy production and concentrating skills and research that would be essential to a hydrogen economy. An exemplar ZERO energy innovation cluster is already being promoted at Ratcliffe-on-Soar Power Station and alongside East Midlands Airport, has also been designated the UK's only inland freeport, providing a fertile testing ground for hydrogen in logistics.

Why Derby and the wider region?

Derby and the D2N2 region hold four core strengths which create the right ecosystem upon which to develop a hydrogen economy

3. Strong Research Institutions & Collaboration

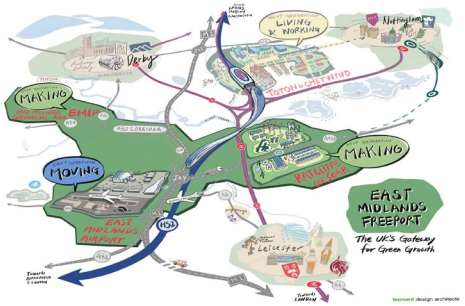
University of Derby

The region is home to a critical network of expertise, research and industry, with three universities, 6 science parks and 15 innovation centres, as well as the Health and Safety Executive.

The region also has a strong track record of collaboration with industry, as demonstrated through other industrial demonstrators at Infinity Park and BioCity, for example.

Infinity Park, Derby

4. Large Potential Users with Strong Transport Infrastructure



East Midlands Freeport Bid

Toyota Burnaston

ITM Power, Sheffield

The region benefits from the presence of existing stakeholders with a strong interest in hydrogen – either as potential producers, within the supply chain or as end users.

This ensures that there is already a strong basis on which to identify and develop synergies in a hydrogen economy. For example, there is potential for a north-west Derbyshire industrial cluster to be developed, to decarbonise the cement industry and collaborate on carbon capture opportunities. This potential market is strengthened by the fantastic road, rail and air links the region benefits from.

Summary

A region with core strengths to catalyse a hydrogen economy in the region

This section has outlined the potential of hydrogen as a future fuel, but also why the Derby and D2N2 region specifically, is well suited to be an early adopter of hydrogen.

It is clear that Derby and the wider D2N2 region's unique assets, infrastructure and collaborative stakeholders create a ripe 'energy ecosystem' to catalyse an inland hydrogen economy that could achieve the mutual goals of decarbonisation, economic growth and upskilling.

Furthermore, the section has highlighted that the alignment of somewhat unprecedented government investment in the region – notably around the East Midlands Development Corporation, HS2 Toton station and proposed Freeport near EMA and Ratcliffe Power Station - makes it a particularly opportune moment to pursue growth opportunities associated with hydrogen.

Taking advantage of synchronised opportunities, driven by an invested stakeholder network and committed place leadership, will ensure that the potential of a hydrogen economy is realised in Derby and the region.

In the next section we analyse the drivers and constraints that create the context in which a hydrogen agenda will operate, taking into account national trends and broad market forces but with particular focus on regional influences.

Drivers and Constraints

Drivers and constraints

Key factors influencing change in the region

To enable change to occur within a region, stimulus must be provided to improve current performance, seize new opportunities and address key issues. Constraints must also be fully understood and mitigated.

This section reviews the current landscape for three of the biggest critical factors that will impact hydrogen adoption within the region today, able to act as either powerful drivers or constraints – policy, cost and funding.

The section concludes with an analysis which incorporates the findings of the policy and funding review as well as other macro-environmental factors brought to light through stakeholder engagement and desktop study to create a high level overview of the current market, growth potential, position and direction of the region.

Hydrogen as a policy priority

The national, regional and local policy landscape of hydrogen

The potential of hydrogen, and associated commitments to support its growth, is featuring more prominently across the policy landscape.

However, there is still more for regional and local level policy makers to do to ensure the position of hydrogen and future fuels in the region's economy is explicitly presented within their clean growth ambitions, to ensure the Derby region is at the forefront of the UK's hydrogen economy.

A full analysis of relevant policies at national, regional and local level can be found in Appendix I.

The national policy landscape is increasingly conducive towards and supportive of hydrogen, contextualised by the **sixth Carbon budget**, which sets out a clear pathway for the UK to reach net zero by 2050. It suggests that 105 TWh of low carbon hydrogen production will be required by 2035 to meet the balanced net zero pathway. Equally, the Prime Minister's **Ten Point Plan for a Green Industrial Revolution** provides a solid marker of the government's commitment to the hydrogen opportunity, setting out plans to drive the growth of low carbon hydrogen, hydrogen for heating, zero-emission vehicles, jet zero and green ships, greener buildings, carbon capture, usage and storage, and green finance and innovation.

National policy also emphasises the importance of scaling (and therefore cost reduction) in unlocking the true potential of hydrogen. However, there is a noticeable focus in the national policy landscape on the hydrogen potential of coastal regions, to the oversight of the opportunity in landlocked regions such as Derby. The national hydrogen strategy, expected in Q2 of 2021, will be of great interest to the region when published.

At a regional level, across **D2N2's Energy Strategy** and **Local Industrial Strategy**, it is made clear that pursuing a clean growth economy is a top priority for the region. Indeed, D2N2 wants to become one of the most dynamic carbon neutral economies both in the UK and internationally, attracting significant inward investment and creating tens of thousands of new jobs. It also wants to be known as the UK's premier location for developing, trialling and implementing innovative energy systems approaches at scale.

The LEP sees low carbon investment as a catalyst for a more productive and inclusive economy generally, a key aim of its **draft industrial strategy**. However, despite this strong emphasis on clean growth, the regional policy landscape is lacking in its explicit support for hydrogen. Going forward, revisions to these documents should strengthen their focus on hydrogen specifically, if the region is serious in conveying its commitment to developing a hydrogen economy.

At a local level, both the city and county councils make promising pledges around **climate change mitigation** and have declared **climate emergencies**, with Nottingham City Council ambitiously committing to become carbon neutral by 2028. However, the importance of hydrogen within these strategies is also somewhat limited, and where referenced, tends to be presented as a part of the solution rather than a stronger commitment as a strategic solution.

The exception to this is **Derby's Future Fuels Strategy (2020)** in which the city declares its ambition to become the UK's centre of excellence for future fuel technologies, and hydrogen is specifically referenced as an area of potential. The strategy includes an exciting proposition for the Council to purchase a city site where an integrated energy approach could be launched and demonstrated. It would link clean energy and by-product power sources to commercial and domestic users and include a low-carbon public transport hub.

The future cost of hydrogen

An important consideration for developing a business case

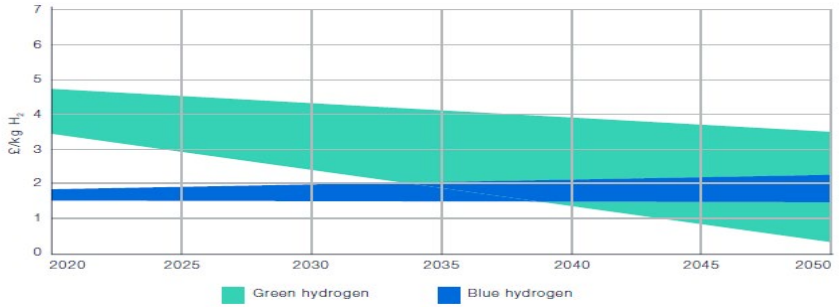
The cost of green hydrogen production is currently falling and will continue to do so in the near term, opening new opportunities. The Scottish Hydrogen Assessment presents the range of price estimates of hydrogen production in the approach to 2050 for both blue and green hydrogen.

The Hydrogen Council outlines that as the price of hydrogen production falls, applications for hydrogen become cost competitive. This begins with hydrogen being used first as an industrial feedstock, before moving into building applications, then heavy duty vehicles, and light duty vehicles, etc.

Key to the falling price of hydrogen, is the availability of low cost, low carbon hydrogen sources such as capacity for CCUS and renewable electricity generation. Being landlocked, the Derby region will have limited capacity for either renewable electricity generation or CCUS.

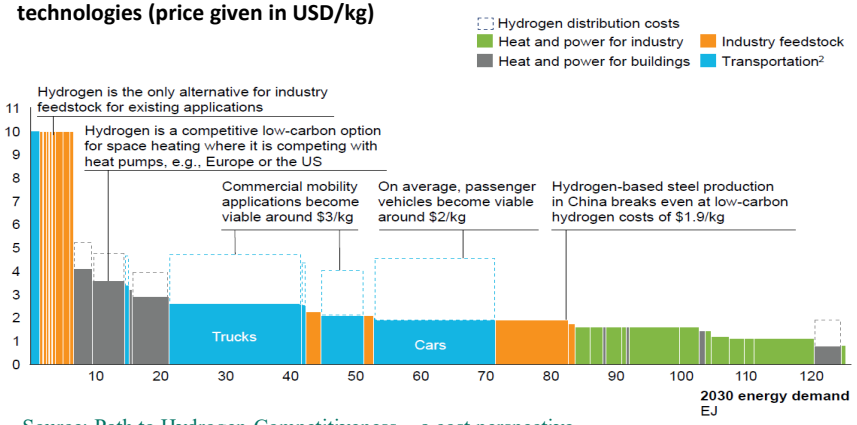
Although some opportunity will exist in the region for hydrogen production, the opportunity in manufacturing of end use technologies will be the greater driver. The region will need to follow market trends here and aggregate demand, i.e. initially ramping up production of heavy duty hydrogen vehicles, hydrogen and hydrogen-ready boilers, etc.

Changing pump price of green and blue hydrogen in the approach to 2050 (price given in GBP/kg)



Source: Scottish Hydrogen Assessment

Cost at which applications for hydrogen become competitive with incumbent technologies (price given in USD/kg)



Source: Path to Hydrogen Competitiveness – a cost perspective

Funding hydrogen: a developing story

The funding picture for hydrogen-related projects

The funding picture for the UK reflects the government's current priorities; notably the levelling up, clean growth and research and development agenda.

There are very few funding options wholly dedicated to hydrogen projects, as demonstrated in the funding review contained in Appendix J, however, there are copious funds with decarbonisation and economic growth agenda, through which hydrogen projects could be funded.

Funding varies quite considerably across the funding geographies, from small scale specialised funds to large-scale generic funds; all of which have potential to provide funding for hydrogen related projects, to a greater and lesser extent, albeit few explicitly.

National funding: The national funding landscape is very mixed, with more specialised funds focused on industry innovation to broadly scoped economic growth funds. The recent March 2021 budget brought news of the Levelling Up fund and proposed UK Infrastructure bank, both of which have potential, especially through transport infrastructure, to incorporate hydrogen-related projects. Equally, in March 2021 the government released an ambitious new bus strategy with £3bn of funding behind it. It includes a significant commitment to increase the zero-carbon emission bus fleet in the UK.

National funds almost all now consistently reference the need for projects to align to the government's clean growth and net zero aims, which again increases the potential for hydrogen schemes to be included. However, the most relevant funds for hydrogen appear to have been in the past, making it worth monitoring any future rounds of the public sector low carbon skills fund, network innovation competition and decarbonisation of industrial clusters competition.

Additionally, two dedicated hydrogen funds appear to be forthcoming from BEIS: the net zero hydrogen fund and the pioneering hydrogen heat trails. More details are expected in the future.

Regional funding: There are limited regional funding opportunities at present, as LEPs await details of the UK's Shared Prosperity Fund, and former EU funds come to an end. The funding picture for Derby and the wider region is limited to the Midlands Engine, which includes a fund focused on promoting innovative renewable energy projects in rural areas as well as a fund to support SMEs, which has supported energy firms in the past. The University of Nottingham is also seeking to develop an East Midlands Hydrogen Innovation Zone which could generate funding streams in the future. It is expected this would extend beyond research to include jobs and skills training.

Local funding: There are a variety of local funding routes but the largest financial packages have been secured through successful local bids of national funds, such as the Towns Fund, Transforming Cities Fund and Future Mobility Zone Fund. Hydrogen is not an explicit focus of these submitted proposals, but there is potential scope for hydrogen solutions to be part of the project's deliverable solutions. However, the scope for influencing project proposals at this stage appears to be limited, with further discussions with local partners required.

Research funding: with three universities and several research institutions, research funding is an area of funding worth monitoring. The University of Nottingham appears to have the most hydrogen focused research funds and training programmes, through the Sustainable Hydrogen Centre for Doctoral Training (SusHY) and Energy Research Accelerator. However, at present, there do not appear to be a wealth of research funds available.

Private funding: private funds are likely to be more limited in scale but still represent an important potential source of funding or investment, especially in research and development or demonstrator technologies. Derby and the wider region benefits from many companies with potential to generate hydrogen related investment, most notably energy companies, transport equipment manufacturers, boiler manufacturers and fuel cell manufacturers.

An assessment of funding alignment to this report's aims - that of growing a hydrogen economy, promoting decarbonisation and promoting economic growth - is provided overleaf.

Funding options

The following table provides a RAG (red, amber, green) status summary of the funds analysed in relation to hydrogen, decarbonisation and economic growth agendas, all of which may help provide a route for funding hydrogen projects. More details can be found in Appendix J.

The RAG summary highlights that from the 15 funding sources identified, currently there are only 5 specifically aligned to hydrogen, most of which are all either for small scale decarbonisation or primarily research and development. The Bus Back Better scheme however, has recently been launched and shows promise as a sizeable pot to tackle decarbonisation challenges within public transport.

From the funding sources which have a significant size and can potentially be aligned to hydrogen, the Automotive Transformation Fund, UK Infrastructure Bank, Transforming Cities fund and East Midlands Development Corporation hold the most promise and should be investigated further for the development of hydrogen projects at scale.

Fund	Alignment to hydrogen	Alignment to decarbonisation	Alignment to economic growth	Funding Pot Size
Energy Research Accelerator				
DE-Carbonise Project				
Sustainable Hydrogen Centre for Doctoral Training (SusHY)				
SBRI Competition rail demonstrations				
Bus Back Better				
Automotive Transformation Fund				
UK Infrastructure Bank				
Transforming Cities Fund				
East Midlands Development Corporation				
Future Mobility Zone funding				
Rural Community Energy Fund				
Midlands Engine Investment Fund				
Levelling Up Fund				
Towns Fund				
Shared Prosperity Fund				
Industrial Energy Transformation Fund				

Overview of findings

A PESTLE summary of the region's macro-environmental position, developed through collaborative engagement with the region's stakeholders.

Political

- Central government policy includes hydrogen commitments for the first time.
- Policy is generally very supportive of decarbonisation at a regional level (LIS, D2N2 Energy Strategy) but should be updated to drive hydrogen specific growth.
- Collaboration identified as key to achieving net zero by 2050.
- Consensus for local universities and institutes to avoid long term research and move towards business partnerships.
- Require policy environment for large scale investments and nationally agreed roadmap to give confidence of policy and funding
- Local Authorities are becoming more aware of the opportunity
- Strong desire for a Government lead, if this is not achievable then a regional lead.

Economic

- The region has a wealth of advanced manufacturing which could make components of the hydrogen economy.
- More hydrogen specific funding is needed for production, storage and transfer at scale rather than for research pilots.
- Supply and demand must develop together. The region often refers to the 'chicken and egg' analogy. A demand aggregation exercise similar to that by Cadent in the Humber region should be done.
- Demand is growing for technology but issues on where the gas can be obtained from, price and cost is still an issue.
- Barriers for businesses growing at scale is access to a skilled workforce. A roadmap will allow alignment with talent providers.
- A subsidy is required for hydrogen fuel to kickstart the market.

Skills & Social

- Skills are a key requirement to support implementation of a hydrogen economy. Belcan has shown how engineers can be reskilled quicky across industries.
- Needs one collective effort to present to government. The region has an ambition to present a roadmap to BEIS.
- Need a location to come together regionally - a centre of excellence or green hub. The freeport would be ideally suited.
- Training must be developed as this is an opportunity for the next generation but currently no investment drivers.
- Vital to develop how industrial operators such as Uniper's Engineering Academy and Vaillant's Centre for Excellence will transition skills e.g. how power station operators will move to new sectors or how gas installers upskill to service hydrogen boilers.

Technological

- The region's existing power generating infrastructure is in a state of transition, three further coal fired power stations will close by 2025.
- Must go beyond demonstration to show real life commercial operation at scale.
- Access to fuelling infrastructure will drive innovation and demand. A key barrier which requires collaboration across industries.
- Major infrastructure projects should be trialling net zero construction – must ensure local planning applications are considering this.
- Energy from waste assets can be better used.
- ITM Power have identified that UK manufacturer of compressors missing from electrolyser manufacture supply chain.

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Legal

- The UK has a legal commitment to get to Net Zero 2050.
- The Health and Safety Executive are supportive of the use of hydrogen in domestic properties, however gas regulations need to be updated.
- Work is ongoing on the safety case of the transportation of hydrogen through road/rail tunnels but again it requires legislation to be amended.
- The conversion of diesel engines to hydrogen combustion is a cost effective transitionary measure for fleets before switching to fuel cell vehicles but issues around manufactures warranties are an issue.
- The UK is migrating to a national version of the EU Emissions trading scheme which will impact polluting industries.

Environmental

- Air quality in inner city areas of Derby, Nottingham and other urban areas is impacting health issues and is driving an increased awareness of the need to act
- Increasing vulnerability to climate risk, particularly recent flooding events, has lead to impetus to cut emissions faster.
- Rural land management is being reimagined to prioritise carbon sequestration, biodiversity benefits, local food production and renewable energy production. Hydrogen can accelerate/ be accelerated by these structural changes.

Summary

A region well positioned to drive change as part of a collaborative vision

The findings in this section highlight that the region is driven by an ambitious set of local and regional policies and is further incentivised at a national level to decarbonise. With the cost of hydrogen set to decrease, these form a strong basis to build upon a hydrogen specific agenda.

We have identified the strong drivers in the region and highlighted the constraints which must be overcome for the smooth creation of a hydrogen economy- constraints which no doubt exist on a national level but which the Derby region can act as a catalyst for the entire sector to unlock. Policy support will continue to grow and must be backed by funding to enable catalytic hydrogen production, distribution and storage projects at scale.

Collaboration has shown that the region understands these challenges and that through a collaborative effort, strong business cases which reflect one vision can be developed to inform and impact policy, funding and legislation right up to the national level.

The next section aims to identify the potential of hydrogen's growth in the region and the assets and opportunities which are available for development and could form the building blocks of a regional roadmap.

Hydrogen’s Growth Potential

Hydrogen's growth potential

Understanding the region's potential

This section explores the potential scale of hydrogen developments which could be established in the region as well as understanding where the region's demand could come from. It assesses the existing and future opportunities in the region which will ultimately serve as the building blocks for a regional roadmap.

We have built a picture of the current regional strengths, drivers and constraints within the region which will impact the adoption of hydrogen. We now look to understand the potential scale of a hydrogen economy that can be developed in the region, and the assets which could be harnessed by the region's leaders, employers and investors to grow demand and supply of hydrogen. These assets will ultimately form the basis of our roadmap.

Potential scale of a hydrogen economy

The economic opportunity of hydrogen for the Derby and D2N2 economy is twofold: both the creation of new jobs and investment as well as critical retention of the region's existing substantial workforce and supply chain, linked to its productive advanced manufacturing, engineering and energy sectors.

There are on estimate 30,000+ jobs related to industries which burn hydrocarbons including their supply chains, a high proportion of which are of high productivity with good pay and make an impact on average income in the region. Hydrogen will be a critical driver in both retaining and upskilling the region's substantial and aligned workforce and supply chain in its productive advanced manufacturing, engineering, and energy sectors, and could account for at least 800 new jobs in the D2N2 area by 2030.

Hydrogen is key to preventing job losses from the region and an opportunity to attract new businesses and jobs particularly in sectors which have been traditionally hard to decarbonise, which is especially important in the context of the government's mandatory net-zero targets by 2050.

This will impact multiple industries established in the region such as, cement and lime production, gas engine manufacture and transport logistics.

The same is true for the region's automotive industry where the ban on new internal combustion engines by 2030 risks forcing existing manufacturers in the region to move to new locations unless they can be replaced with cleaner technologies. In short, hydrogen ensures the region can achieve the mutually reinforcing goals of decarbonisation and economic growth.

Conservative high level estimates suggest that the hydrogen economy could account for at least 800 jobs in the LEP area by 2030, but this only considers the two main, most direct sectoral opportunities i.e. vehicles and boilers. Indeed, D2N2 currently accounts for 7% of all transport vehicles manufacturing[2] in the UK[3]. The Hydrogen Taskforce estimates 8,500 jobs to be created across hydrogen investments in transport in the whole of the UK by 2030. If just 7% of these jobs are created in the region, that would translate to 620 local jobs alone.

There is also significant opportunity for secondary industries associated with the region's growing focus on clean growth industries, and already there are signs of related investment in the region.

For example, the 700-acre Ratcliffe-on-Soar Power Station is being promoted- as part of both a Freeport and Development Corporation – as an International Centre for Zero Carbon Futures, which will be at the forefront of global, university and private sector-led, zero carbon innovation.

To do a meaningful bottom-up quantitative analysis for the potential growth of hydrogen within each sector in the region requires a certain level of detail, and we recommend that a detailed study be carried out to fully understand the impact of a hydrogen roadmap and its secondary benefits to the region. However, what is emergent is that policy and stakeholder support is gathering momentum and any early mover adoption of hydrogen allows the region to be at the forefront of hydrogen development and innovation, creating the strongest possible scenario to capture a significant share of hydrogen jobs compared to other regions in the country.

75,000[4]
Hydrogen-related jobs in the UK by 2035

18.2 billion[4]
Hydrogen-related GVA in the UK by 2035

Estimates by the Economic Impact Assessment Report prepared by the Hydrogen Taskforce in August 2020[4]

[1] Estimates of cumulative gross impact, so not only additional jobs, but all hydrogen-related jobs created. [2] Defined through SIC2007 codes: 29: Manufacture of motor vehicles, trailers and semi-trailers, and 30: Manufacture of other transport equipment. [3] Midlands LEPs in total account for 35%.

Estimating potential demand in the region

The following section estimates the scale of potential hydrogen demand for the region in the run up to 2050 and the split between transport, industry and heating.

As noted in our policy landscape review (see Appendix I), there is a growing appetite for the use of hydrogen in the UK. The government's Energy White Paper in December 2020, committed to hydrogen for the first time; 5GW by 2030. However, the quantity of hydrogen required to get to net zero 2050 is not yet clear and the UK is awaiting the publication of the national hydrogen strategy in 2021.

Our preferred approach is to provide a conservative baseline on hydrogen, so for this project we have used the December 2020 Committee for Climate Change (CCC) 6th carbon budget recommended scenario called the 'Net Zero Balanced Pathway' (NZBP) . The NZBP is a conservative approach which estimates around 220TWh of hydrogen in the UK in 2050, compared to the more ambitious Headwinds scenario which estimates 380TWh (see graph top right). We have applied the NZBP to the Derby Region with modifiers to account for the fact that the region is landlocked. (See Appendix H).

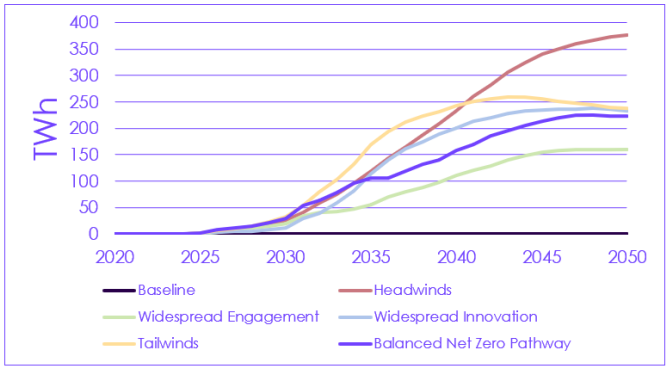
The graph (bottom right) shows our estimated growth path of hydrogen in the region split between industry, heating and transport demands . The graph indicates that by 2050, based on the CCC's recommended NZBP, that at least 8.5TWh of hydrogen will be consumed in the Derby Region, the majority through industry, but increasingly through transportation.

This conservative estimate is about 4% of the national hydrogen demand as recommended by the CCC. This represents only around 10% of the region's total energy needs, the remainder being largely through electricity. We have benchmarked our hydrogen estimate against another recent hydrogen assessment for Scotland and found it also to be comparable to their most conservative approach.

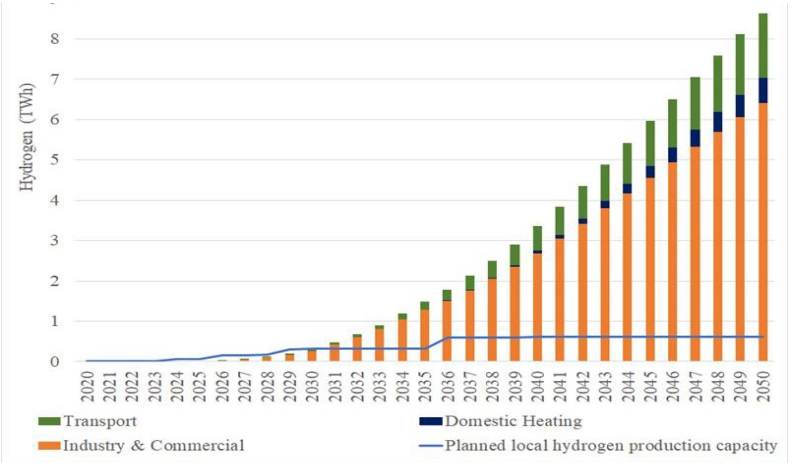
As mentioned above, our approach is to provide a conservative baseline. In 2050 the actual amount of hydrogen consumed in the region could be up to 1.5-2 times higher largely dependant on national energy decisions.

We have also estimated how based on current stakeholder ambitions for identified sites, locally produced hydrogen in the region will grow. The graph (bottom right) indicates that from 2030, hydrogen demand will exceed that which can be produced locally and hydrogen will need to be imported into the region likely first via road, then rail but ultimately via a repurposed gas network to meet demand. Up until then the region's central location, availability of power station sites, proximity to the Humber and its extensive road and rail infrastructure is ready to meet this challenge.

On the following page we look further into use cases for hydrogen in decarbonising industry.



CCC 6th carbon budget: Hydrogen production scenarios



H2 demand profile vs local production capacity at identified sites in the region

Decarbonising large emission sites

We have investigated the largest carbon emission sites in the region for two reasons: primarily because of the imperative to reduce emissions, but also for their potential to play a role in hydrogen production, energy balancing and potentially the role of introducing other clean industries which could use hydrogen.

Hydrogen has multiple specific industrial uses including ammonia production, petroleum refining, metalworking, glass manufacture, welding and food production. The top carbon emitting sites in the region have been plotted on the map to the right, using BEIS local authority emission data.

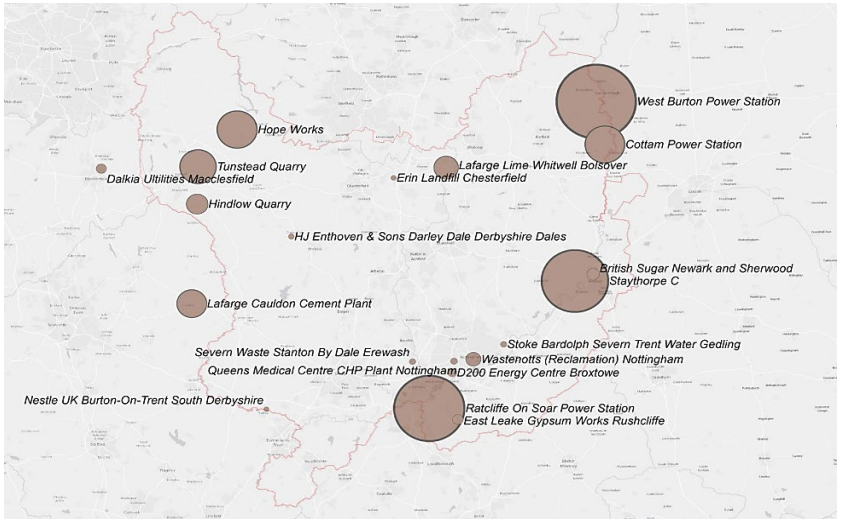
The top 2 carbon emitting sites (Ratcliffe and West Burton) in the region include coal fired power which will be phased out by 2025, and the energy mix by 2050 is unlikely to include gas, especially at these inland power stations.

Five of the main use cases of hydrogen are outlined on the table to the right. These five uses for decarbonising existing industry are mapped against the top ten emitting sites in the table (below).

Use Cases	Description
a.	Combustion of hydrogen for power production or for heat in a blast furnaces– either blended with natural gas/biomass or with 100% hydrogen
b.	Use of the by products of hydrogen production (oxygen from green hydrogen or carbon dioxide from blue hydrogen production) in existing or new industry.
c.	Use of hydrogen to decarbonise heavy duty transport associated with industry road or rail,
d.	Using waste heat from industrial processes to pre-heat methane in blue hydrogen production.
e.	Use of zero carbon hydrogen in new clean industry not currently at the site

Rank	Site	Stakeholders	CO2 Emissions (kt)	H2 Use cases				
				a	b	c	d	e
1	West Burton Power Station Bassetlaw	EDF Energy (Coal and Gas)	**4254**	✓		✓		✓?
2	Ratcliffe On Soar Power Station Rushcliffe	Uniper UK Ltd (Coal)	**3333**		✓?	✓	✓?	✓?
3	Staythorpe C Power Station Newark and Sherwood	RWE Npower Plc (Gas)	**3004**	✓		✓	✓?	
4	Hope Works High Peak	Hope Construction Materials Ltd	**1084**	✓	✓?	✓		
5	Cottam Power Station Bassetlaw	Uniper UK (Gas)	**1062**	✓		✓		✓?
6	Tunstead Quarry High Peak	Tarmac Cement & Lime Ltd	**900**	✓	✓?	✓		
7	Whitwell Bolsover	Lafarge Lime Ltd	**399**	✓	✓?	✓		
8	Hindlow Quarry High Peak	Tarmac Cement & Lime Ltd/Lhoist UK Ltd	**321**		✓?	✓		
9	Wastenotts Reclamation Nottingham	Wastenotts (Reclamation) Ltd	**150**			✓		
10	British Sugar Plc Newark and Sherwood	British Sugar Plc	**107**			✓		

Top 10 point source emissions within the region and the potential role of hydrogen in reducing emissions



The top emission sites across the region, mapped according to emission (kTCo2) size (BEIS local authority data)

Regional assets and opportunities

A credible and effective roadmap is built by leveraging assets, infrastructure and stakeholder strengths to create a trajectory where the benefits derived are greater than the sum of the whole, unlocking new synergies through a holistic assessment.

In this section, a number of hydrogen potential sites are identified, assessed and prioritised. These sites (detailed further in Appendix K) are identified through the stakeholder engagement process and desktop mapping of the region. The 16 sites identified in the region are mapped to the right and can be found within our mapping tool (Appendix A).

Next, the criteria for assessment is developed. The table below identifies the 6 criteria for assessing each site and a weighting given to each criteria. Carbon Reduction, Jobs Skills and Green Growth are given a higher weighting as they represent the three core benefits that hydrogen brings to the region.

Deliverability and Strategic Importance are prioritisation criteria. Each site is then scored and ranked based on the site information captured as part of this work.

Extract from the Derby Region Hydrogen Potential Mapping tool (Appendix A)

Ref	Title	Description	PESTLE	Weighting
1	Carbon Reduction	Anticipated CO_2 reduction impact as a result of the successful delivery of the intervention (1=high impact, 5=low impact)	Environmental	25%
2	Job/Skills Generation	Ability for the intervention to contribute to the generation of jobs and skills in the region (1=high contribution, 5=low contribution)	Social	25%
3	Green Growth	Ability for the site to contribute to additional GVA, either though production of hydrogen, supply chain activities or attracting complementary industries to the region.(1=high growth, 5=low growth)	Economic	25%
4	Deliverability	Measure of the scale of the barriers to successfully deliver of the intervention (social, financial, technological) (1=easily deliverable, 5= challenging to deliver)	Technological	10%
5	Strategic Importance	Strategic alignment of the site due to stakeholder support, common priorities and goals (1= high alignment, 5=low alignment)	Political/Legal	15%

Key hydrogen potential sites identified

Having assessed the hydrogen growth trajectory in the region and identified key carbon emitting sites, it becomes important to understand how this potential hydrogen supply could be met by the region's existing and future assets. The following table identifies and describes 16 hydrogen potential sites that have hydrogen production as well as end use capability. These sites have been identified by stakeholders during workshops and assessed and prioritised using 5 criteria in a weighted matrix in the followings page. See Appendix K for full description of each site.

Ref	Site Name	Site Potential	Key Stakeholders	Production	Transport	Heating	Industry	Jobs
1	Willington power station	Former power station site with potential for large scale H2 Production/Importation/Distribution site	Previously Calon Energy	✓	✓	✓		
2	Ratcliffe power station	Existing power station site with potential to be a large scale H2 production/importation/distribution site. Located near East Midlands Airport with great transport and infrastructure links.	Uniper	✓	✓			
3	Drakelow power station	Former power station with planning permission for energy from waste	EON	✓	✓			
4	Burnaston	Under development - small scale Shell forecourt refuelling site near Toyota's factory with hydrogen refuelling facility to be opened in 2021	Shell/ITM	✓	✓			
5	Confidential Site Derby	Proposed medium scale city based hydrogen production/importation/ distribution site located near HDV fleet depots and light industry	DCC	✓	✓	✓	✓	✓
6	Featherstone Farm	Proposed small scale hydrogen production for rural/agricultural use next to existing and proposed PV, planning permission granted	CA Strawson Farming Ltd	✓	✓			
7	East Midlands Freeport	Existing freight airport, with potential to locate the UK's first H2 HGV fleet refuelling station as part of the Freeport concept	Manchester Airports Group	✓	✓	✓	✓	✓
8	West Burton power station	Existing power station site with potential to be a medium scale H2 production/ importation/ distribution site,	EDF	✓	✓			
9	Staythorpe power station	Existing power station site with potential to be a medium scale H2 production/ importation/ distribution site	RWE	✓	✓			
10	Peak Resort	Proposed leisure development with medium scale hydrogen demand potential for heat and transport	Birchall Properties	✓	✓	✓		
11	SmartParc	Proposed light industry food production site within Derby. Committed to produce its own energy.	Smart Parc	✓	✓	✓	✓	✓
12	Hope Valley Cement Works	Existing major industrial cement works. Potential for hydrogen in process and for transport (rail and road)	Breedon Aggregates	✓	✓		✓	✓
13	Tunstead Lime Works	Existing major industrial lime works. Potential for H2 in lime manufacture process and meet transport demands (road and rail)	Tarmac	✓	✓		✓	✓
14	Cauldon Cement Works	Existing major industrial cement works. Potential for hydrogen in process and for transport (road)	Lafarge	✓	✓		✓	✓
15	Cottam power station	Existing power station site with potential to be a medium scale H2 production/ importation/ distribution site	Uniper	✓	✓			
16	East Midlands Intermodal Park	Proposed H2 generation and refuelling at a potential strategic rail freight logistics interchange	Goodman	✓	✓		✓	✓

Assessing assets and opportunities

A weighted matrix, using the assessment criteria described earlier, is used to score each of the 16 sites:

The table below indicates the scores given to each site against the benefits and prioritisation assessment criteria. The final scores have been ranked below to the right.

The highest score is achieved by the East Midlands Freeport, which promises to unlock 60,000 new jobs in the region and has a specific focus to drive innovation, alternative energy sources and green technology, making it an ideal hydrogen opportunity.

The current and former power station sites Willington, Ratcliffe, Drakelow, West Burton Staythorpe, and Cottam score highly, primarily due to size and the ability to produce hydrogen at scale.

It should be noted that the timeframe within which hydrogen can be developed at these large power station sites is often slower than smaller locations, with ultimate decision-making being part of a wider international strategy subject to large corporate or national policy decisions.

Smaller, locally owned sites are able to act with more agility, which is why the Confidential site in Derby scored highly.

Although the direct impact of small sites like Burnaston and Featherstone farm is small, these demonstrator sites act as catalysts within the region, showing hydrogen's potential in action and stimulating confidence to invest.

The cement and lime industry scored the lowest due to a large scale hydrogen solution for decarbonisation still being in the early stages of development, compounded with logistical issues of being within the national park.

There is a need for not just one, but a pipeline of catalytic anchor hydrogen projects in the region and for synchronisation in the ramp up of both supply and demand of hydrogen. The pieces of the puzzle have been identified and must now be bound within a roadmap to define when these opportunities can be realised.

Assessment Matrix

Ref		1	2	3	4	5
	PESTLE	Environmental	Social	Economic	Technological	Political/Legal
	Criteria	Carbon Reduction	Job/Skills Generation	Green Growth	Deliverability	Strategic Importance
	Weighting	**25%**	**25%**	**25%**	**10%**	**15%**
Ref	**Site Name**					
1	Willington power station	1	2	2	2	3
2	Ratcliffe power station	1	2	2	2	1
3	Drakelow power station	1	1	3	3	2
4	Burnaston	4	4	3	1	2
5	Confidential Site Derby	3	2	2	2	1
6	Featherstone Farm	4	4	4	1	4
7	East Midlands Freeport	1	1	1	1	1
8	West Burton power station	1	3	4	3	2
9	Staythorpe power station	1	3	4	3	3
10	Peak Resort	5	4	2	1	4
11	SmartParc	3	3	3	2	2
12	Hope Cement Works	2	5	5	5	3
13	Tunstead Lime Works	1	5	5	4	3
14	Cauldon Cement Works	2	5	5	5	3
15	Cottam power station	1	3	4	3	3
16	East Midlands Intermodal Park	3	3	2	3	2

Assessment Score

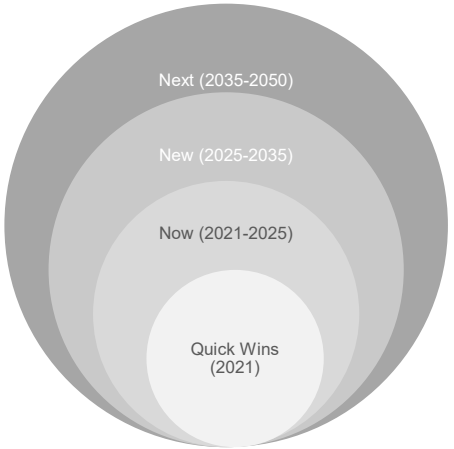
Rank	Site Name	
1	East Midlands Freeport	1.00
2	Ratcliffe power station	1.60
3	Drakelow power station	1.85
4	Willington power station	1.90
5	Confidential Site Derby	2.10
6	West Burton power station	2.60
7	East Midlands Intermodal Park	2.60
8	Staythorpe power station	2.75
9	SmartParc	2.75
10	Cottam power station	2.75
11	Burnaston	3.15
12	Peak Resort	3.45
13	Tunstead Lime Works	3.60
14	Featherstone Farm	3.70
15	Hope Cement Works	3.95
16	Cauldon Cement Works	3.95

Summary

This section has described the hydrogen potential in the region, as well as demand and has assessed existing and future assets which could form part of the hydrogen supply and demand story in the region.

It is clear that there are a number of high potential sies in the region which can be unlocked through a combined collaborative effort and strong leadership.

These sites act as the building blocks for a regional roadmap. By *jumping together* as part of a time defined hydrogen agenda, these sites can be bought together as a region to unlock demand and supply synergies as they ramp up, and create a path towards achieving decarbonisation, skills development and green growth.



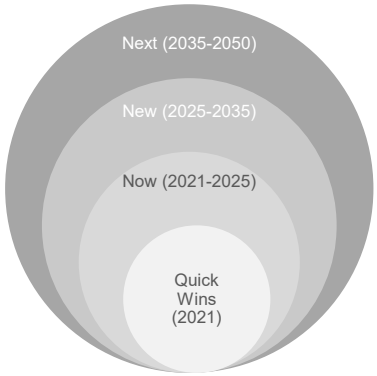
The four timescales which will be built upon in the next section to ensure supply and demand aligns in the region as part of a regional picture.

The Proposed Roadmap

The proposed roadmap

Introduction

Having reviewed the regional core strengths, drivers and constraints, assessed the relevant policy and funding landscape, and identified the potential regional assets which could form the building blocks for a hydrogen economy, we are now in a position to outline to the leadership and key collaborators in the region a roadmap to 2050.

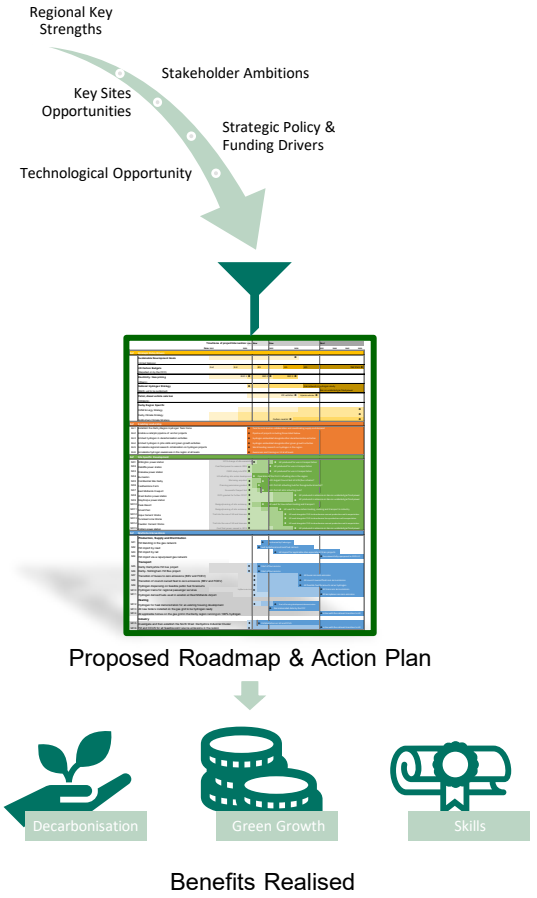


The proposed Derby region hydrogen roadmap provides a proposed high-level pathway to the establishment of a regional hydrogen economy, and as such has been developed to present to the regional leadership and its key collaborators, a timeline of developments to support the net-zero pathway.

It is split across four time-horizons (see below left), each one requiring a different regional focus, serving to enable and catalyse the next step to growth of hydrogen activities.

The infographic to the right depicts how the roadmap funnels the knowledge which has been developed during this investigation, to create a time-bound set of priorities and actions that can be adopted for the region.

The following slide provides a rolled-up summary version of the roadmap before each element is broken down in further detail.



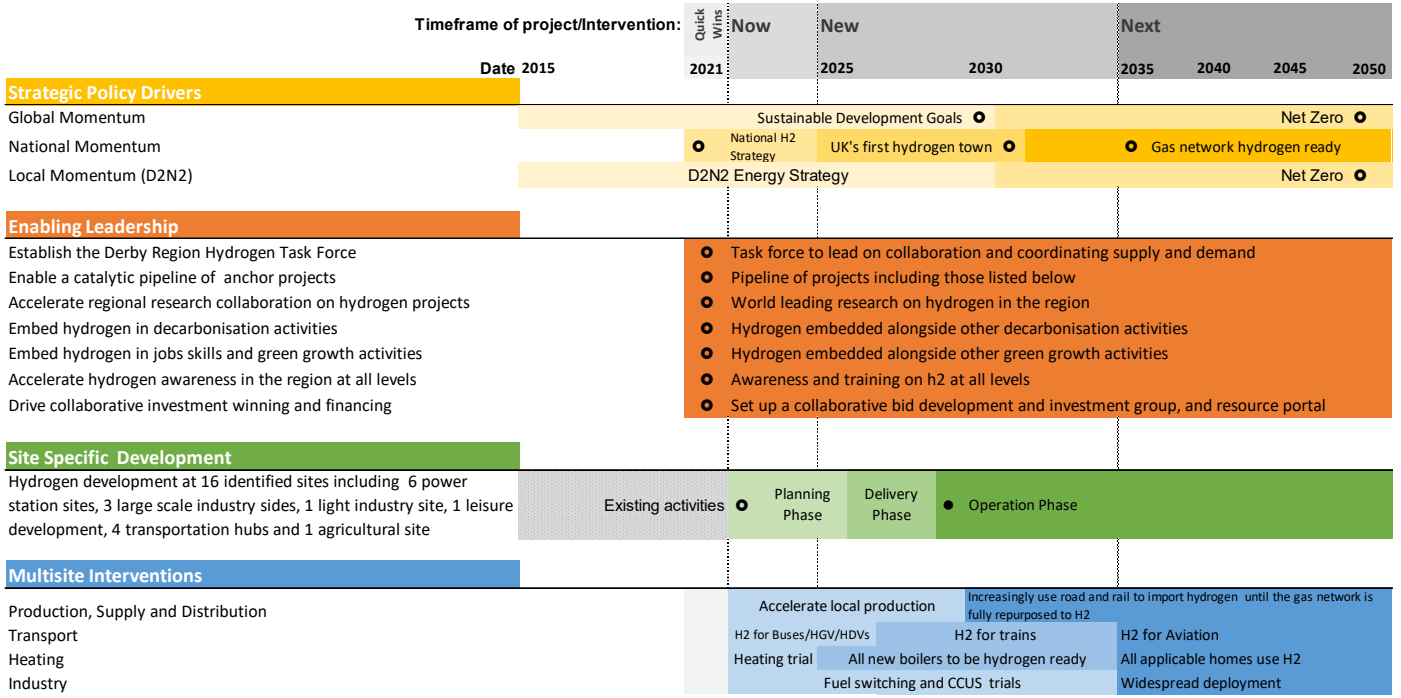
The proposed roadmap

Roadmap summary

Here we outline a summary of the proposed roadmap before going into detail on each element.

The roadmap has been be split across the following six intervention areas:

1. Strategic policy drivers
2. Enabling Leadership
3. Site Specific Development
4. Multisite Interventions
    a) Production and Distribution
    b) Transport
    c) Heating
    d) Industry



Key:

Timeframe:		QWs	Now	New	Next
Existing Processes:					
Shading key:	Planning	Delivery	Operation		

- ♦ Recommended feasibility study
- ● Recommended start of h2 production/consumption
- ⭘ Strategic Drivers / Milestones

On the left is a key to identify the roadmap items. It should be noted that recommended processes are not necessarily part of a published plan or strategy of any stakeholder, but those recommended as part of this project. Where possible we have aimed to reflect the ambition of the key stakeholders of these interventions or sites..

The proposed roadmap

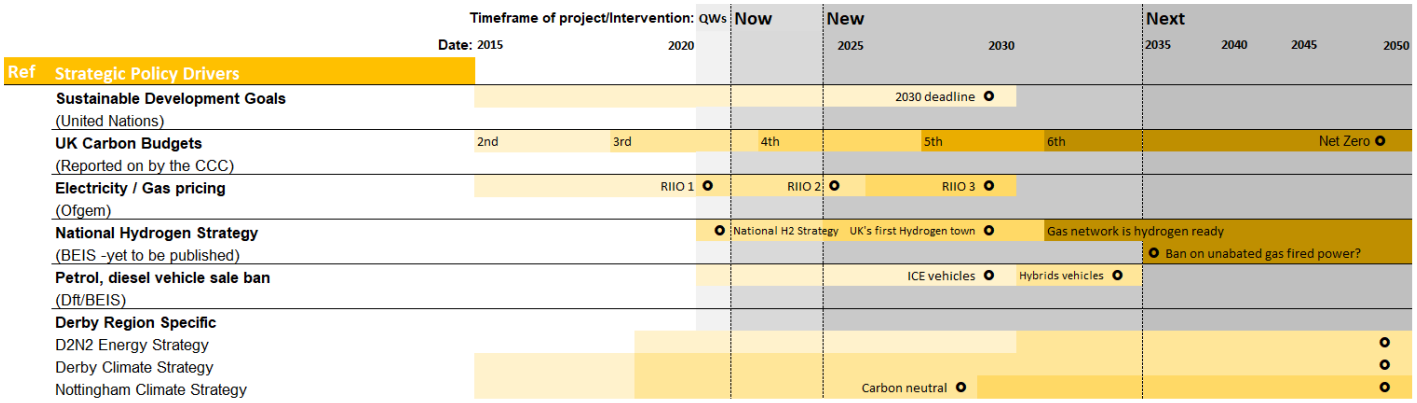
1. Strategic policy drivers

Strategic policy drivers have been identified as a first step to provide a grounding of the policy landscape upon which to build the roadmap proposal.

The aim is to enable regional leadership and industrial collaborators to implement national and local policy and to facilitate the advocacy for better and strong policy for green growth and decarbonisation.

Our approach to developing a roadmap for hydrogen for the Derby Region has been to ensure we are cognisant of strategic drivers, globally, nationally and locally. The Sustainable Development Goals provide holistic framework of 17 global goals to implement by 2030, not least goal 7: Clean and Affordable Energy and Goal 13: Climate Action. The UK's Carbon budget, which was built on the Paris agreement and reported on by the CC, outlines the UK's trajectory to Net Zero 2050. The UK's electricity and gas regulator, Ofgem use a performance based model "RIIO" to set price controls for customers, ensuring they pay a fair price whilst delivering a low carbon energy system. A UK National Hydrogen Strategy is expected in Q2 of 2021 which will build on the Energy White Paper and 10 point plan which includes significant commitments to hydrogen.

The hydrogen strategy is expected to provide dates for the repurposing of the gas network for 100% hydrogen as well as an end date for unabated gas fired power generation. Of particular relevance to the region famous for automotive manufacturing was a policy change in late 2020: the bringing forward of the ban on internal combustion engine vehicle sales from 2040 to 2030 (2035 for hybrids). Finally the regional energy, and climate plans for both Derby and Nottingham are driving the low carbon economy and building the case for, as well as benefitting from the role of hydrogen.



Key:

Timeframe:		QWs	Now	New	Next
Existing Processes:					
Shading key:	Planning	Delivery	Operation		

o Strategic Drivers / Milestones

The proposed roadmap

2. Enabling leadership actions

Strong leadership is key to catalysing momentum behind a roadmap and bringing the region's key collaborators together to achieve action. A clear set of interventions are identified here to engage thought leaders and industrial to raise awareness, accelerate decision making and take steps together as a region.

Leadership actions focus on enabling the collaboration, skills, policy and research required to drive the establishment of a regional hydrogen economy and underpins all elements of the roadmap. The region has an ambition not only to lead the UK's largest carbon turnaround, but also to be the UK's centre of excellence for future fuels. This means an ability to export manufactured components globally as well as undertake globally significant research.

Timeframe of project/Intervention:	QWs	Now	New		Next			
Date:	2015	2020		2025	2030	2035	2040	2045	2050
Ref	**Enabling Leadership**								
EL1	Establish the Derby Region Hydrogen Task Force								
EL2	Enable a catalytic pipeline of anchor projects								
EL3	Embed hydrogen in decarbonisation activities								
EL4	Embed hydrogen in jobs skills and green growth activities								
EL5	Accelerate regional research collaboration on h2 projects								
EL6	Accelerate hydrogen awareness in the region at all levels								

- Task force to lead on collaboration and coordinating supply and demand
- Pipeline of projects including those listed below
- Hydrogen embedded alongside other decarbonisation activities
- Hydrogen embedded alongside other green growth activities
- World leading research on hydrogen in the region
- Awareness and training on h2 at all levels

The concept of a Derby Region Hydrogen Taskforce is recommended as a focal point for collaborating and coordinating hydrogen activities. Once the terms of reference are established, it is recommended that a website is launched; this could contain an online version of the hydrogen potential map of the region that is updated regularly as further data sets are made available. The website would also allow stakeholders to publicly submit their intention or commitment to supply or consume hydrogen and so be a means to coordinate the introduction of hydrogen in the region. This would be combined with a series of stakeholder networking events and workshops. The website could also be used to showcase local industry to the world and attract businesses to the region. Critical to the success of this concept is regional research collaboration on hydrogen, including the initiation of research into topics such as hydrogen for aviation and hydrogen from nuclear power. The commencement of a vocational skills training program is recommended; vocational training requirements may be small initially and ramp up in later years. It is recommended that an outreach program to secondary schools is commenced, focused on engaging students on careers in a wide range of net zero topics, including hydrogen.

Key:

Timeframe: QWs Now New Next

Existing Processes:

Shading key: Operation

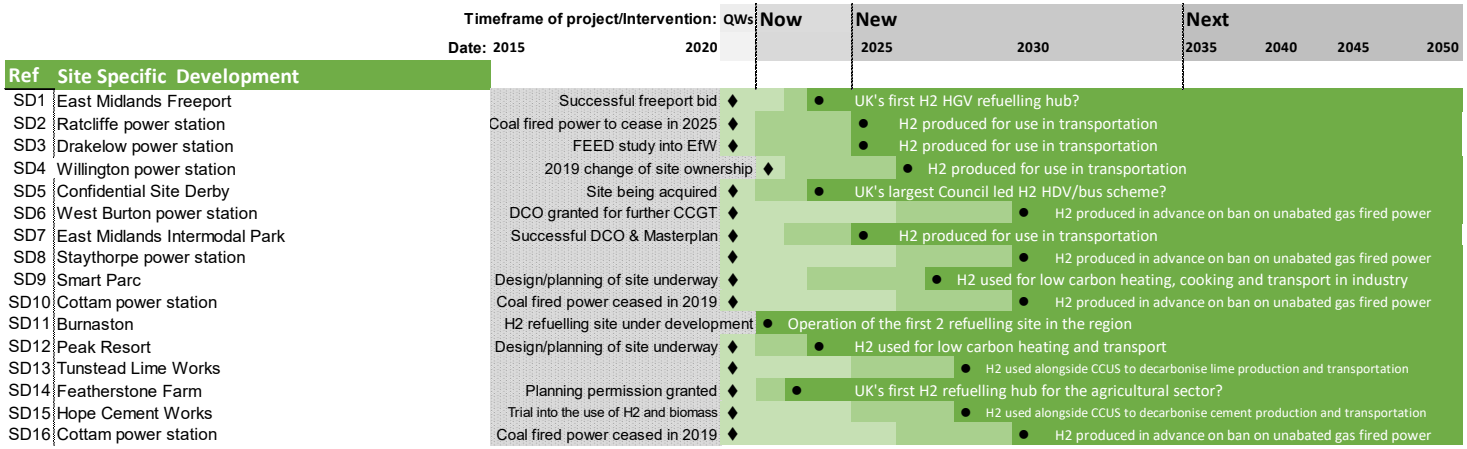
- Strategic Drivers / Milestones

The proposed roadmap

3. Site specific development

Through both stakeholder workshops and mapping of hydrogen assets, we have identified and assessed 16 key hydrogen potential sites. Here we outline the timeframe for Planning, delivering and operating hydrogen production or consumption at these sites.

The 16 sites are comprised of 6 power station sites, 3 large scale industry sides, 1 light industry site, 1 leisure development, 4 transportation hubs and 1 agricultural site. The list is by no means exhaustive; in the case of Burnaston, the first hydrogen refuelling facility to open in 2022 on an existing fuel forecourt, it is likely to serve as a catalyst for a number of similar projects. A feasibility study including an outline business case is recommended as the first step in each case, and it is recognised that the planning duration is longer for some sites than others, particularly for the large power station sites. We have outlined when, in line with policy drivers, we envisage hydrogen production/consumption could start at each site and provide an aspiration/ rationale for each.



Key:

Timeframe: QWs Now New Next
Existing Processes:
Shading key: Planning Delivery Operation

- ♦ Recommended feasibility study
- ● Recommended start of h2 production/consumption

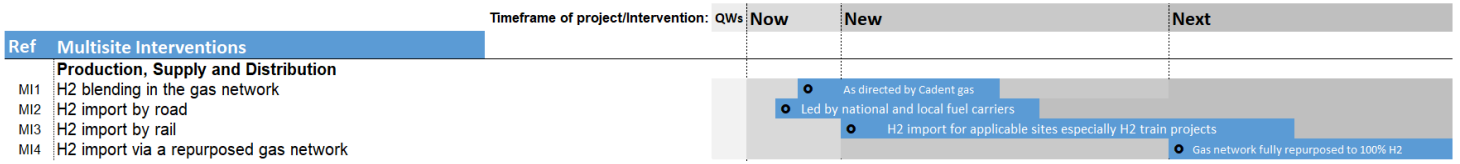
The proposed roadmap

4. Multisite interventions: hydrogen production and distribution

Having identified specific sites, we now look at interventions across multiple sites. In particular we look at the mechanisms by with the produced hydrogen can be distributed to and within the region.

In the near term, hydrogen will be blended (up to 20%) with methane into the gas network. This provides a means of storing excess zero carbon energy from renewables and aid the decarbonisation of the gas network. Up to 20% blending entails no requirement to alter downstream appliances such as domestic boilers and cookers. The points at which blending can take place and how the quantity is controlled, require discussion and planning with Cadent Ltd, the region's Gas Network Operator. Having access to blending points adds to the case for hydrogen productions as they have, subject to ensuring an attractive price point, another means by which to be renumerated for hydrogen production.

As indicated earlier in this report, hydrogen demand in the region is likely to necessitate import into the region at around 2030. Prior to this date, hydrogen may be distributed from production to demand centres by road tanker in much the same way as petrol or diesel is distributed today. This could be a hub and spoke model, where a central hydrogen production site uses the road network to distribute hydrogen to a number of, say HGV fleet depots where it is used in transportation. Hydrogen will also be delivered via road tanker to rural demand centres. Later it is thought that hydrogen will be imported by rail - this is particularly possible at some of the former power stations sites which previously imported coal by rail. Finally, distribution will occur by a repurposed gas network using 100% hydrogen. This requires a significant logistical effort to ensure all downstream appliances (e.g. domestic boilers and cookers) are installed as hydrogen ready on the day of the switch. This is discussed further under hydrogen for heating.



Key:

Timeframe: QWs Now New Next
Existing Processes:
Shading key: Planning Delivery Operation

- Strategic Drivers / Milestones

The proposed roadmap

5. Multisite interventions: hydrogen for transport

The transport sector is likely to be the early mover for hydrogen, which catalyses further hydrogen activities in the region. A number of specific opportunities have been identified in this section.

Hydrogen propulsion is complementary with battery electric propulsion and is likely to be used initially in the region for heavy duty, long range, back to base road vehicle fleets. Burnaston, the Derby site and Featherstone farm are discussed as production sites on the preceding page but are also dispensing sites for vehicles.

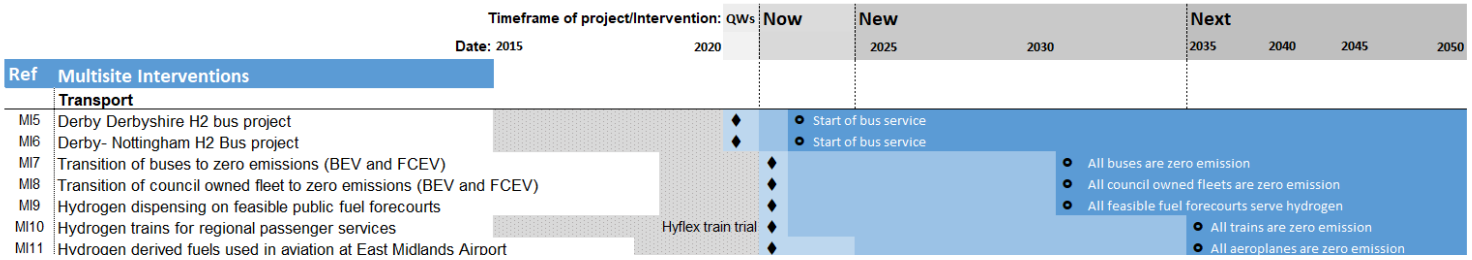
Key:

Timeframe: QWs Now New Next
Existing Processes:
Shading key: Planning Delivery Operation

- ♦ Recommended feasibility study
- ⭘ Strategic Drivers / Milestones

It is recommended that two hydrogen bus schemes are initiated, one between Derby and the Derbyshire Peak District towns of Matlock, Bakewell and Buxton. The other could be between Derby and Nottingham/Nottinghamshire. It is recommended that for both buses and council owned fleets, no new petrol and diesel vehicles are purchased triggering the process of transition to both battery electric vehicles (BEV) and fuel cell electric vehicles (FCEVs).

Where possible it is recommended that diesel vehicles are converted to hydrogen combustion as a transitionary measure. Following the example of Burnaston, it is recommended that hydrogen dispensing is added to all feasible petrol and diesel forecourts, starting with those that serve trucks. It is recommended that hydrogen passenger train services are introduced on the region's rail network, starting on lines that are challenging to electrify. The region's first rail H2 refuelling hub could be at Etches Park in Derby. The first use of hydrogen derived fuels in aviation at the East Midlands Airport is likely take place by around 2035, this could be earlier as technology advances and more cost effective hydrogen becomes available.

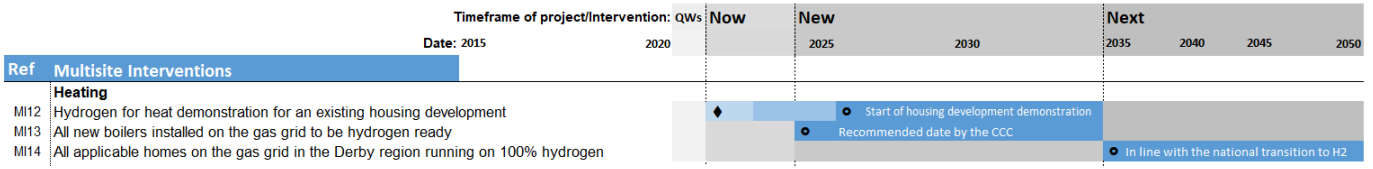


The proposed roadmap

6. Multisite interventions: hydrogen for heating

Hydrogen for domestic heating and cooking is one of the largest potential opportunities for hydrogen. Significant logistics are required to switch the gas network from methane to hydrogen and this is being studied in detail by National Grid and all the UK's gas network operators.

Hydrogen for heating is a complimentary intervention with other low carbon heating interventions, especially heat pumps and must be pursued alongside energy efficiency measures for homes. Hydrogen can be blended in the gas network up to 20% without any need to change downstream appliances including boilers and cookers. However, work is ongoing to repurpose the entire gas network with 100% hydrogen including planning the logistics of having hydrogen ready appliances in place and switching between one to the other. Cadent are the Gas Network Operators for the region.



Hydrogen for heating and cooking is an intervention that is only applicable for houses on the gas network and some houses on the gas network may choose to use other forms of heating. At present around 85% of the UK's housing stock is connected to the gas network, with lower percentages in rural areas. In the absence of a national hydrogen strategy, the CCC 6th carbon budget's Net Zero Balanced pathway recommends that all new boilers that are installed from 2025 are hydrogen ready.

The final UK percentage of houses connected to the gas network varies from 11% in the Net Zero balanced scenario to 71% in the Headwinds scenario. Either way a significant number of hydrogen boilers and boilers will be required. In the region there are two major boiler manufacturers and it is recommended that a domestic hydrogen for heat trial is proposed as a way to both trial and showcase UK manufacturing. Already 100% hydrogen in domestic houses is being trialled on a small scale in Gateshead and on a larger scale in Fife. It is recommended that any trial proposed in the Derby region, is significantly differentiated from these trials in scale or scope, so as to add to the national narrative.

The key date for the transition of the gas network depends on the initiation of large scale production and a coordination policy drive from central government. In the absence of a national strategy the date for the full conversion of the gas network to 100% hydrogen is assumed to be 2035. Industrial and commercial boilers, as well as power stations that currently consume natural gas will also need to transition to hydrogen at this date.

Key:

Timeframe: QWs Now New Next
Existing Processes:
Shading key: Planning Delivery Operation

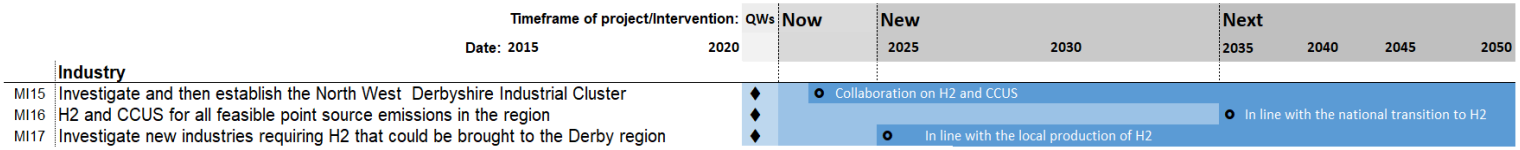
♦ Recommended feasibility study
o Strategic Drivers / Milestones

The proposed roadmap

7. Multisite interventions: hydrogen for industry

A hydrogen roadmap for industry is difficult to develop at a high level and requires a level of detailed engagement with individual stakeholders to make credible assumptions. At this stage we look to present an initial snapshot of the art of the possible as a basis for further discussion.

Hydrogen poses an opportunity to decarbonise heavy, medium and light industries. During this project potential for a new industrial cluster was identified in discussion with stakeholders. The proposed North West Derbyshire Industrial Cluster.

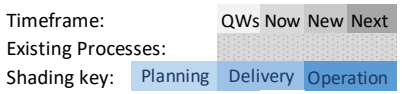


Once the coal powered sites are removed from the list (these will be decommissioned in 2024) the three sites of Hope cement works, Buxton lime works and Cauldon cement works are the largest non-power carbon emitters. Hope cement works and Buxton lime works are both on the rail network, and hydrogen could be imported by rail as well as carbon dioxide captured and exported for storage/disposal. These two sites, and other smaller industrial sites nearby, could form the anchor members to a new industrial cluster know as the North West Derbyshire Industrial Cluster with a focus on collaboration for net zero interventions including hydrogen and CCS.

The CCC's net zero balanced pathway recommends that 'no new unabated gas plants should be built after 2030, and the burning of unabated natural gas for electricity generation should be phased out entirely by 2035. Any gas plant built before 2030 should be made ready for a switch to CCS or hydrogen'. Staythorpe CCGT will be the largest source of carbon emissions in the region once the coal fired power stations are closed. With CCC recommendation in mind, given Staythorpe is not a coastal location nor served by rail infrastructure that could serve as a means for transporting carbon dioxide, it is recommended that the feasibility of its conversion to blended and then 100% hydrogen is investigated.

Finally there may be new industries that could be attracted to the region to consume from low carbon hydrogen. This could be flat glass production, ammonia production, specific food manufacturing, metalworking and welding, electronics manufacturing and in certain medical applications.

Key:



♦ Recommended feasibility study
o Strategic Drivers / Milestones

Next Steps – a call to action

Next steps – a call to action

Delivering the proposed roadmap requires a collaborative effort. With the number of stakeholders required to engage with the process set out previously, a clear outlining of priorities and action owners is needed to draw commitment and delivery to set timescales. This section concludes the work by taking the proposed roadmap to the next level and defining practical next steps through an action plan.

To turn our proposed roadmap into a tangible, time-bound set on actionable steps, an action plan has been sufficiently detailed to rally the region, engage and enable momentum and obtain commitment across multiple sectors with multiple stakeholders.

Six questions must be asked of any strategy: Why?, Where?, What?, How?, When?, and Who? The first two questions are answered throughout this report: hydrogen in the Derby region presents a once in a generation opportunity to accelerate decarbonisation, accelerate green growth and accelerate growth in jobs and skills.

The remaining four questions form the basis of the next steps table as shown below:

Ref	Action (What?)	Process (How?)	Timeframe (When?)	Proposed Action Owner (Who?)	Proposed Delivery Partners (Who Else?)

39 recommendations are tabulated under the format shown above and these 40 have been categorised into three categories:

1. Enabling Leadership Actions: 7 are listed, thee are primarily actions for local government
2. Site Development Actions: 16 are listed, these are primarily actions for the 16 site owners
3. Multisite Development Interventions: 16 are listed, these are actions for a mixture of both local government, site owners and other stakeholders.

Action plan – enabling leadership actions

	Enabling Leadership Actions					
	Ref	**Action (What?)**	**Process (How?)**	**Timeframe (When?)**	**Proposed Action Owner (Who?)**	**Proposed Delivery Partners (Who Else?)**
Convene and Enable the Market	**EL1**	**Establish the Derby Region Hydrogen Task Force**	Develop Terms of reference and seek internal funding. Assign appropriate resources for both fund raising and for advocacy for at least 5 years. Launch this report with stakeholder workshops ongoing to COP 26. Develop a website with a online map of hydrogen assets, use the website coordinate commitments for hydrogen supply and demand.	**Quick Win (2021) - PRIORITY**	D2N2	DCC, NCC, Universities and Key industrial partners
	EL2	**Enable a catalytic pipeline of anchor projects for the region**	Crystallise project essentials in a one page brief, commission technical feasibility study and outline business studies for each site. Prioritise transition of council owned assets fleets in all project to ensure leading by example.	**Quick Win (2021) - PRIORITY**	D2N2	DCC, NCC,
	EL3	Accelerate regional research collaboration on hydrogen projects	Through Task Force, work with academia and industry to promote collaboration between university research projects including key innovation areas such as hydrogen derived fuels in aviation, hydrogen from small modular nuclear reactors, offshore electrolysis, etc.	Quick Win (2021)	D2N2	DCC, NCC, Universities and colleges
Lead by Example	**EL4**	**Embed hydrogen in decarbonisation activities**	Update Derby Region Climate Strategy to include plans/ambitions on hydrogen. Update the ambition in the D2N2 Energy Strategy on hydrogen. Ensure hydrogen is included in all strategic transport, heating and industry project/intervention discussions. Develop a strategy for specifically for gas fired power stations, CCS and hydrogen.	**Quick Win (2021) - PRIORITY**	D2N2	DCC, NCC,
	EL5	Embed hydrogen in jobs skills and green growth activities	Update low carbon jobs skills assessment with hydrogen specific categories in line with reports elsewhere. Commission a hydrogen skills/jobs action plan and assign resource. Showcase hydrogen projects/capabilities in the region using website/events to accelerate national and global export. Assess the viability of the establishment of a regional vocational hydrogen training centre for hydrogen component manufacture, installation and repair.	Quick Win (2021)	D2N2	DCC, NCC, Department for International Trade
Prepare the Future Workforce	EL6	Accelerate hydrogen awareness in the region at all levels	'Provide online basic training for all relevant local authority staff on hydrogen. Establish an outreach program to secondary schools on hydrogen and other net zero topics. Use the website as a platform to provide information and awareness.	Quick Win (2021)	D2N2	DCC, NCC, Universities, colleges and schools
Win Resources & Investment	**EL7**	**Support collaborative investment winning and financing**	Establish a collaborative bid development / investment group within the Derby Region Hydrogen Task force as well as a resource portal to jointly bring funding into regional hydrogen initiatives	**Quick Win (2021) - PRIORITY**	D2N2	DCC, NCC, Universities and Key industrial partners

Action plan – site development actions

(The order of these sites in the table below is based on the multicriteria assessment (page 42) and a map of these sites can be found on page 40 and in Appendix A)

Site Development Actions

Ref	Action (What?)	How?	Timeframe (When?)	Proposed Action Owner (Who?)	Proposed Delivery Partners (Who Else?)
SD1	East Midlands Freeport - Existing freight airport, with potential to locate the UK's First H2 HGV fleet refuelling station as part of a Freeport concept	Feasibility study required. Main user case hydrogen for heavy duty, long range, back to base fleets, however airside vehicle fleet investigation also recommended. Production onsite or offsite potentially from Ratcliffe. Future investigation into hydrogen in aviation use case.	Now (2021 – 2025)	Manchester Airports Group	Amazon, DHL, Intelligent Energy
SD2	Ratcliffe - Existing power station site with potential to be a large scale H2 production/importation/distribution site	Feasibility study required. Coal production on this site to cease by 2025. Site is in an ideal location for playing a key role in the energy transition. Potential for green hydrogen production on site or green/blue h2 importation by rail. Proximity to M1 and East Midland airport and HS2 Toton hub means Ratcliffe could act as H2 Hub in a hub and spoke model, potential for future distribution by pipeline and connection to the gas network.	Now (2021 – 2025)	Uniper	Multiple partners
SD3	Drakelow -Former power station with planning permission for energy from waste, potential for electrolytic H2 production for transport of waste.	Feasibility study required. FEED study for electricity from waste is underway, it could be an economic source of power for green hydrogen. Hydrogen could be used to power waste fleets or private h2 vehicles travelling on A38. Proximity of high pressure gas main offtake point at Alrewas, is identified as a site for h2 blending and therefore adds to business case for h2 production at Drakelow particularly if demand is variable.	Now (2021 – 2025)	EON	Vital Energi
SD4	Willington - Former power station site with potential for large scale H2 Production/Importation/Distribution site	Feasibility study required. Ownership of site and conditions of sale to be confirmed. Proximity to the gas network means site could be a green or blue hydrogen production site. Rail connection means H2 import/export by rail is possible.	Now (2021 – 2025)	Previously Calon Energy	South Derbyshire District Council
SD5	Confidential Site Derby - Proposed medium scale city based H2 production/importation/distribution site located near HDV fleet depots and light industry	Feasibility study required. Key demand case is heavy duty vehicle refuelling; study could analysis of adjacent vehicle fleet. Also provide analysis and options of onsite/offsite production and potentially distribution to nearby housing and industry.	Quick Win (2021)	DCC	TBC
SD6	West Burton - Existing power station site with potential to be a medium scale H2 production/importation/distribution site,	Feasibility study required. Coal production on this site to cease by 2025. DCO granted in 2020 for up to 299MW of new gas fired production (West Burton C) , currently on hold due to market conditions. Hydrogen potential yet at this site to be established in line with the future national strategy for hydrogen and gas fired power stations in the UK. Investigation into requirement for low carbon heating demand at Cotham power station redevelopment 6km away which could be supplied from West Burton.	Now (2021 – 2025)	EDF	National Grid
SD7	East Midlands Intermodal Park Proposal - Develop H2 production/import/distribution capacity for rail and road freight	Create initial masterplan and progress DCO application. Feasibility study required. Key demand case is heavy duty road and rail refuelling; study could be an analysis of on-site H2 production and distribution capability as well as expected demand and any synergies with exisitng waste treatment facility and potential distribution to nearby housing and industry.	Now (2021 – 2025)	Goodman	South Derbyshire District Council, East Midlands Freeport
SD8	Staythorpe - Existing power station site with potential to be a medium scale H2 production/importation/distribution site	Feasibility study required. Coal production on this site to cease by 2025. DCO granted in 2020 for up to 299MW of new gas fired production, currently on hold due to market conditions. Hydrogen potential yet at this site to be established in line with the future national strategy for hydrogen, CCUS and gas fired power stations in the UK.	Now (2021 – 2025)	RWE	National Grid

Action plan – site development actions

Site Development Actions					
Ref	**Action (What?)**	**How?**	**Timeframe (When?)**	**Proposed Action Owner (Who?)**	**Proposed Delivery Partners (Who Else?)**
SD9	Smart Parc - Proposed light industry food production site within Derby, potential for H2 use in space heating, cooking and transport.	Feasibility study required. Light weight industry will require low carbon energy for space heating and cooking. Hydrogen use in back to base vehicle fleets also to be investigated given proximity of adjacent vehicle fleets locations. Power infrastructure associated with the decommissioned Spondon power station now decommissioned to be investigated. Potential for energy production from food waste given the development's focus. Renewable/biomethane energy generation at adjacent waste water site to be investigated.	Now (2021 – 2025)	Smart Parc	DCC
SD10	Cottam - Existing power station site with potential to be a medium scale H2 production/importation/distribution site	Feasibility study required. Coal production on this site to cease by 2025. Hydrogen potential yet at this site to be established in line with the future national strategy for hydrogen, CCUS and gas fired power stations in the UK.	Now (2021 – 2025)	Uniper	National Grid
SD11	Burnaston - Under development - small scale Shell forecourt refuelling site near Toyota's factory with H2 refuelling facility to be opened in 2021	Completion of existing project is underway. Site is on a major interchange and near Toyota factory and close to Willington, a former power station stie. Lessons learnt from this site could be applied to all fuel forecourts in the region.	Quick Win (2021)	Shell	ITM, Toyota
SD12	Peak Resort - Proposed leisure development with medium scale H2 demand potential for heat and transport	Feasibility study required. Use case is hydrogen for transport and potentially for heating at the site. Potential for the site to be a world leading resort in terms of low carbon energy and transport.	Now (2021 – 2025)	Birchall Estates	TBC
SD13	Tunstead Lime/Cement Works - Existing major industrial site. Potential for H2 in cement/lime manufacture process and meet transport demands (road and rail).	Feasibility study required. Fuel switching to hydrogen plus biomass a potential solution for cement subject to trials elsewhere. Investigation into carbon capture with other nearby industrial emission sources recommended. Hydrogen for refuelling of rail and road transport movements to be included in investigation.	Now (2021 – 2025)	Tarmac	TBC
SD14	Featherstone Farm - Proposed small scale H2 production for rural/agricultural use next to existing and proposed PV, planning permission granted	Feasibility study required including stakeholder engagement with nearby agricultural fleets. Study could include co-investigation with Cadent into a local hydrogen for heating project given the proximity to an isolated section of the medium pressure gas network.	Now (2021 – 2025)	Hexgrave Estates, C A Strawson Farming Ltd	Fisher German, Cadent
SD15	Hope Cement Works - Existing major industrial site. Potential for H2 in cement manufacture process and to meet transport demands (rail and road).	Feasibility study required. Fuel switching to hydrogen plus biomass a potential solution for cement subject to trials elsewhere. Investigation into carbon capture with other nearby industrial emission sources recommended. Hydrogen for refuelling of rail and road transport movements to be included in investigation.	Now (2021 – 2025)	Breedon Aggregates	Porterbrook
SD16	Cauldon Cement Works Existing major industrial site. Potential for H2 in process and to meet transport demands (road).	Feasibility study required. Fuel switching to hydrogen plus biomass a potential solution for cement subject to trials elsewhere. Investigation into carbon capture with other nearby industrial emission sources recommended. Hydrogen for refuelling of road transport movements to be included in investigation.	Now (2021 – 2025)	Lafarge	TBC

Action plan – multi site intervention actions

Multisite Intervention Actions					
Ref	**Action (What?)**	**How?**	**Timeframe (When?)**	**Proposed Action Owner (Who?)**	**Proposed Delivery Partners (Who Else?)**
Production/ Supply/ Distribution Interventions					
MI1	H2 blending in the gas network	Cadent led investigation into hydrogen blending as a means to accelerate hydrogen production. At present one site in the region at the village of Alrewas, near Burton on Trent is identified as a blending location given it is the high pressure offtake point for Cadent.	Now (2021 – 2025)	Cadent	Hydrogen production sites, Tube trailer (road) distribution companies (see below)
MI2	H2 distribution by road	Investigation into delivery of hydrogen by road by existing/future road gas companies. Key use cases are a) delivery to existing fleet depots (hub and spoke model) , b) delivery to off grid hydrogen for heat areas including domestic properties c) as a precursor to construction of a hydrogen pipeline.	Now (2021 – 2025)	Hydrogen production sites	Road Gas, Halso, Peak Oil
MI3	H2 distribution by rail	Investigation into the delivery of hydrogen by rail both imported into the region and export to other regions.	Now (2021 – 2025)	Hydrogen production sites	Porterbrook, East Midlands Rail,
MI4	H2 import via a repurposed gas network	Multi stakeholder investigation including Cadent is already underway investigating the case for repurposing of the gas network to 100% hydrogen. This needs to be investigated inline with national policy and in conjunction with coastal hydrogen production sites where volumes of hydrogen production/import will be far greater than within the Derby Region	Now (2021 – 2025)	Cadent	National Grid, Coastal hydrogen production sites
Transport Interventions					
MI5	Derby Derbyshire H2 Bus project	Feasibility into a fleet of hydrogen buses between Derby focusing on the longer distance and topographically more challenging routes into the Peak District including to locations such as Matlock, Bakewell and Buxton.	Now (2021 – 2025)	DCC	Trent Barton, Arriva, TM Travel, Hulleys, Stagecoach, First,
MI6	Derby- Nottingham H2 Bus project	Feasibility into a fleet of hydrogen buses between Derby and Nottingham building on the Red Arrows route.	Now (2021 – 2025)	DCC	Trent Barton,
MI7	Transition of buses to zero emissions (BEB and FCEB)	Technical feasibility study and then road map for the transition of all buses to either battery electric buses (BEB) or fuel cell electric buses (FCEB).	Now (2021 – 2025)	DCC	Trent Barton, Arriva, TM Travel, Hulleys, Stagecoach, First,
MI8	Transition of council owned fleet to zero emissions (BEV and FCEV)	Technical feasibility study and then road map for the transition of all council owned fleet to battery electric vehicles (BEV) or fuel cell electric vehicles (FCEV)	Now (2021 – 2025)	DCC,NCC	TBC
MI9	Hydrogen dispensing on feasible public fuel forecourts	Technical feasibility study and then road map for the addition of hydrogen refuelling to all applicable petrol/diesel fuel forecourts. Study to look at onsite and offsite hydrogen production.	Now (2021 – 2025)	TBC	Shell, Total, BP, Texaco etc.
MI10	Hydrogen trains for regional passenger services	Technical feasibility study and then roadmap for the introduction of hydrogen train passenger services on regional and mainline routes. Study to cover refuelling locations, safety implications and rolling stock.	Now (2021 – 2025)	Network Rail	Porterbrook, Network Rail, East Midlands Rail, Etches Park Depot
MI11	Hydrogen derived fuels used in aviation at East Midlands Airport	Research and feasibility study into the use of hydrogen in aviation. East Midlands airport being focused on freight logistics and proximity to hydrogen production sites being a key angle of investigation.	Now (2021 – 2025)	Manchester Airports Group	Rolls Royce

Action plan – multi site intervention actions

Multisite Intervention Actions					
Ref	**Action (What?)**	**How?**	**Timeframe (When?)**	**Proposed Action Owner (Who?)**	**Proposed Delivery Partners (Who Else?)**
Heating Interventions					
MI12	Hydrogen for heat demonstration for an existing housing development	Technical feasibility study into optimal location for a hydrogen for heating demonstration in a suburb or village, ideally located on an isolated branch of the gas network, adjacent to a production site.	Now (2021 – 2025)	Cadent	Worcester Bosch, Baxi, Vaillant, Derby Homes
MI13	All new boilers installed on the gas grid to be hydrogen ready	Research study into the number of boilers being renewed/changed in the region and engagement with key stakeholders e.g. Derby Homes - (council owned accommodation).	Now (2021 – 2025)	Cadent	Worcester Bosch, Baxi, Vaillant, Derby Homes
MI14	All applicable homes on the gas grid in the Derby region running on 100% hydrogen	Multi stakeholder investigation including Cadent is already underway investigating the case for repurposing of the gas network to 100% hydrogen. This needs to be investigated inline with national policy and in conjunction with coastal hydrogen production sites where volumes of hydrogen production/import will be far greater than within the Derby Region. The optimal percentage of homes that are suitable hydrogen for heat compared to other low carbon options such as heat pumps to be studied for each locality.	Now (2021 – 2025)	Cadent	Worcester Bosch, Baxi, Vaillant, Derby Homes
Industry Interventions					
MI15	Establish the North West Derbyshire Industrial Cluster	Technical feasibility, stakeholder engagement and workshops with key industrial point source emission sites in the North West Derbyshire. Investigate hydrogen use case and shared carbon capture infrastructure.	Now (2021 – 2025)	D2N2	Breedon Aggregates, Tarmac
MI16	Hydrogen use in the top 20 point source emission sites in the region	Technical feasibility and stakeholder engagement with all of the top 20 carbon emitters in the region, with a focus on the potential for energy efficiency, energy demand management, hydrogen and carbon capture.	Now (2021 – 2025)	D2N2	TBC

Conclusions

Conclusions

The next few years represent a once-in-a-generation opportunity for Derby and the wider D2N2 region. The Government has stated its bold vision for clean growth to re-balance the economy towards regions whose manufacturing expertise was once the backbone of the world's most progressive industrial economy.

We are on the cusp of a green revolution which, if harnessed, can propel us forward as the UK leader in development of low carbon and future fuel solutions. This work has established a clear road map and vision to make the hydrogen economy achievable. With an eye on maximising benefits in decarbonisation, green growth, energy security and new skills, the time for supporting the enabling moves towards a hydrogen economy here, is now. Derby and the wider D2N2 region is extremely well positioned to grasp the hydrogen opportunity.

The area has the industry, skills and research capabilities, infrastructure and assets required to deliver viable, at scale hydrogen projects. With a rich legacy of industrial innovation and making, it is part of the region's heritage to drive change.

By maximising our locational advantages, assets and working with stakeholders both large and small; our proposals around hydrogen are compelling, deliverable, and provide a rich competitive advantage for Derby and the wider region, and the UK.

It is important that the region collaborates with neighbouring regions on hydrogen. From 2030 hydrogen demand in the region will exceed that which can be produced locally and hydrogen will need to be imported into the region likely first via road, then rail but ultimately via a repurposed gas network. In summary, this study has established the following conclusions:

- **Collaboration is key**. The entire supply chain from producers to demand end users must 'jump together' to be joined up. This study has identified key stakeholders who are eager to form a coalition of the willing, primed to drive change and realise opportunities relating to hydrogen. The collective will of the region's public and private sectors will help ensure its success and ability to join up with neighbouring regions to import supply.

- **Aggregate opportunities and synchronizing the ramp up of supply and demand.** To overcome the 'chicken and egg' scenario, opportunities for hydrogen demand should be multi sectoral, aggregated across the use cases of transportation, heating and industry and across the public and private sector. The increase in hydrogen supply needs to match with the increase in demand, with export/import into the region used to counter imbalances.

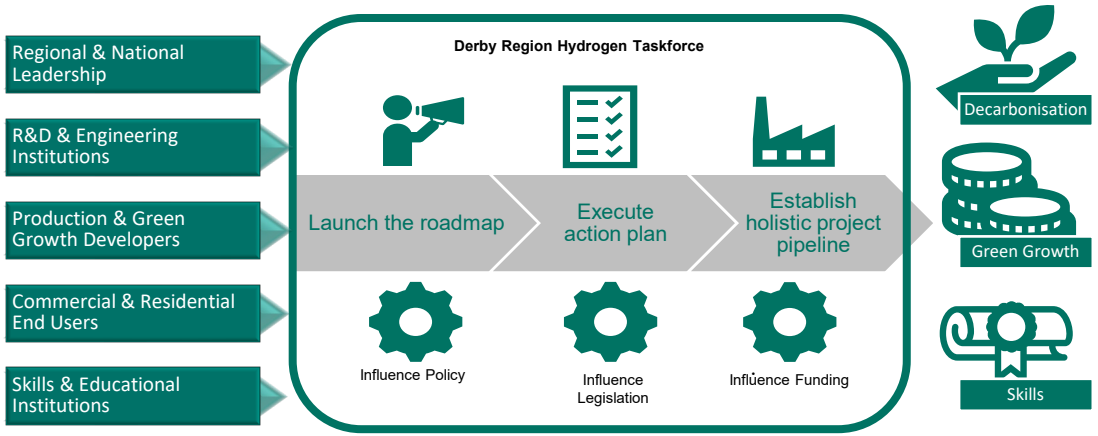
Conclusions

- **Leadership to drive opportunities already exists in Derby and the wider D2N2 region but needs to be harnessed and championed as one voice.** Leadership has an important role in matching supply and demand so that stakeholders have the confidence to jump together. There is a need to provide a prominent voice in the hydrogen debate and present a compelling case for Derby and the wider D2N2 region to receive vital Government support needed to realise the benefits of hydrogen. We have identified the need for a Derby Region Hydrogen Task Force to spearhead efforts.

- **Go large, go at scale and maximise assets.** Whilst there will remain a need for pilots and demonstrator projects to provide proof of concept around hydrogen, Derby and the wider D2N2 region should spearhead projects at scale, as identified in the roadmap, to ensure decarbonisation and full supply chain benefits are realised and existing assets are capitalised upon.

- **Take forward the catalytic and anchor projects identified in the roadmap.** These projects have been identified to provide a plethora of benefits and maximise synergies between sites and stakeholders. In the short term, projects within the influence and jurisdiction of Derby City Council such as the Derby Confidential Site and hydrogen bus fleet project should be supported by well defined briefs and technical feasibility studies. Private sector site opportunities such as SmartParc and Toyota should be explored further with their owners.

- **Scale up to unlock public and private finance. S**eek commercially viable projects at scale, achievable through strategic alignment enabling joint ventures and aggregated demand anchors.



Infographic shows the proposed process to establish hydrogen in the region

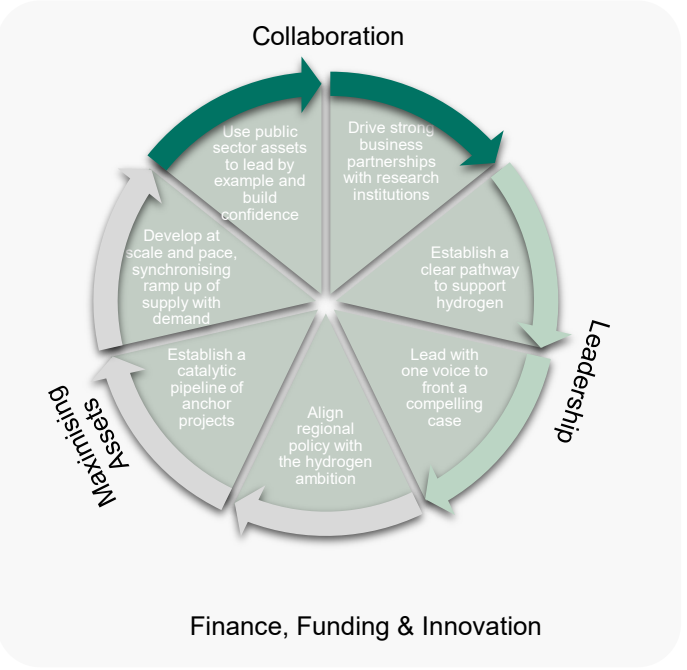
Conclusions

- **Use public sector assets effectively to drive change and lead by example.** Focus should be on delivering high profile projects quickly. As identified in the roadmap, there are easily achievable goals, such as enabling the transition of council owned vehicle fleet to hydrogen. This will build further confidence, experience and a supply chain needed to tackle more complex challenges such as using hydrogen for heating

- **Research into hydrogen is important but establishing stronger partnerships with business will bear more fruit, quicker**. The organisations and institutions which lead research in the region into hydrogen and future fuels must establish stronger business and industrial partnerships.

- **A skills and training audit and clear skills pathway to support jobs associated with the needs of the hydrogen economy is required**. To tackle challenges around retention, automation and a smooth transition of skills to support the hydrogen economy, there is a need to identify training requirements and those responsible for provision.

- **Hydrogen and future fuels should form the focus of a targeted educational outreach programme, in partnership with business.** This will help establish interest from younger generations and establish early interest in green skills programmes. This targets social value and the levelling up agenda.



The infographic shows the key actions required around collaboration, leadership and assets to establish a regional hydrogen economy.

In conclusion …

'We need greater investment and innovation in critical technologies, such as hydrogen, carbon capture and storage, and sustainable aviation fuels… A market in the transition to net zero is…turning an existential risk into one of the greatest commercial opportunities of our time. ***And it's now within our grasp to create a virtuous cycle of innovation and investment for the net zero world that people are demanding, and that future generations deserve.'***

Mark Carney former Bank of England Governor
Current finance advisor for the UK presidency of the COP26 United Nations Climate Change conference.
From the Reith lectures 2020: 'How we get what we value, lecture 4 -From Climate Crisis to Real Prosperity.'

Appendices

Appendices

A. Derby Region Hydrogen Potential Mapping Tool v2.0

B. Why Hydrogen and Why Derby Region Poster

C. Stakeholder Contacts & Engagement Tracker (Redacted)

D. Stakeholder Hydrogen Activities Tracker

E. Stakeholder Engagement Introductory Workshop World Café Forum Provocation Outputs

F. Why Derby & the Wider Region – Spatial Mapping of Regional Strengths

G. Estimating Hydrogen Demand in the Derby Region

H. Estimating the Economic Potential of Hydrogen in the Derby Region

I. Policy Review

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Appendix A

Derby Region Hydrogen Potential Mapping Tool v2.0

Derby Region Hydrogen Potential Mapping Tool

Identifying Assets & Opportunities

Rev 2.0

The layers function in the PDF can be used to toggle different points and areas on and off

Zoom in to see more

HYDROGEN OPPORTUNITIES

(SITES OF POTENTIAL HIGHLIGHTED IN OUR REPORT)

- TOP 14 SITES

1 - HYDROGEN FOR PRODUCTION, STORAGE, DISTRIBUTION

- NON RENEWABLE ENERGY SITES
- RENEWABLE ENERGY SITES
- WATER WASTE SITES
- HIGH PRESSURE GAS OFFAKE POINT (ALREWAS)
- NATIONAL GRID SUBSTATION
- SOLID WASTE SITES
- PLEASE LABEL AS UNDERGROUND GAS FACILITY (HATFIELD MOOR)

2 - HYDROGEN FOR TRANSPORT

- TRUCK STOPS
- MOTORWAY SERVICE AREAS
- BUS DEPOT
- RAIL DEPOT
- AIRPORT
- MOTORWAY
- MAJOR ROAD
- MAJOR RAIL
- PROPOSED HS2

MOTORWAY TRUCK COUNT

(TOTAL PER AVERAGE DAY, BOTH DIRECTIONS)

<1000 | 1000 - 10,000 | 10,000>

3 - HYDROGEN FOR DOMESTIC HEAT - GAS NETWORK

- HIGH PRESSURE
- INTERMEDIATE PRESSURE
- MEDIUM PRESSURE

4 - HYDROGEN FOR INDUSTRY

(TOP 20 INDUSTRIAL POINT SOURCE EMISSIONS, KTON CARBON)

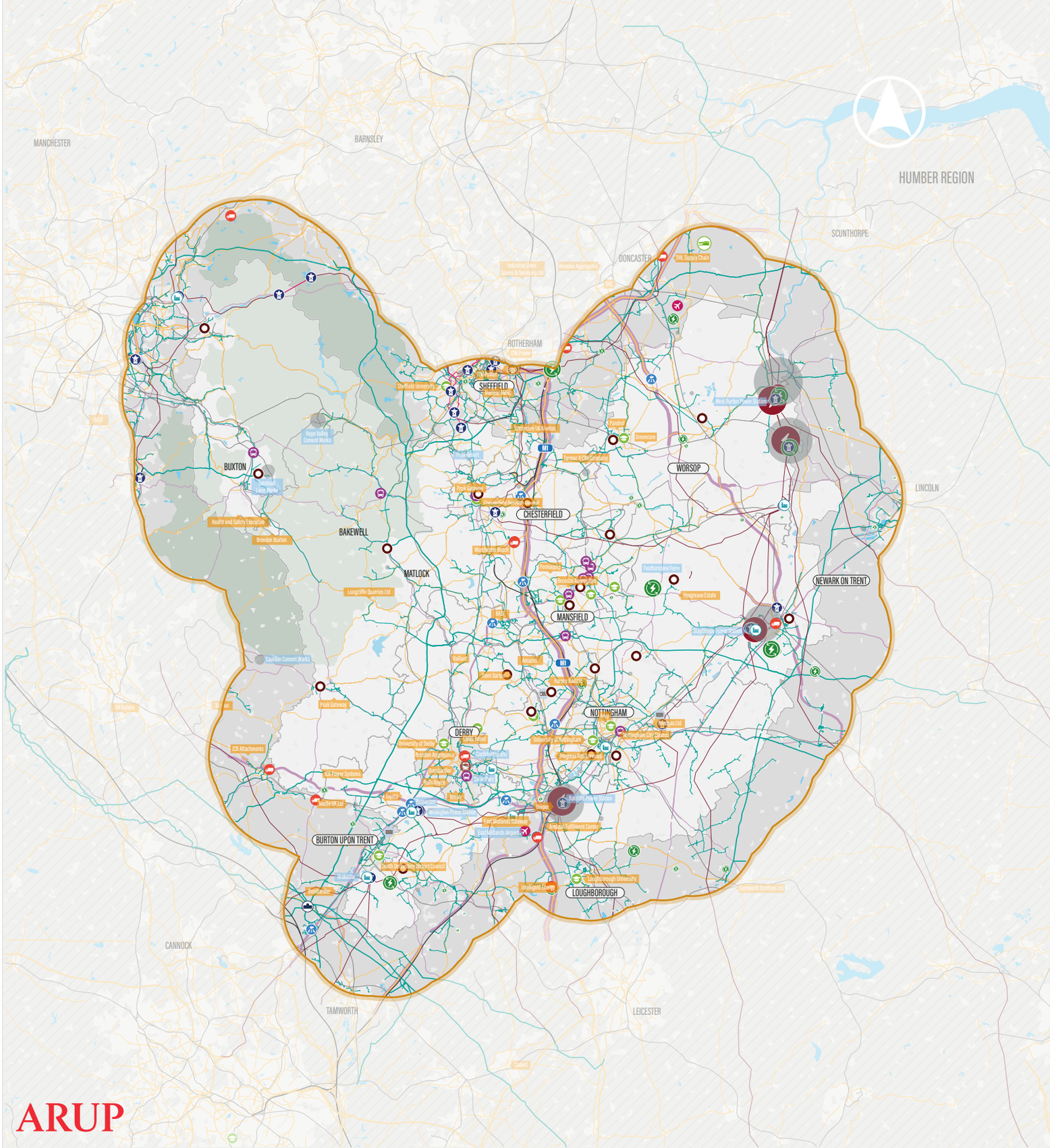
>50 >500 >1000 >4500

5 - HYDROGEN FOR JOBS SKILLS AND RESEARCH

- UNIVERSITIES
- STAKEHOLDERS

Derby City Council

ARUP



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Appendix B

Why Hydrogen and Why Derby Region Poster

WHY DEVELOP A HYDROGEN ROADMAP?

Since the UK Government's 2050 net zero carbon target was announced, hydrogen has risen from being seen as an option to a critical enabler for a more resilient low carbon energy system, and a significant key to unlocking clean growth and economic recovery.

Hydrogen offers a unique cross-system opportunity for fundamental change in the energy landscape, which reduces the carbon intensity of energy by replacing fossil fuel usage with low carbon sources.

It is one of the least disruptive options for consumers and is achievable with the current technology, which is rapidly becoming scalable. The primary barrier to realising this opportunity is the need for cohesive planning which enables investment and market-driven solutions to establish regional hydrogen economies and further unlock the necessary regulatory mechanisms.

The following five key themes highlight the potential opportunity of hydrogen:

HYDROGEN PRODUCTION, STORAGE AND TRANSFER

Low carbon hydrogen is primarily produced by either gas reformation with carbon capture (referred to as blue hydrogen) or electrolysis to split water into hydrogen and oxygen (referred to as green hydrogen).

Both methods can be undertaken in large scale centralised facilities or more locally to reduce storage and distribution costs.

Hydrogen can be stored over or below ground and then transported by pipeline or by tube trailer on road or rail. Hydrogen can be blended into the existing gas network up to about 20% without the need change downstream appliances; a factor than can accelerate adjacent renewable energy production.

HYDROGEN JOBS, SKILLS AND RESEARCH

The transition to a hydrogen economy requires product, service and infrastructure innovation which creates numerous opportunities in leading research and development. New skills and expertise are required in innovative engineering and manufacturing and new jobs are created either in this field or with capabilities relevant to developing and delivering cost effective hydrogen powered products, services and infrastructure.

With a responsive vocational training network, a region can be capable of delivering significant replacement and additional jobs from a transition to a hydrogen economy.

HYDROGEN FOR INDUSTRY PROCESSES

Industrial sites where methane combustion takes place such as blast furnaces, presents an opportunity to switch to hydrogen, which when combusted releases no carbon emissions.

Hydrogen is also used in various industrial applications; in metal alloying, flat glass production, and in the electronics industry.

In addition, hydrogen production via electrolysis has pure oxygen as a by-product which may be required by industry or hospitals.

HYDROGEN FOR HEATING

The gas network, operated in this region by Cadent, serves urban and most of the rural areas. Blending with hydrogen up to 20% has already been proven viable, and planning and strategy work is both complete and underway to demonstrate the case for 100% hydrogen replacement of methane in the gas network for both heating and cooking.

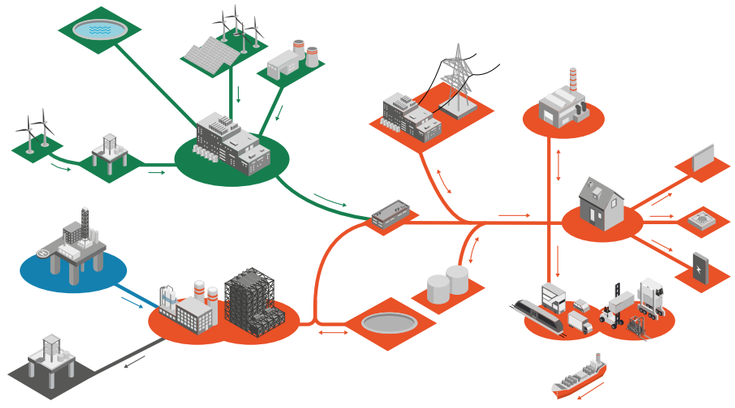
Hydrogen ready appliances have been developed and could be manufactured in the region. The UK's first large scale hydrogen for heat trial could be implemented in part of the gas grid, particularly where new housing is proposed.

HYDROGEN FOR TRANSPORT

Hydrogen fuel cells are functionally equivalent to batteries and benefit from better range and fill rate following development and deployment. Whichever decarbonisation strategy is adopted within the transport market, hydrogen will likely play a key role.

Sitting at the heart of the UK's road and rail transport network and hosting a major freight airport and logistics hub, the region is well placed to support the transition to hydrogen for buses, heavy haulage and logistics fleets, trains, and potential for aviation.

The region hosts a number of large transport equipment engineering and manufacturing companies and their supply chains whose products, services and manufacturing footprints will change. Creating an environment that encourages hydrogen product development and testing represents an important opportunity for the region.



We invite you to view the Arup report

Establishing a Hydrogen Economy The Future of Energy 2035

A pioneering vision for the role hydrogen could play in helping to meet carbon reduction targets and contribute to the economic prosperity of the region.

For those who are newer to the discussion we also have a **Five Minute Guide to Hydrogen**.

WHAT MAKES DERBY REGION A GOOD PLACE FOR HYDROGEN?

Derby has recently declared its ambition to become the UK's centre of excellence for future fuel technologies, using the city's advanced manufacturing expertise to revolutionise the way low-carbon energy is used to power businesses, transport and homes. Coupled with the region's aims to lead the most ambitious carbon turnaround in the country, investigating the hydrogen potential in the region makes good sense.

This region includes the urban conurbations of Derby, Nottingham, Chesterfield and Mansfield as well as the Peak District National Park to the North West and large agricultural areas to the East. Engineering and Manufacturing has always been synonymous with the region and has only become stronger, with global players in the aerospace, rail and automotive industries present today.

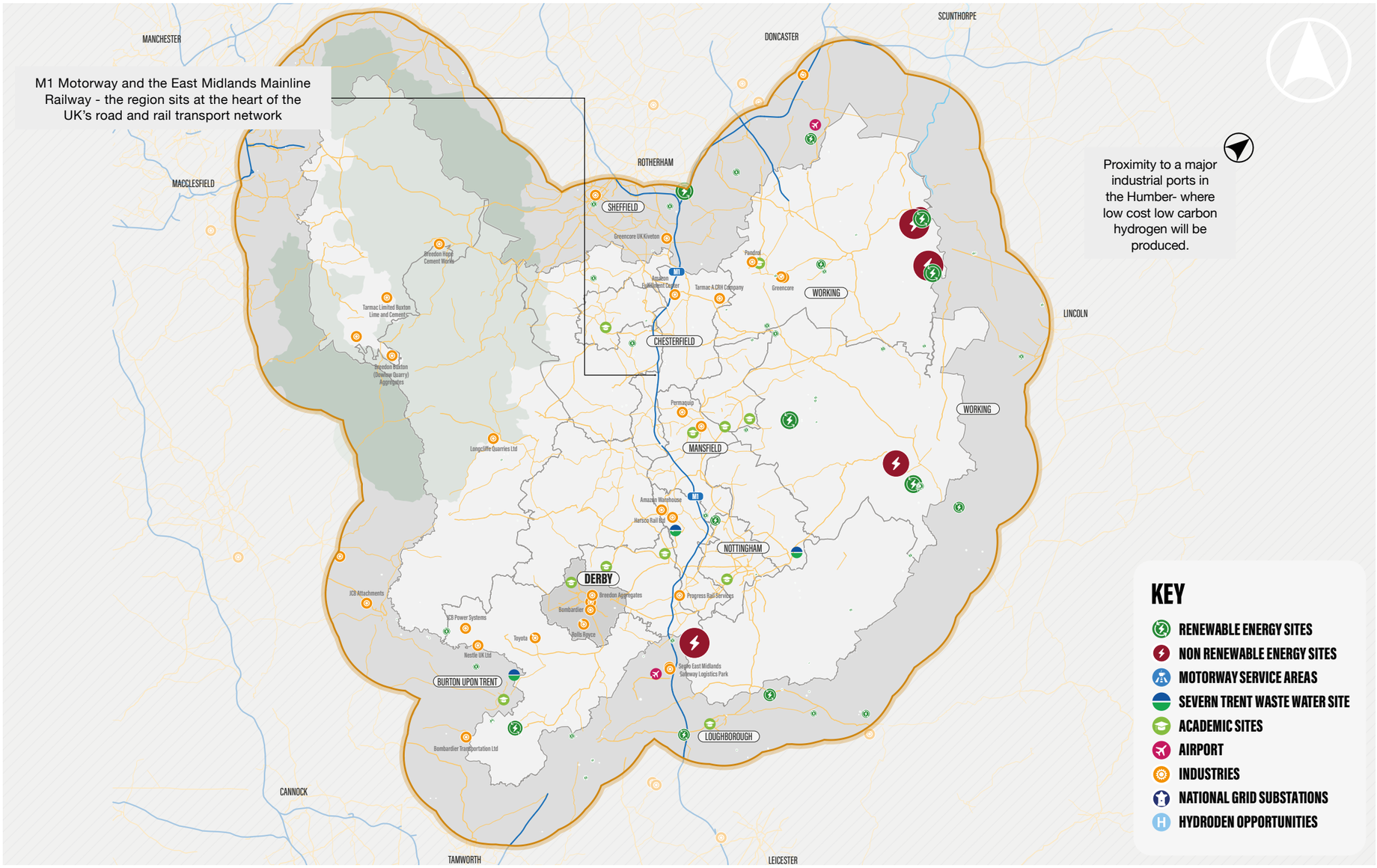
Click on the buttons on the interactive map below to understand more about why the Derby Region is primed for growth and development through the creation of a hydrogen economy in the region.

ADVANCED MANUFACTURING AND ENGINEERING EXCELLENCE

HIGH DEVELOPMENT POTENTIAL SITES FOR GREEN ENERGY HUBS AND PRODUCTION

STRONG RESEARCH INSTITUTIONS AND REGIONAL COLLABORATION

LARGE RELEVANT STAKEHOLDERS IN THE REGION



For more details and if you would like to get involved please contact:

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Appendix C

Stakeholder Contacts & Engagement Tracker (Redacted)

Appendix C. Stakeholder Contacts & Engagement Tracker (Confidential)

ARUP Derby City Council

Company	Area	Location(s)	Brief Description	Attendee	Role	Contact Details	Hydrogen Production, Storage and Transfer	Hydrogen for Heating	Hydrogen for Transport	Hydrogen for Industry	Hydrogen Jobs, Skills and
Arup	Consultants	NG1 5AT									
Arup	Consultants	NG1 5AT									
Baxi	Boiler Manufacturers	DE21 6BF									
Belcan	Consultants	DE24 8UP									
Belcan	Consultants	DE24 8UP									
Belcan/Lagoni	Consultants	DE24 8UP									
Cadent	Energy firms	LE10 0NA									
Cadent	Energy firms	LE10 0NA									
Cadent	Energy firms	LE10 0NA									
Carbon Legacy	SMEs	LE12 6PW									
Chesterfield Borough Council	Councils & Local Bodies	S40 1LP									
Chesterfield Borough Council	Councils & Local Bodies	S40 1LP									
D2N2 LEP	Councils & Local Bodies	NG2 1EP									
Derby City Council	Councils & Local Bodies	DE1 2FS									
Derby City Council	Councils & Local Bodies	DE1 2FS									
Derby City Council	Councils & Local Bodies	DE1 2FS									
Derby City Council	Councils & Local Bodies	DE1 2FS									
Derby City Council	Councils & Local Bodies	DE1 2FS									
Derbyshire County Council	Councils & Local Bodies	DE4 3AG									
Derbyshire County Council	Councils & Local Bodies	DE4 3AG									
Derbyshire County Council	Councils & Local Bodies	DE4 3AG									
Derbyshire Dales District Council	Councils & Local Bodies	DE4 3NN									
East Mids Chamber of Commerce	Councils & Local Bodies	S41 8ND									
East Mids Chamber of Commerce	Councils & Local Bodies	S41 8ND									
Engie	Energy firms	LS12 1BE									
Engie	Energy firms	LS12 1BE									
EoN	Energy firms	CV4 8LG									
Fisher German	Consultants	DN4 5RA									
Green Arch Consulting	SMEs	S40									
Hexgreave Estate	Energy Users	NG22 8LS									
HSE (Buxton)	Consultants	SK17 9JN									
HSE (Buxton)	Consultants	SK17 9JN									
HSE (Buxton)	Consultants	SK17 9JN									
Igas	Energy firms	LN2 2QX									
Igloo Energy	Energy Users	SO15 2NP									
ITM Power	Energy firms	S9 1DZ									
ITM Power	Energy firms	S9 1DZ									
National Grid	Energy firms	CV34 6DA									
Nottingham City Council	Councils & Local Bodies	NG2 3NG									
Nottingham City Council	Councils & Local Bodies	NG2 3NG									
Nottingham City Council	Councils & Local Bodies	NG2 3NG									
Nottingham Energy Partnership	Councils & Local Bodies	NG2 2DF									
Nottinghamshire County	Councils & Local Bodies	NG2 7QP									
Nuclear AMRC	Universities / Research	S60 5WG									
Nuclear AMRC	Universities / Research	S60 5WG									
Nuclear AMRC	Universities / Research	S60 5WG									
Phi Advisory	Consultants	W1T 5HP									
Roadgas Ltd	Energy firms	NG4 2JW									
Siemens	Energy firms	NG7 2NR									
Smartparc	Energy Users	DE21 7BS									
South Derbyshire District Council	Councils & Local Bodies	DE11 0AH									
South Derbyshire District Council	Councils & Local Bodies	DE11 0AH									
Uniper	Energy firms	NG11 0EE									
Uniper	Energy Users	NG11 0EE									
Uniper	Energy firms	NG11 0EE									
Uniper	Energy firms	NG11 0EE									
Uniper	Energy Users	NG11 0EE									
Uniper	Energy firms	NG11 0EE									
Uniper Academy	Energy firms	NG11 0EG									
Western Power Distribution	Energy firms	DE24 8EP									

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Appendix D

Stakeholder Hydrogen Activities Tracker

Appendix D. Derby Region Hydrogen Stakeholder Activities Tracker

This tracker has been created to serve as a working document which is kept up to date by the region's leadership as a tool to inform stakeholders of the development of hydrogen activity in the region.

Stakeholder	Production, Distribution & Storage	Heating	Transport	Industry	Jobs, Skills & Research
Abellio			• Abellio East Midlands will be trialling hydrogen fuel cell trains on the Midland Main Line. • Abellio London has recently trialled a hydrogen powered single deck bus.		• Abellio East Midlands will be trialling hydrogen fuel cell trains on the Midland Main Line.
Altran					• Currently developing hydrogen sensors. • Altran Foundation for Innovation.
Amazon			• Invested in hydrogen fuel cell vehicles • EM airport potential to use hydrogen with Amazon warehouses trucks,		• Recently invested in developing hydrogen fuel cells in the US. • Climate Pledge Fund.
Arup	•	•	•	•	•
BASF				• Developing technology to produce hydrogen (H_2) from natural gas without carbon dioxide (CO_2) emissions. • Considering the construction of a 50MW hydrogen facility in Germany.	
Baxi		• Baxi is part of the government funded Hy4Heat project to establish if it is technically possible, safe and convenient to replace natural gas with hydrogen in residential and commercial buildings.			• Developing domestic hydrogen boilers for demonstration.
Bayotech		• Produce on-site hydrogen generators.			
Bombardier			• Recently acquired by Alstom, who have developed Coradia iLint, the world's first passenger train powered by a hydrogen fuel cell - in commercial service in Germany.		
Belcan			• Working on transportation technology, including innovative rail and mass transit projects across Europe. With a focus on green energy technologies, such as electric vehicles (EV) and hydrogen-fuelled vehicles.		
Breedon Aggregates				• Exploring the potential use of low-carbon technologies like bioenergy; hydrogen and carbon capture and storage	
Cadent					• Hy4Heat project • NW HyNet programme looking to use pipes to transport hydrogen created from natural gas – main drive is to decarbonise heavy industrial users. HyDeploy (Keel Uni) – blending hydrogen into heating network domestic level. Barriers of policies and regulations to encourage movement into hydrogen. • Part of a group which is trying to bring transport demand together to attract OEMs
Carbon Legacy	•	•	•	•	•
Chesterfield Borough Council	•	•	•	•	•
D2N2 LEP	• D2N2 Clean Industrial Revolution: Energy Strategy 2019-2030, includes aim to coordinate Hydrogen infrastructure feasibility studies for scalable low carbon energy storage	• D2N2 Clean Industrial Revolution: Energy Strategy 2019-2030, includes aim to coordinate Hydrogen infrastructure feasibility studies for scalable low carbon heating	• D2N2 Clean Industrial Revolution: Energy Strategy 2019-2030, includes aim to coordinate Hydrogen infrastructure feasibility studies for scalable low carbon transport		• Target to create 100 new businesses and 1000 new jobs in the Low Carbon and Renewable Energy sector in the D2N2 region by 2030

	• Aiming to enable and host pilot trials on re-purposing existing gas infrastructure	• Looking to enable and host pilots of hydrogen and heat pumps as low-carbon heating options	• Aiming to coordinate action to transition to hybrid, fully electric and hydrogen vehicles		
Derby City Council	•	•	•	•	•
Derbyshire County Council	•	•	•	•	•
Derbyshire Dales Councillor	•	•	•	•	•
DHL	•	•	• Adding hydrogen fuel-cell vehicles to its fleet of delivery vans	•	•
East Midlands Airport	•	•	• Developing hydrogen fuel capabilities. • Opportunities include zero-emission airport vehicles, as well as ground and aircraft power units.	• Developing hydrogen fuel capabilities. • Opportunities include hydrogen fuel cell powered material handling equipment for warehousing and logistics • Significant warehousing at EMA and the neighbouring SEGRO gateway could provide trials for this approach	•
East Midlands Gateway	•	•	•	•	•
East Mids Chamber of Commerce	•	•	•	•	•
EMBS Talent	•	•	•	•	•
Empirical Science Ltd.	•	•	•	•	•
Energy Research Accelerator	•	•	•	•	• The Energy Research Accelerator is pursuing opportunities for Hydrogen research, building on the expertise at Nottingham University.
Engie	•	•	•	•	•
Enterprise Holdings	•	•	• large fleets looking to electrify by 2030 – infrastructure challenges, currently trialling small fleet of HEV (17 no.).	•	•
EoN	•	•	•	•	•
Evolve Growing Solutions Ltd.	•	•	•	•	•
Far-UK Ltd	•	•	•	•	•
Fisher German	•	•	•	•	•
Giltbrook Dyers and Cleaners Ltd (The)	•	•	•	•	•
Green Arch Consulting	•	•	•	•	•
Greencore	•	•	•	•	•
Hexgreave Estate	•	•	•	•	•
Hope Valley Cement Works	•	•	•	•	•
HSE (Buxton)	•	•	•	•	• involved in hydrogen for last 18/20 years looking at safety of hydrogen, refuelling stations, and gas networks moving to hydrogen. • IAHS safety challenges around hydrogen, many key stakeholders are members – there is a website, this group involved in lots of hydrogen projects.
IGas	•	•	•	•	•
Igloo	•	•	•	•	•
Infinite Perspective	•	•	•	•	•
Intelligent Energy	• Provide hydrogen fuel cells – can be used and deployed already. Plans for big	•	• working closely EMA – part of Strategy – service equipment – airside fleet - buses –	•	•

	schemes in future can use this technology now. Based in Loughborough.		SEGRO (11 warehouses), Amazon, UPS, DHL, warehousing and distribution – Freeport – how create a hydrogen hub at EMA. Motorway services. Benefitting from that. Localised hydrogen filling point.		
ITM Power	•	•	•	•	•
JCB	•	•	•	•	•
Laing O'Rourke	•	•	•	•	•
Lindhurst	•	•	•	•	•
Longcliffe Group	•	•	• based near Matlock, chair institute of quarrying – Tunstead, Hope Works, 150 trains leaving Buxton a week – largest county of extractive minerals. Desperate for hydrogen – only solution for our haulage and manufacture.	•	•
Loughborough University	•	•	•	•	• doctoral centre. Lots of projects in Loughborough – opportunity for refuelling station next to the motorway.
National Grid	•	•	•	•	•
Nestle	•	•	•	•	•
Midlands Energy Hub	•	•	• Main project Midlands wide review identifying transport hubs clean energy. Sites have been identified in each area across the region. Challenge identifying where to progress from this stage and ensuring the correct investment and selections are made.	•	•
NITEC (UK) LIMITED (now CBE+)	•	•	•	•	•
Nottingham City Council	•	•	•	•	•
Nottingham City Transport	•	•	•	•	•
Nottingham Energy Partnership	•	•	•	•	•
Nottingham Trent University	•	•	•	•	•
Nottinghamshire County	•	•	•	•	•
Nuclear AMRC	•	•	•	•	•
Peak District National Park Authourity	•	•	•	•	•
Peak Gateway (Birchall Properties)	•	•	•	•	•
Peak Resort	•	• Looking at heating etc. Will switch to district system on the site.	• Developing a resort gateway into national park – keen on hydrogen as transport and energy mix. Currently under construction. New take on transport strategy. 2,800 car parking spaces on site. Hydrogen coaches, part of a broader network to take people to different parts of the park. Use of ride hailing system.	•	•
Porterbrook	•	•	• Hydrogen power train, looking to produce in next few years. Barriers of refuelling, currently using a portable refueler – seeking to refuel across the network.	•	• Developed HydroFLEX, the first hydrogen-powered train in the UK, in collaboration with The University of Birmingham's Centre for Railway Research and Education (BCRRE)
Positive Homes	•	•	•	•	•
Roadgas Ltd	•	•	•	•	• Have been involved in biomethane transition.

Rolls-Royce	• currently involved in hydrogen fuel cells – packaging and selling to data centres globally. Sustainable aviation fuel is a key component – fuel currently manufactured overseas. Barriers of cost and co-ordination	•	•	•	•
Rototek Ltd	•	•	•	•	•
Samworths	•	•	•	•	•
Segro	•	•	•	•	•
Sheffield University	•	•	•	•	•
Siemens	•	•	•	•	•
Smartparc	•	•	•	• sustainable food production in the region. Leading the way.	•
South Derbyshire District Council	•	•	•	•	•
Tarmac	•	•	•	•	•
Total Integrated Solutions	•	•	•	•	•
Toyota	•	•	•	•	•
Trent Barton	•	•	•	•	•
Trent Barton	•	•	•	•	•
Uniper	• Developed PEM and Alkaline electrolysis and tested methanation overseas • Part of Zero-carbon Humber •	•	•	•	•
Uniper (Academy)	•	•	•	•	• skills for hydrogen economy – working with Uniper. Working on skills bid – knot across the region. Need to make sure not duplicating efforts. Call for knowledge exchange. (Plus Peak Resort) • hydrogen production at scale – can deliver lower cost hydrogen at scale in the region. Research and development centre – ZERO – advancement decarbonisation of technologies – local universities. Extension existing centre of skills. Skills training. In the past – centre for EV charging roll outs. Would be good to understand quantities from Uniper.
Uniper (Ratcliffe Power Station)	•	•	•	•	•
Uniper (Technology)	• energy from waste.	•	•	•	•
Uniper Energy	•	•	•	•	•
University of Birmingham	•	•	•	•	•
University of Derby	•	•	•	•	• skills for hydrogen economy – working with Uniper. Working on skills bid – knot across the region. Need to make sure not duplicating efforts. Call for knowledge exchange. (Plus Peak Resort) • working on decarbonisation projects with businesses and supporting in uptake of hydrogen. LEP funded project looking at rail systems – freight needs to be decarbonised.
University of Nottingham	•	•	•	•	• sustainable centre for hydrogen. Relationship with industrial partners (4-6). Industrial ready students. Centre open to ideas for industry. Research challenges. Largest hydrogen test lab. Test prototypes.

					• rail and connectivity links. Build on that. Rail opportunities across Derbyshire and Nottinghamshire. Not just training centres/ colleges, facilities or expertise they can contribute.
Vaillant	•	• manufacturing at Belper for boilers • gas boiler/heat pumps currently developing hydrogen boilers. Looking to access trial opportunities 2021.	•	•	•
WPD	•	•	•	•	•
Worcester Bosch	•	•	•	•	•

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Appendix E

Stakeholder Engagement Introductory Workshop World Café Forum Provocation Outputs

Introductory Workshop

World Café Forum Provocation 1 Outputs:

Ref	Group 1	Group 2	Group 3
1	Skills – national skills centre, academies. Tech is there – how can we adopt / systematise. Barriers for businesses growing at scale is access to skilled workforce. Roadmap will allow alignment with talent providers	Opportunities: 'dirty' fuels used at EMA – potential / commercially viable centre to be a hydrogen hub? Multi-modal – aircraft / freight logistics, warehousing, rail link, freeport, road network. Anchor tenant can be material handling	Energy transition – focus on fuel cell centre of competence is positive. End to end supply chain of hydrogen and ensuring all the building blocks are in the region to achieve end product. Global competition is a threat
2	Engagement with universities needs lead from business – need to avoid long term research and move towards business partnership	Threat regionally is siloed - government mentality – threat of dictated short term solutions that ignore wider benefits	Green hydrogen as a future for Derbyshire – in the stage of wanting to run pilot projects, particularly hydrogen transport
3	Threat: other regions doing similar and not joined up – needs one collective effort to present to government	Not about single hydrogen production but about wider economic benefit – understanding downstream uses and benefits	Commuting is a great opportunity to look at coordinated approach – opportunities for universities and campuses
4	Opportunities to extend to other levels of training outside universities	Need to facilitate more opportunities for innovation, novel solutions in terms of energy efficiency and hydrogen	Lack of refuelling stations is a deterrent – ITM power initiatives are positive for this
5	Opportunity: Historical legacy in the region – hydrogen permeation is growing from transport to domestic and industry – regional legacy has a role	Costs and viability – bringing stakeholders together and how to structure a deal that allows all parts of the supply chain to invest	Greater education of the capabilities of hydrogen is needed – efficiencies in production (e.g. energy store) – social awareness
6	Threats outweigh opportunities, particularly fragmentation of responsibility/leadership	Discussions with infrastructure providers will allow a more integrated approach	A clear role for local authorities in this - communication / awareness raising
7	Not many options for decarbonising global aviation – competitive tension e.g. sustainable aviation fuel	Systems perspective needed considering electricity grid – electrification can't do everything!	Maybe a 'solution' but lack of 'application'
8	Cost of developing technology – risks, need public support, incentives	Applications are available (passenger buses, taxis etc.) – making use of opportunity to showcase this offers educational piece – going beyond demonstration to show real life commercial operation	Major infrastructure projects should be trialling net zero construction – ensuring planning applications are considering this
9	Other nations further ahead than UK e.g. Germany's National Hydrogen Strategy – creating policy environment for large scale investments	Need certainty for supply side to come on board	Education and understanding – particularly for local authorities, there is work going on in this space
10	Opportunity is capacity within existing businesses in Derbyshire	Fuel cell grade hydrogen is difficult to get hold of and expensive in the UK – Ratcliffe-on-Soar power station is good opportunity for this	
11	Limbo – waiting for policy to change, need clarity	Building regs Part L / FHS – generally seen as move to electrification – is there ambition for local hydrogen heating – at scale demonstrations	
12	Distribution of hydrogen resource – transport, domestic? Need to do quickly and at scale	Important that Local Authorities are more aware – new topic, needs a campaign to drive this, people will be weary	
13	E.g. Port of Antwerp – 'next gen site' physical focus around hydrogen – need a location to join together at a centre of excellence, come together regionally	Skills – where are the apprenticeships, who is driving this, are schools talking about it? Opportunity for next generation	
14	Not just about Derby – about how we bring collective thought together. Hydrogen part of a mixed picture – how do we capitalise on hydrogen and other fuels available e.g. biomass etc.		
15	Collaboration to deal with complexity – need to ensure the hydrogen opportunity is positioned more broadly with technologies and need for decarbonisation		

"This is a region that has historically made products that produce greenhouse gas emissions in use. What are the most important opportunities and threats to your organisation and this region from a transition to a 'net zero' economy, including significant adoption of hydrogen energy?"

Introductory Workshop

World Café Forum Provocation 2 Outputs:

Ref	Group 1	Group 2	Group 3
1	**Uniper** – hydrogen production at scale – can deliver lower cost hydrogen at scale in the region. Research and development centre – ZERO – advancement decarbonisation of technologies – local universities. Extension existing centre of skills. Skills training. In the past – centre for EV charging roll outs. Would be good to understand quantities from Uniper.	**Tourism - Rupert Carr – Peak Resort –** not on the map. Developing a resort gateway into national park – keen on hydrogen as transport and energy mix. Looking at heating etc. Currently under construction. Will switch to district system on the site. New take on transport strategy. 2,800 car parking spaces on site. Hydrogen coaches, part of a broader network to take people to different parts of the park. Use of ride hailing system.	**Intelligent Energy** – working closely EMA – part of Strategy – service equipment – airside fleet - buses – SEGRO (11 warehouses), Amazon, UPS, DHL, warehousing and distribution – Freeport – how create a hydrogen hub at EMA. Motorway services. Benefitting from that. Localised hydrogen filling point.
2	**HSE** – hydrogen fuel cells etc, international hydrogen. Wealth of data – **national population dataset** – hubs of people – seen as gold standard. When considering map – NPD – enrich the analysis. (Cadent have helped with mapping of domestic properties)	**Intelligent Energy -** Provide hydrogen fuel cells – can be used and deployed already. Plans for big schemes in future can use this technology now. Based in Loughborough.	**Altran – Amazon** – distribution and user. Smartparc – **sustainable food production** in the region. Leading the way. Could overlay supermarket distribution plus food production. Data available. City Council can help reinforce that.
3	**David Parker – Valent** – history very important part of this – burton on trent heritage. High pressure grid north – transmission line – bisects cities and towns – blue hydrogen initial opportunity – blessed with position we are in and conversion to natural gas. (plus other pressure lines – other assets to add to the map).	**Longcliffe Group –** based near Matlock, chair institute of quarrying – Tunstead, Hope Works, 150 trains leaving Buxton a week – largest county of extractive minerals. Desperate for hydrogen – only solution for our haulage and manufacture.	**M Gallagher** – fuel cells points – EV charging points – keen to share. Midlands wide – 6 sites – couple in Derbyshire and Nottinghamshire as well as EMA.
4	**Warren Manning (UoD) – skills for hydrogen** economy – working with Uniper. Working on skills bid – knot across the region. Need to make sure not duplicating efforts. Call for knowledge exchange. (Plus Peak Resort)	**Valent group –** manufacturing at Belper for boilers – challenge re decarb. Already has hydrogen boilers – challenge is different. Need fixed infrastructure – need to migrate – need timelines and policies. Hydrogen ready boilers – get on map.	**Gavin Walker** – HS2 – transport hub – rail and connectivity links. Build on that. Rail opportunities across Derbyshire and Nottinghamshire. Not just training centres/ colleges, facilities or expertise they can contribute. Universities – ERDF funding to support SMEs.
5	**Far UK** – fuelling stations. Used to be a hydrogen fuelling centre at UoN and Loughborough. Need infrastructure to support them. Access to fuelling stations can drive innovation and demand. (Adrian – things in pipeline – but need to accelerate – look at larger sites and multiply these)	**Cadent – some heavy industries missing on map** – East Leake. Depots of transport facilities to include on map – missing at the moment. Policy side of things Cadent are lobbying for.	**Becky Rix** – grid connections for gas – where put hydrogen in and out – important where big connections are. (Adrian – Cadent looking at this separately).
6	**Loughborough Uni** – with UoBirm and UoN – doctoral centre. Lots of projects in Loughborough – opportunity for refuelling station next to the motorway.	**Nick Booth – Ratcliffe** - close 2025 – redevelopment. Academic site – training centre – mark on map – skills – vital how take industrial operators and transition skills. Also, need to think about how central position as part of broader UK national network.	**Rachel North** – public services – how capitalise on using our assets e.g. refuse vehicles, transforming cities fund.
7		**Duncan – ITM** – locating where transport facilities are. Refuse collection facilities. Hard to find these.	**Paul Harris** – specific session on storage and transfer.
8		**Gulcan – University of Nottingham** – sustainable centre for hydrogen. Relationship with industrial partners (4-6). Industrial ready students. Centre open to ideas for industry. Research challenges. Largest hydrogen test lab. Test prototypes. Calibration of opportunity. Hydrogen storage opportunities. Hydrogen cylinders.	Waste management and landfill sites – **Uniper** – creating energy from waste. These are assets which can be better used – *turquoise* hydrogen. Battery electrification as other option.
9		**Jon Hunt – Toyota –** need to include associated companies. Stations, refuelling stations.	Rail depot location

"We have mapped some known assets and potential opportunities using the 5 themes of Production / Transfer / Storage, Transport, Heating, Industry, Jobs/ Skills / Research. What sites, assets and capabilities are missing to enable a hydrogen transition and what support do you require to make it happen?"

Introductory Workshop

World Café Forum Provocation 3 Outputs:

Ref	Group 1	Group 2	Group 3
1	**Uni of Derby** – working on decarbonisation projects with businesses and supporting in uptake of hydrogen. LEP funded project looking at rail systems – freight needs to be decarbonised. Skills are a key requirement to support implementation of hydrogen economy.	**Cadent Gas –** NW HyNet programme looking to use pipes to transport hydrogen created from natural gas – main drive is to decarbonise heavy industrial users. HyDeploy (Keel Uni) – blending hydrogen into heating network domestic level. Barriers of policies and regulations to encourage movement into hydrogen.	**RoadGas Ltd –** developing ways to store hydrogen, barrier of obtaining hydrogen itself and infrastructure as to how hydrogen is going to be delivered.
2	**HSE** – IAHS safety challenges around hydrogen, many key stakeholders are members – there is a website, this group involved in lots of hydrogen projects.	**Porterbrook –** Hydrogen power train, looking to produce in next few years. Barriers of refuelling, currently using a portable refueler – seeking to refuel across the network. Legislation in the rail network on use of hydrogen – this limit where the train can be run.	**University of Nottingham** – supporting research around barriers of hydrogen technologies.
3	**LoR** – who is the regional representative for hydrogen? Potential disconnect between globally and regionally working companies.	**Intelligent Energy –** Material handling is a big area that gives opportunity for hydrogen – EM airport potential to use hydrogen with Amazon warehouses trucks, this is the starting point to potentially grow hydrogen use on site.	**Intelligent Energy** – demand is growing for technology but issues on where the gas can be obtained from, price and cost, green hydrogen.
4	**Hy4Heat project** – refusion of collaboration from other companies.	Hydrogen refuelling stations – want to see more availability of Heavy-Duty vehicles, a UK manufacturer of compressors, subsidy for hydrogen fuel to kickstart the market.	**Vaillant group** – gas boiler/heat pumps currently developing hydrogen boilers. Looking to access trial opportunities 2021.
5	**Rolls Royce –** currently involved in hydrogen fuel cells – packaging and selling to data centres globally. Sustainable aviation fuel is a key component – fuel currently manufactured overseas. Barriers of cost and co-ordination – will it ever pay off? Require a supportive environment from Gov. and nationally agreed roadmap to give confidence funding will be sustained.	Challenge hydrogen needs to be available to more people, homeowners need to engage with hydrogen and understand value, also require gas installers to upskill to hydrogen. Policy and legislation also a barrier.	**Enterprise rent-a-car** – large fleets looking to electrify by 2030 – infrastructure challenges, currently trialling small fleet of HEV (17 no.). Concerns around missing the boat in UK on hydrogen tech.
6	Institutional blockers – identified 12 authorities that have influence on progression of hydrogen, strong desire for a Government lead, if this is not achievable then a regional lead. No sense of co-ordination.	Barriers refuelling availability, skills behind hydrogen, support for network, collaboration – very few networking points for businesses to get involved and understand opportunity.	**Midlands Energy Hub** – Main project Midlands wide review identifying transport hubs clean energy. Sites have been identified in each area across the region. Challenge identifying where to progress from this stage and ensuring the correct investment and selections are made.
7	There is strength in region to work together – need to establish a regional council to communicate and to encourage collaboration.	Is the energy required to electrolyse hydrogen clean and sustainable? This is a future development – currently not.	**HSE** – involved in hydrogen for last 18/20 years looking at safety of hydrogen, refuelling stations, and gas networks moving to hydrogen.
8		Barrier CAPEX – this is now absorbed into OPEX due to recent climate. However there is good appetite to invest in hydrogen.	**Toyota –** key barrier is the refuelling infrastructure, this requires collaboration across industries. Efficiency argument around hydrogen.
9		**University of Nottingham** – Collaboration is key, UoN is a centre of excellence, actively want involvement and further involvement, initiate more industrial.	**Derby Council** – what is the role of council and how can they support to gain infrastructure required to support hydrogen growth.
10		**Chesterfield council -** Barrier on refuelling	Doc training
11		Contact in chat for refuelling - ross dy@itm-pow.com	Collaboration with universities

"What hydrogen and hydrogen derived fuels activities is your organisation involved in (globally, nationally and regionally) and what are your barriers to progress?"

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Appendix F

Why Derby and the Wider Region, Spatial Mapping of Regional Strengths

Why Derby and the wider region?

Derby and the D2N2 region hold four core strengths which create the right ecosystem upon which to develop a hydrogen economy:

1. Advanced Manufacturing and Engineering Excellence

Porterbrook

Rolls-Royce

Bombardier

2. High Development Potential Sites for Green Energy Hubs

Ratcliffe Power Station

Willington Power Station

West Burton Power Station

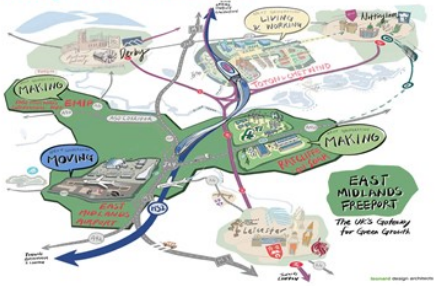
3. Strong Research Institutions & Collaboration

University of Derby

East Midlands Chamber
Derbyshire
Nottinghamshire
Leicestershire
D2N2

Infinity Park, Derby

4. Large Potential Users with Strong Transport Infrastructure



East Midlands Freeport Bid

Toyota Burnaston

ITM Power, Sheffield

M1 Motorway and the East Midlands Mainline Railway - the region sits at the heart of the UK's road and rail transport network

ADVANCED MANUFACTURING & ENGINEERING EXCELLENCE

With multiple large businesses in operation in the region e.g. Rolls Royce, Bombardier, Toyota, the region benefits from a nationally significant **engineering and advanced manufacturing cluster**. It is the only location in the UK where **rail technology** is still designed, and the city's aerospace and rail sectors alone produce approximately one third of the city's GVA and 12% of its total employment[1]. It is also home to Porterbrook, who have introduced **Hydroflex**, the UK's first hydrogen powered train. The region area is also home to a significant **national cluster of activity in boiler manufacturing**, accounting for 45% of UK jobs in that sector[2], as well as **fuel cell manufacture** e.g. Valliant Group, Worcester Bosch and Intelligent.

Litchurch Lane Rail Works, Derby

MANUFACTURING STRENGTH

The region generates £8bn in GVA, 2nd largest outside London region.

TRANSPORT EQUIPMENT MANUFACTURING CLUSTER

Strong expertise of global aerospace, automotive and rail manufacturers and engineers. These include Toyota Manufacturing UK's headquarters in Burnaston, and Rolls Royce and Bombardier at Litchurch Lane Works.

Toyota, Burnaston

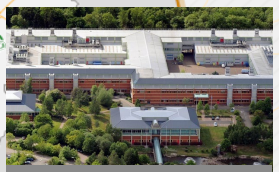
Civil Aerospace Site, Sinfin, Derby

ITM Power, Sheffield

Proximity to a major industrial port in the Humber- where low cost low carbon hydrogen will be produced.

ITM POWER

Manufactures integrated hydrogen energy equipment and electrolysers for fuel cell products. They have been involved in a number of high profile trials and projects and have even opened their first public hydrogen station.



Intelligent Energy Loughborough

KEY

- RENEWABLE ENERGY SITES
- NON RENEWABLE ENERGY SITES
- MOTORWAY SERVICE AREAS
- SEVERN TRENT WASTE WATER SITE
- ACADEMIC SITES
- AIRPORT
- INDUSTRIES
- NATIONAL GRID SUBSTATIONS
- HYDRODEN OPPORTUNITIES

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M1 Motorway and the East Midlands Mainline Railway - the region sits at the heart of the UK's road and rail transport network

HIGH DEVELOPMENT POTENTIAL SITES

The region has two of the last-standing coal-fired power stations that will cease to use coal by 2025 (Ratcliffe and West Burton) as well as numerous other former power station site available for development. This gives rise to new opportunities to develop innovative low carbon hubs that speak to the region's strong ambition to lead a dramatic carbon turnaround. With the benefit of national grid connections and through the initiative of forward thinking site owners, these sites hold significant potential to become green energy hubs: leading clean energy production and concentrating skills and research that would be essential to a hydrogen economy. An exemplar ZERO energy innovation cluster is already being promoted at Ratcliffe-on-Soar Power Station and alongside East Midlands Airport, has also been designated the UK's only inland freeport, providing a fertile testing ground for hydrogen in logistics.

STRATEGIC PLANNED HOUSING

There are several large housing sites in and around Derby City, and its boundaries. Further east, The HS2 East Midlands Hub at Toton and Chetwynd Barracks is planned for c4,500 housing units which could provide a hydrogen for heating pilot site.

East Midlands Hub, Toton

RATCLIFFE POWER STATION SITE

Uniper have plans for the site to be an exemplar for world class energy systems as well as an innovation hub to solve decarbonisation challenges and scale clean energy solutions.

The site is leading the development of an innovative Freeport Enterprise Zone and working with Midlands Engine Development Corporation and East Midlands Airport to develop a unique approach to trade.

Ratcliffe Power Station, Nottingham

High Marnam Power Station, Nottinghamshire

Coalite Regeneration Project, Bolsover

COALITE REGENERATION PROJECT

Development of a network of hubs which was a former coalfield that the which has an ambition to be a clean growth employment site.

Proximity to a major industrial ports in the Humber- where low cost low carbon hydrogen will be produced.

West Burton Power Station

COTTAM POWER STATION SITE

Due for decommissioning in early 2021 with plans to focus on low carbon energy and technology.

HIGH MARNHAM POWER STATION SITE

Former coal power station to be a green energy hub and production site.

Cottam Power Station, Retford

KEY

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M1 Motorway and the East Midlands Mainline Railway - the region sits at the heart of the UK's road and rail transport network

HEALTH AND SAFETY EXECUTIVE BUXTON

Regional facility exists to test the safety of hydrogen in pipes.

HSE Buxton

STRONG RESEARCH INSTITUTIONS & COLLABORATION

The region is home to a critical network of expertise, research and industry, with three universities, 6 science parks and 15 innovation centres, as well as the Health and Safety Executive. The region has a strong track record of collaboration with industry, as demonstrated through other industrial demonstrators at Infinity Park and BioCity, for example.

Proximity to a major industrial port in the Humber- where low cost low carbon hydrogen will be produced.

UNIVERSITY OF DERBY

Has strong business engagement in decarbonisation with many projects and the Institute for Innovation in Sustainable Engineering. Also strong capabilities in data analytics, systems engineering and modelling of both physical and economic aspects of supply/demand systems.

THE RAIL RESEARCH AND INNOVATION CENTRE (UNIVERSITY OF DERBY)

Provides collaboration between the knowledge base and rail supply businesses within the regional rail supply chains to unlock new skillsets and market opportunities needed for growth.

University of Derby

Nottingham Trent University

UNIVERSITY OF NOTTINGHAM

A renowned public research university with an advanced materials research group looking at hydrogen and thermal storage systems.

INFINITY PARK DERBY

Contains the ihub, a 'Centre for Supply Chain Innovation in Transport Engineering' which hosts Enscite, established as a collaboration between Universities to provide access to cutting edge research and technology transfer to supply chain companies in the aerospace, automotive and rail sectors.

Infinity Park, Derby

University of Nottingham

Loughborough University

LOUGHBOROUGH UNIVERSITY

Intelligent Energy - is a world leading fuel cell engineering company.

KEY

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M1 Motorway and the East Midlands Mainline Railway - the region sits at the heart of the UK's road and rail transport network

LARGE POTENTIAL USERS WITH STRONG TRANSPORT INFRASTRUCTURE

The region benefits from the presence of existing stakeholders with a strong interest in hydrogen – either as potential producers, within the supply chain or as end users. This ensures that there is already a strong basis on which to identify and develop synergies in a hydrogen economy. For example, there is potential for a north-west Derbyshire industrial cluster to be developed, to decarbonise the cement industry and collaborate on carbon capture opportunities. This potential market is strengthened by the fantastic road, rail and air links the region benefits from.

Proximity to a major industrial port in the Humber- where low cost low carbon hydrogen will be produced.

LARGE ENERGY USERS

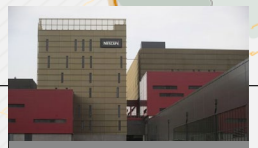
Cement works and quarrying operators such as Breedon at Hope Valley and Tarmac at Tunstead present a fuel switch opportunity

Breedon Hope Valley Cement Works

Tarmac Lime Works, Buxton

FOOD MANUFACTURERS

The area is also characterised by several large food processing and manufacturing facilities e.g. Nestle at Tutbury and, Swizzels Matlow at New Mills.



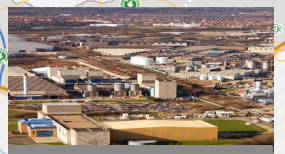
Nestle, Tutbury

TRANSPORT EQUIPMENT MANUFACTURING CLUSTER

Strong expertise of global aerospace, automotive and rail manufacturers and engineers. These include Toyota Manufacturing UK's headquarters in Burnaston, and Rolls Royce and Bombardier at Litchurch Lane Works.

Litchurch Lane Rail Works, Derby

M1 Motorway



Civil Aerospace Site, Sinfin, Derby

Ratcliffe Power Station, Nottingham

East Midlands Airport & Logistics Hub

HS2 Toton & East Midlands Development Corporation

EAST MIDLANDS AIRPORT / LOGISTICS BUSINESS PARK

A major freight airport and logistics hub, the region is well placed to support the transition to hydrogen for heavy haulage and logistics fleets and/or hydrogen derived fuels for a proportion of air travel as well as public transport links within and between its cities.

KEY

- RENEWABLE ENERGY SITES
- NON RENEWABLE ENERGY SITES
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Appendix G

Estimating Hydrogen Demand in the Derby Region

Estimating hydrogen demand - introduction

A high level assessment as to the potential for hydrogen in the region was carried out; the infographic below gives an overview of the of the four steps that were taken and data sets used:

Data sources used	Publisher
The Sixth Carbon Budget	CCC
Greenhouse gas reporting: conversion factors 2018	BEIS
Emissions of carbon dioxide for Local Authority areas	BEIS

Estimating hydrogen demand

1. Determining the Derby region fuel split

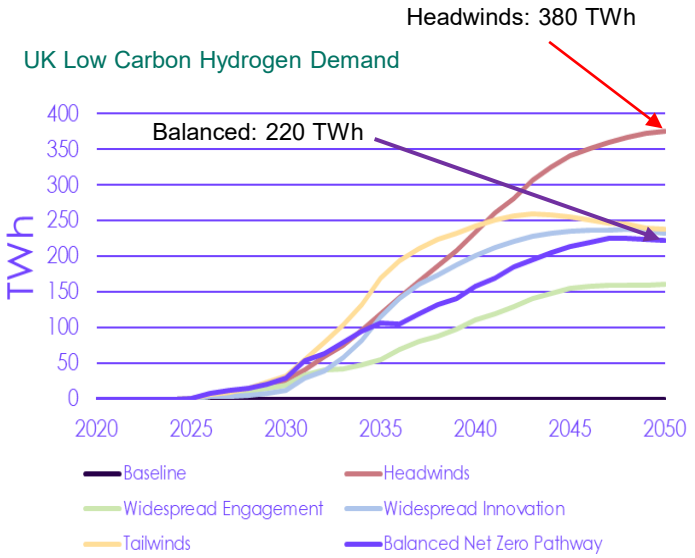
The CCC has developed 5 scenarios that include differing assumptions to achieve 2050 net zero as compared in graph shown. In an attempt to 'under promise and over deliver', we have provided a regional quantitative approaches to hydrogen to 2050 that are in line with the CCC's 6th Carbon budget 'Net Zero Balanced Scenario', which is conservative on hydrogen, their Headwinds scenario is much more optimistic on hydrogen.

Areas within Derby and Nottinghamshire have been considered and the emissions data extracted from BEIS datasets. These were:

- Amber Valley
- Ashfield
- Bassetlaw
- Bolsover
- Broxtowe
- Chesterfield
- Derby
- Derbyshire Dales
- Erewash
- Gedling
- High Peak
- Mansfield
- Newark and Sherwood
- North East Derbyshire
- Nottingham
- Rushcliffe
- South Derbyshire

The 6th carbon budget report was used to determine the UK's 2050 fuel split. The CCC splits demand usage into the following fuel types for multiple industrial sectors:

- Electricity
- Gas*
- Petroleum*
- Solid Fuel*
- Bio-energy & Waste*
- Low Carbon Hydrogen



Source: CCC 6th Carbon budget

* For brevity, all fuels other than hydrogen and electricity are grouped into "Bioenergy and other fuels"

Estimating hydrogen demand

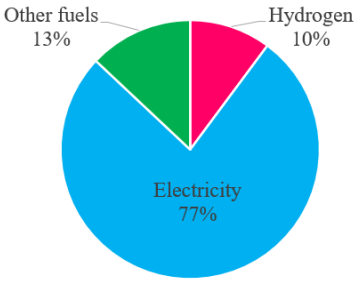
1. Determining the Derby region fuel split

The fuel demands for each industry sector (with exclusions such as aviation) are shown by the graph to the right. These were then grouped into the following categories:

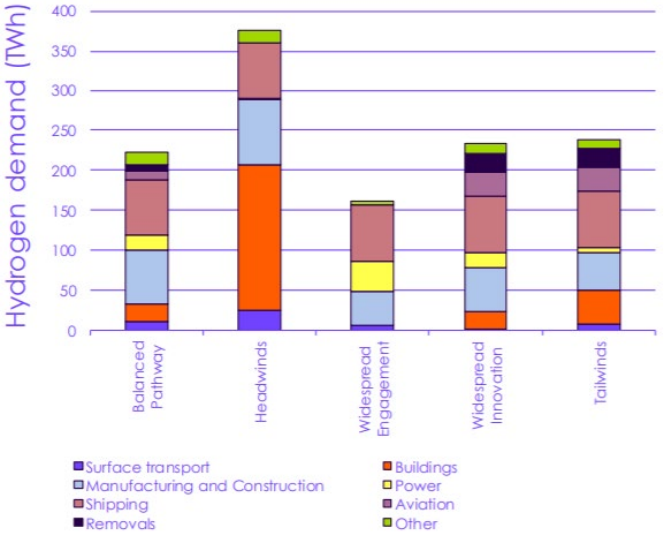
- Industry and Commercial
- Domestic Heating
- Transport

Modifications were made in an attempt to make the UK fuel split more specific to the Derby region:

- Additional hydrogen use for industry/commercial and transportation. Slightly less hydrogen for domestic heating due to electrification.
- Additional electrification of industry/ commercial and domestic heating.
- No bioenergy, waste and other fuels are used for transport and less are used for domestic heating and industrial/commercial sectors (exc. Agriculture and industrial alternative fuels).



Derby Region 2050 Fuel Split (Net Zero Balanced Scenario)



Sectoral hydrogen demands in 2050 for the 5 net zero scenarios in the CCC's 6th Carbon budget.

Estimating hydrogen demand

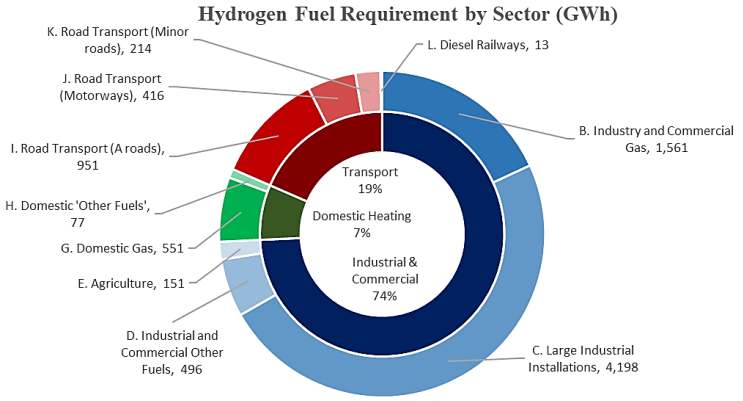
2. Determining the 2050 Derby Region Hydrogen Fuel Requirement/Replacement Potential

This fuel type demand for the Derby region was then applied to industrial sector emissions extracted from the Local and Regional Carbon Dioxide Emissions Estimates for 2005–2018 for the UK (BEIS). Demand-based assumptions for this analysis were:

- Emissions due to electricity are assumed to stay electrified
- Domestic electricity, gas and "other fuel" use decreases by 20%, 50% and 50% respectively due to more efficient systems and behaviour change
- The green and blue hydrogen split has been assumed to be 50/50 and only SMR using natural gas has been considered
- Local generation is assumed to be make up 20% of the demand
- Large industrial installations are assumed to have a 35/65% fuel split of electricity and natural gas
- The petrol and diesel split is 32/68% respectively

Requirement	Value	Unit
Green H2 (Mostly non-local generation with some imported)		
Renewable electricity requirement	6,162	GWh
Total electrolyser capacity	0.88	GW
Of which is local generation	0.18	GW
Local electrolyser cost	88	£M
Blue H2 (Likely imported from coastal SMR sites with CCS		
Natural gas requirement*	6,162	GWh
Estimated CCS electrical requirement	1,232	GWh
Amount of CO2e to capture	1,020	ktCO2e
Residual CO2e emissions	113	ktCO2e
SMR plant capacity	0.54	GW

- ~75% of hydrogen use will be used in Industrial and Commercial applications – mostly in large installations to replace natural gas
- A small amount of domestic heating will be served by hydrogen but will mainly electrify
- The majority of hydrogen in transport is envisaged to be for HGVs and public transport (although most trains are expected to electrify)

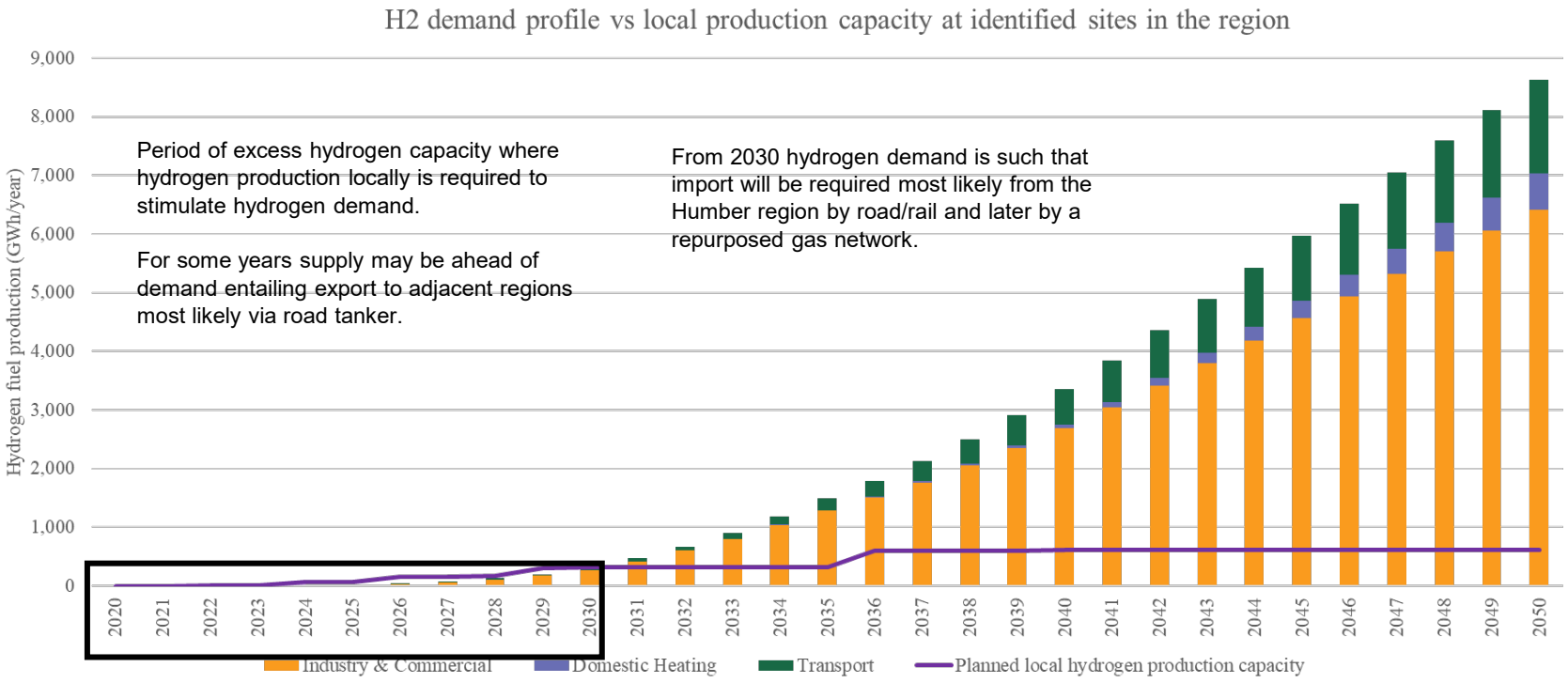


* CCS has a parasitic electrical requirement which is assumed to be "green" for this study

Estimating hydrogen demand

3. Developing a Demand Profile to 2050

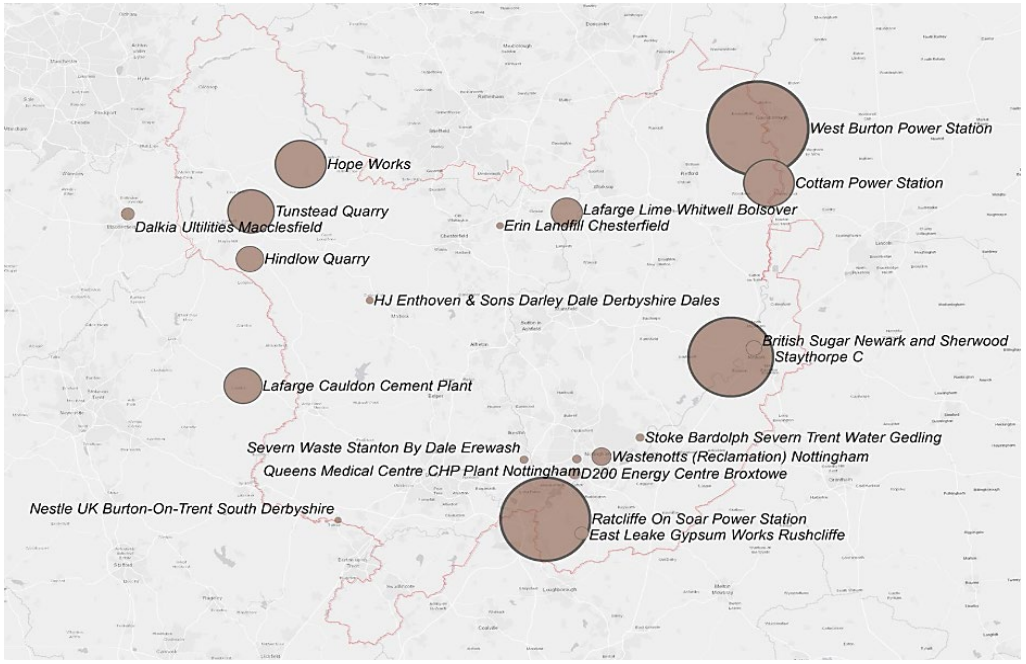
A demand profile for the D2N2 hydrogen requirement was constructed based upon the balanced scenario developed by the CCC.



Estimating hydrogen demand

4. Hydrogen for Industry

The analysis of hydrogen for industry began by looking at the industrial point source emissions in the region and the potential five hydrogen cases which could be adopted:



Top 10 point source emissions within the region and the potential role of hydrogen in reducing emissions

Use Cases	Description
1	Combustion of hydrogen for power production or for heat in a blast furnaces– either blended with natural gas/biomass or with 100% hydrogen
2	Use of the by products of hydrogen production (oxygen from green hydrogen or carbon dioxide from blue hydrogen production) in existing or new industry.
3	Use of hydrogen to decarbonise heavy duty transport associated with industry road or rail,
4	Using waste heat from industrial processes to pre-heat methane in blue hydrogen production.
5	Use of zero carbon hydrogen in new clean industry not currently at the site

Five use cases for hydrogen within industry

Data used: https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2018 filtered for years 2018 only and sites within D2N2
Please note: where 2019 data was available from https://ec.europa.eu/clima/ets/oha.do this has been updated. Where appropriate some sites have been aggregated where entries were present for the same postal location and reference number in the data.

Estimating hydrogen demand

4. Hydrogen for Industry

It should be noted that the top 2 carbon emitting sites (Ratcliffe and West Burton) in the region include coal fired power sites which will be phased out by 2025. Plans for these sites are discussed in this report. The fourth highest carbon emitting site is Staythorpe which is a gas power station. Any sites on the gas network will be influenced by discussions to repurpose the gas network for 100% hydrogen.

More work is needed to understand the individual opportunities for specific sites and businesses.

Rank	Site	Stakeholders	CO2 Emissions (kt)	H2 Use cases				
				a	b	c	d	e
1	West Burton Power Station Bassetlaw	EDF Energy (Coal and Gas)	**4254**	✓		✓		✓?
2	Ratcliffe On Soar Power Station Rushcliffe	Uniper UK Ltd (Coal)	**3333**		✓?	✓	✓?	✓?
3	Staythorpe C Power Station Newark and Sherwood	RWE Npower Plc (Gas)	**3004**	✓		✓	✓?	
4	Hope Works High Peak	Hope Construction Materials Ltd	**1084**	✓	✓?	✓		
5	Cottam Power Station Bassetlaw	Uniper UK (Gas)	**1062**	✓		✓		✓?
6	Tunstead Quarry High Peak	Tarmac Cement & Lime Ltd	**900**	✓	✓?	✓		
7	Whitwell Bolsover	Lafarge Lime Ltd	**399**	✓	✓?	✓		
8	Hindlow Quarry High Peak	Tarmac Cement & Lime Ltd/Lhoist UK Ltd	**321**		✓?	✓		
9	Wastenotts Reclamation Nottingham	Wastenotts (Reclamation) Ltd	**150**			✓		
10	British Sugar Plc Newark and Sherwood	British Sugar Plc	**107**			✓		

The top emission sites across the region, mapped according to emission (kTCo2) size (BEIS local authority data)

Estimating hydrogen demand

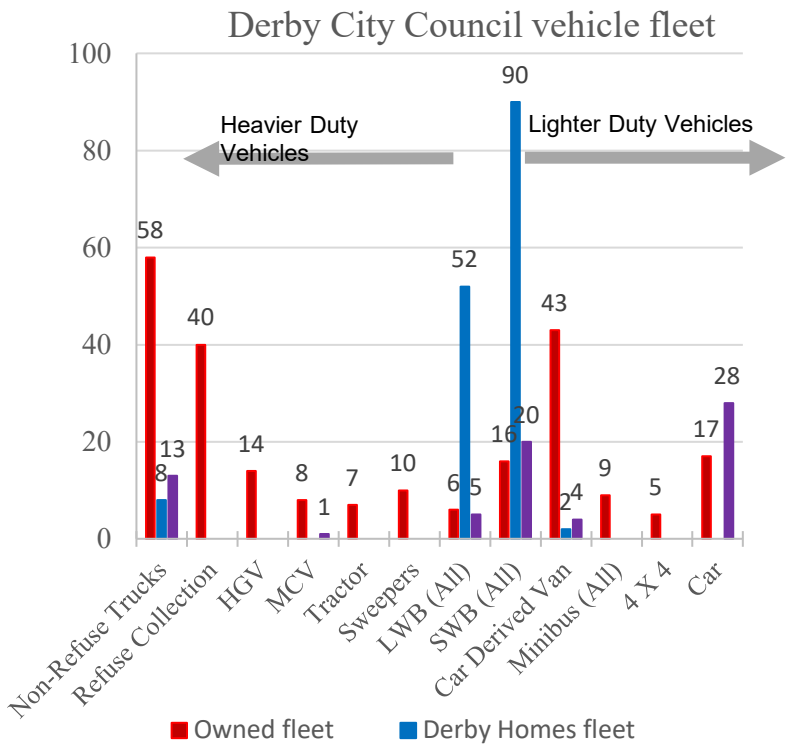
4 Case study of Derby Council's fleet

The Derby Council vehicle fleet has been analysed and placed in order of vehicle weight with heavier vehicles to the left of the graph and lighter vehicles to the right.

Standard heavier duty vehicles (e.g. Refuse Collection Trucks) are more suited to a hydrogen fuel cell technology due to the added mass cost that a battery pack would incur (although this is partially negated by the inclusion of a lighter drivetrain for both hydrogen fuel cell and electric vehicles).

Points to consider:

- Infrastructure/fuel supply lines: A hydrogen depot would require infrastructure to generate the hydrogen on site or set up a supply line for imported hydrogen (and likely to include storage.)
- Refuelling: Compared to electric vehicles, hydrogen vehicles can be refuelled much faster which logically decreases downtime.
- Range: The range of hydrogen vehicles are typically greater than electric vehicles, due to a higher energy density which allow for a larger radius of operation.
- Sphere of influence: Derby Council would naturally not have control of the vehicles that a hired fleet provide but are in control of who to purchase from – albeit likely at a higher cost.
- Alternative pathway – Hydrogen Internal Combustion Engine (ICE) conversion
- Converting an existing diesel ICE to a hydrogen ICE (or possibly a dual fuel system) is a relatively cost effective way to decarbonise a vehicle fleet whilst still being subject to the advantages and limitations listed above - as well as a vehicle efficiency decrease and possibly some residual emissions still being present.



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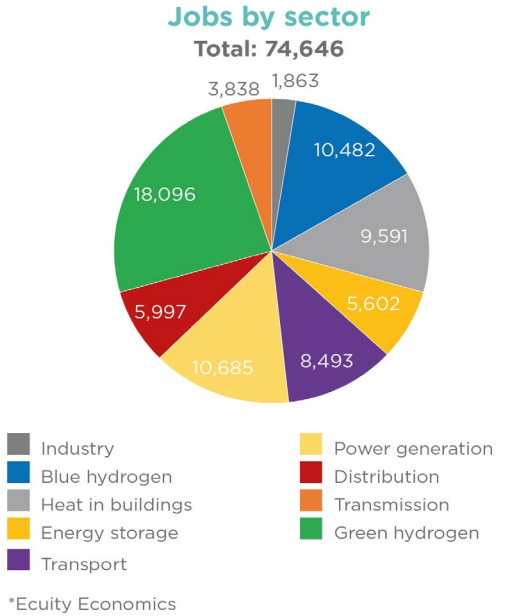
Appendix H

Estimating the Economic Potential of Hydrogen in the Derby Region

Economic impact potential of hydrogen in the Derby region

The Derby region's economy is the 4th largest outside London and the South East region[1] and contributes 46 billion in Gross Value Added to the UK economy annually (2.5%). The region is known for its heritage and expertise in advanced manufacturing; a strength which positions it to be a potential leader in the manufacturing of hydrogen road and rail vehicles and hydrogen heating solutions.

Currently D2N2 accounts for 7% of all transport vehicles manufacturing2 in the UK3. The H2 Taskforce estimates 8,500 jobs to be created across hydrogen investments in transport in the whole UK by 2030. If only 7% of those are created in the area, that would mean over local 620 jobs.



Source: Hydrogen Taskforce EIA, graph by Arup

Composition of employment and GVA impacts at UK level

[1] D2N2 Local Industrial Strategy Evidence Base, November 2019. [2] Defined through SIC2007 codes: 29: Manufacture of motor vehicles, trailers and semi-trailers, and 30: Manufacture of other transport equipment
[3] Midlands LEPs in total account for 35%.

Economic impact potential of hydrogen in the Derby region

Estimating the employment impact of the UK transition to Net Zero is still very challenging. While it will certainly enable the national economy to create many new jobs, it is important to remember that it will also play a large role in enabling people in existing high carbon sectors to transition and protect their jobs and develop their careers further.

Even if all the 225,000 jobs mentioned in the Ten Point Plan are new, additional jobs; that is around 1% of our current national employment. Similar results have been estimated by the Cambridge Econometrics macro-econometric modelling conducted for the Sixth Carbon Budget. Their analysis suggests a boost to employment of around 1% by 2030 if the UK follows the recommended Balanced Pathway.

Therefore, while transitioning to Net Zero it is unlikely to significantly impact our national labour market, although it is likely to have a marked impact on local economies with existing strengths and potential, such as the Derby region.

Conservative, high level estimations presented on the previous two slides suggest that the hydrogen economy could account for at least 800 jobs in the LEP area by 2030, which is already close to the LEP target of 1,000 jobs by 2030, while only considering the two main, most obvious sectoral opportunities (i.e. vehicles and boilers).

Source: Climate Change Committee Sixth Carbon Budget (Figure B5.6)

GVA and employment impact in the Sixth Carbon Budget Balanced Pathway

Economic impact potential of hydrogen in the Derby region

The D2N2 area is also home to a significant national cluster of activity in boiler manufacturing1. According to ONS BRES data, it accounts for 45% of UK jobs that in that sector. Key local manufacturers have already been developing and field-testing hydrogen boiler technologies.

Vaillant Group UK, part of Vaillant Group, which is one of the world's leading manufacturers of heating technology, is headquartered in Belper in Derbyshire. The company is currently working on developing a 100% hydrogen-run boiler for field testing in 2021.

Worcester Bosch is another market leader in domestic gas and oil boilers. While headquartered in West Midlands, their boiler factory in Clay Cross in Derbyshire employs 300 people. At the beginning of 2020 the company revealed its first hydrogen-fired boiler, developed as part of the government-funded Hy4Heat programme. The boilers are now being tested in specially built demonstration houses in Northumberland, funded by Ofgem.

Another UK market leader, **Baxi Heating UK**, is based nearby in West Midlands and currently employs 1,300 people.

The H2 Taskforce estimates 9,600 jobs to exist in the UK in hydrogen heating-related industry by the 2030. It is rather unrealistic to think that almost half of those jobs would be based in Derbyshire and Nottinghamshire, because that would mean at least 100% growth of the local sector up to 2035. On the other side, total growth of 100% between 2019 and 2035 translates into an average annual growth rate (CAGR) of 4.8%. This is not completely unrealistic, especially if we consider the CCC Sixth Carbon Budget and its most hydrogen-friendly "Headwinds" scenario (out of all five scenarios), which assumes that 71% of UK homes will be using hydrogen for heat by 2050.

Having said that, a more realistic balanced scenario suggests that it will be 11% of homes that will use hydrogen for heat by 2050, and that all new gas boilers are hydrogen-ready by 2025 at the latest which does still pose a significant opportunity for the D2N2 economy. Even if the local boiler sector increases by 10% (as opposed to 100%), that will translate to around 200 jobs.

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Appendix I

Policy Review

National policy overview

The future of hydrogen – seizing today's opportunities (June 2019)

The IEA have outlined the opportunity posed by hydrogen and the challenges faced in realising that opportunity.

The IEA identifies four near-term opportunities which could be used to ignite the hydrogen economy and encourage widespread adoption:

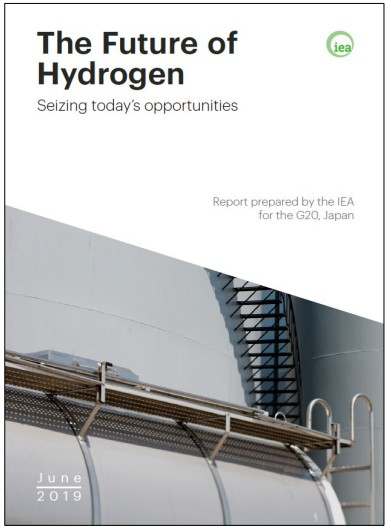
1. Making industrial ports the nerve centred for scaling up the use of clean hydrogen
2. Building on existing infrastructure, such as the kilometres of natural gas pipelines
3. Expand hydrogen in transport through fleets, freight and corridors
4. Launch the hydrogen trade's first international shipping routes

The Derby region has limited ability to capitalise on points 1 and 4 of the above. However focus could be made on points 2 and 3.

Close stakeholder engagement with network operators could leverage opportunities for hydrogen both in demonstrating hydrogen for heat (repurposing the gas network) and deploying hydrogen through fleets of vehicles such as busses, refuse trucks and delivery vans.

The report goes on to making 7 recommendations:

1. Establish a role for hydrogen in long term energy strategies
2. Stimulate commercial demand for clean hydrogen
3. Address investment risks of first-movers
4. Support R&D to bring down costs
5. Eliminate unnecessary regulatory barriers and harmonise standards
6. Engage Internationally and track progress
7. Focus on the key opportunities listed above to increase momentum over the next decade



Source: https://www.iea.org/reports/the-future-of-hydrogen

National policy overview

Path to hydrogen competitiveness – a cost perspective (January 2020)

The Hydrogen Council's report highlights the recognition hydrogen is receiving in its ability to decarbonise difficult sectors such as transport, freight, and industry. The report stresses the critical role hydrogen also has to play in energy security.

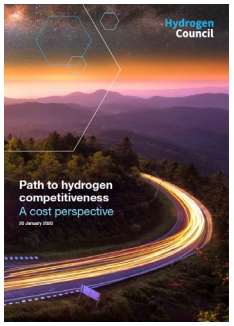
Scaling up the hydrogen economy is presented as a key to driving cost reduction. The Derby region should therefore consider how hydrogen deployment can scale.

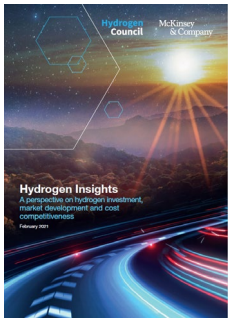
Hydrogen production costs are envisaged to fall by 60% in the next decade due to:

- Widely available, cheap, renewable electricity
- Scale up of electrolyser manufacturing
- Development of low cost carbon storage facilities.

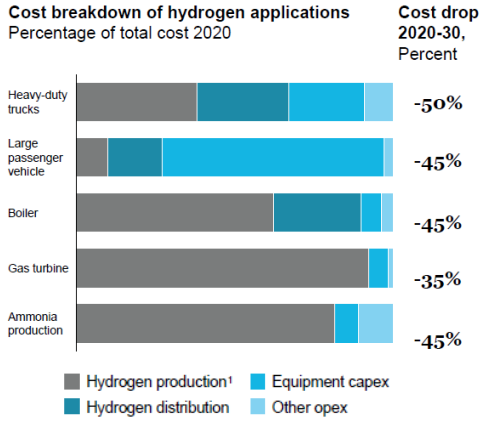
As a land locked region, access to renewable electricity generation and carbon storage facilities are likely to be limited. The Derby region should therefore focus on the demand side and what can the region offer in terms of appliance manufacturing and skills. The Hydrogen Council predicts that there is scope for 70% reduction in the cost of end-use hydrogen equipment, coupled with the region's history within manufacturing, there could be a large opportunity to manufacture hydrogen vehicles and appliances.

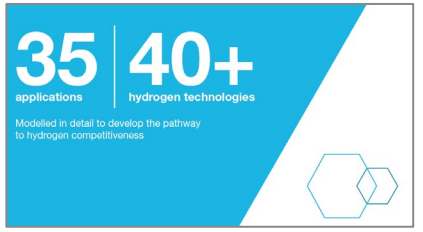
A further report from the Hydrogen Council recently released shows an even more optimistic view of the price of hydrogen, with costs being 20-30% lower than in the 2020 report.





Source: https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf





National policy overview

Future energy scenarios – National Grid (July 2020)

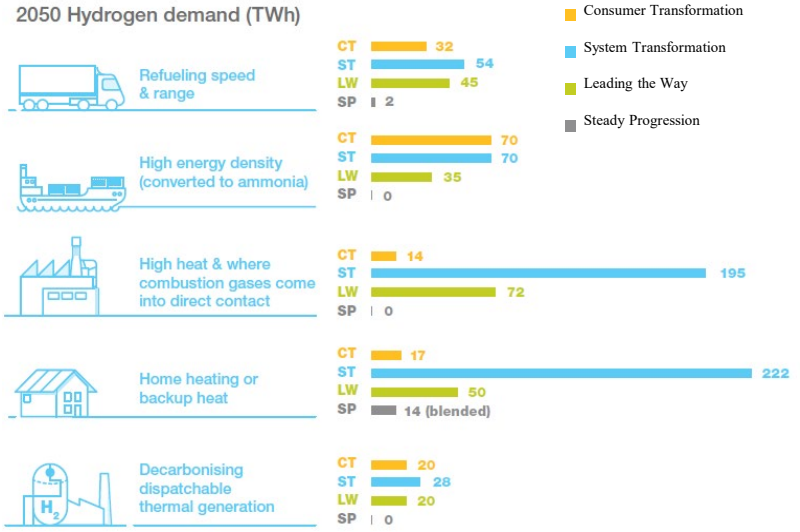
To ensure the most current information is presented the Future Energy Scenarios document is updated annually. Four Net Zero Future Energy Scenarios are presented. The speed with which Net Zero is reached varies, between the scenarios, based on the extent of societal change required by the scenario.

Source: https://www.nationalgrideso.com/document/173821/download

Four headline messages are also presented in the report which can be summarised as:

1. Immediate action and widespread engagement is required across the entire energy landscape if net zero is to be reached by 2050.
2. Hydrogen and CCS are essential and large scale demonstration is required this decade.
3. Economics of energy will change, markets must adapt to provide incentives for zero carbon technologies.
4. Open data and digitalisation is essential in navigating the emerging complexities.

The 2020 report shows the varying hydrogen demand required across the scenarios in 2050. Demand varies from 16-570 TWh depending on the amount of societal change to be applied.



National policy overview

The Sixth Carbon Budget – the UK's path to Net Zero (December 2020)

The Sixth Carbon budget outlines a pathway for the UK to reach net Zero by at least 2050, setting out ambitious but realistic targets along the path. After considering a number of Net Zero scenarios a recommendation was made to follow the 'balanced' approach: Achieving 78% reduction in green house gas (GHG) emissions (relative to 1990 levels) by 2035 and at least a 68% reduction in emissions by 2030.

By Pledging to achieve these targets, the UK aims to lead in necessary increased global ambitions. Estimations suggest that achieving the reductions will cost less than 1% of GDP, from both public and private sector funds.

Consumer engagement is highlighted as being more important than ever in achieving the budgets. The need for education around consumer choice is evident as is the need for a 'fair' energy transition. How the local authority can lead in engagement should be considered in the Derby region.

The balanced Net Zero pathway suggests that 105 TWh of low carbon hydrogen production will be required in 2035. The report mentions that hydrogen will be focused in areas less suited to electrification such as shipping, industry and heavy goods vehicles. As a landlocked region, D2N2 should consider what are the opportunities where hydrogen can best lend itself.

	Brief Description	Net-Zero	Approx. 2050 H_2 demand/ TWh
Headwinds	High hydrogen and carbon capture and storage (CCS) ambition	2049	380
Widespread Engagement	Reliance on behavioural changes e.g. change of diet towards plant based, reduced air travel and reduced use of personal vehicles.	2050	160
Widespread Innovation	Innovation drives the cost of low-carbon technologies down and technological improvements lower emissions and raise efficiencies.	2045	230
Balanced	Mixed view of the above scenarios based on moderate assumptions as to innovation, hydrogen adoption and engagement.	2050	220
Tailwinds	Most ambitious scenario based on high levels of innovation and high levels of public engagement.	2042	240

National policy overview

The sixth carbon budget – the UK's path to net zero (December 2020)

During 2020, the UK Government set out its plan for achieving Net Zero by 2050 in the Prime Minister's Ten Point Plan (10PP) along with the Energy White Paper.

Pertinent to hydrogen, within the action points in the plan, the Prime Ministers Ten Point Plan sets out plans for:

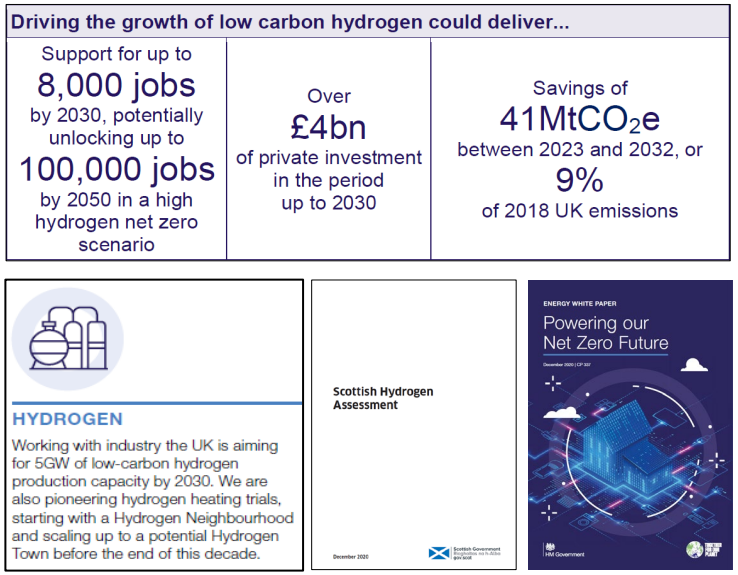
- Driving the Growth of Low Carbon Hydrogen
- With a focus on supporting hydrogen for heating applications, enabling blending and deploying low carbon hydrogen production out of industrial clusters
- Accelerating the Shift to Zero Emission Vehicles
- Jet Zero and Green Ships
- Greener Buildings
- Investing in Carbon Capture, Usage and Storage
- Green Finance and Innovation

Of significance to the Derby Region is the decision to bring forward the ban of the sale of new petrol and diesel cars and vans from 2040 to 2030, with hybrids being allowed until 2035. This creates significant opportunities for the switch to battery and hydrogen fuel cell vehicle manufacture.

The opportunity for hydrogen in the coming years is clear with the 10PP setting out ambitions for 5 GW of low carbon hydrogen production by 2030. However, central to those ambitions is keeping energy fair and affordable therefore cost effective deployment of hydrogen is essential and must be considered. In developing a hydrogen economy jobs will be created and it is necessary to consider the skills within the region and how individuals may need to adapt.

Similar to the work done in the Scottish Hydrogen Assessment the Derby region needs to assess the potential within the region both to decarbonise the area and consider opportunities for exporting (hydrogen, appliances, skills).

Until the national hydrogen strategy is published (expected Q2, 2021) the Scottish Hydrogen Assessment forms the best available large scale strategy, relevant to the UK.



Regional policy overview

D2N2 Energy Strategy, 2019-2030

D2N2's Energy Strategy sets out the LEP's ambitions to start a clean growth revolution in the region. It aims to make Derbyshire and Nottinghamshire a national pioneer in clean growth and a test-bed for world-class energy systems innovation by 2030.

The strategy makes clear that pursuing a clean growth agenda also goes hand in hand with bolstering the region's economic growth. Through early adoption, D2N2 wants to become one of the most dynamic carbon neutral economies both in the UK and internationally, attracting significant inward investment and creating tens of thousands of new jobs. It also wants to be known as the UK's premier location for developing, trialling and implementing innovative energy systems approaches at scale.

10 key actions are identified which drive the strategy, of which the following are most relevant to the hydrogen economy:

- 15% of buildings using low carbon heating;
- 100% low carbon energy supply with 60% renewable generation output and increase of 180MW in electricity storage;
- increase the provision of smart transport infrastructure to support a target of 70% of vehicle miles to be Ultra Low Emissions;
- 100 new businesses in the Low Carbon and Renewable Energy sector and 1000 new jobs;
- Secure at least £100m of investment in local energy projects; and
- 15MW of community energy installed and two industrial sites brought into low-carbon energy generation and innovation.

The strategy sees hydrogen as one of many solutions in its target to move away from fossil fuels and to generate 13 times the amount of renewable electricity generation than in 2016, and a key component in meeting regional electricity demand in 2030. Specifically, for hydrogen, the strategy states the following actions:

- Coordinating hydrogen infrastructure feasibility studies for scalable low carbon heating, storage and transport;
- Building on the expertise of Nottingham University to pursue opportunities for hydrogen research, via the Energy Research Accelerator;
- Enabling and hosting pilots and community trials on re-purposing the existing gas infrastructure, and explore other low-carbon heating options at scale as part of a broader energy system transition.

D2N2 Energy Strategy's clean growth priorities

The Strategy makes clear that the D2N2 region has the required delivery and research partners to make its aims feasible.

Source: D2N2 Energy Strategy 2019-2030: https://d2n2lep.org/energy-strategy/

Regional policy overview

D2N2 Draft Local Industrial Strategy 2020

Clean and green growth strongly underpins all aspects of D2N2's Local Industrial Strategy, which proposes to lead the most ambitious carbon turn-around of any area in the country.

TD2N2 seeks to evolve from being the birthplace of the industrial revolution to spearheading a green revolution, and for a new low carbon economy to act as a catalyst for a more productive and inclusive economy.

The strategy sets out three guiding principles:

Upskilling for Productivity – which includes ensuring the labour force is upskilled to take advantage of jobs in clean growth sectors by embedding clean growth principles into local curricula, training and apprenticeship programmes;

Clean Growth – which includes reducing the LEP region's reliance on non-renewable energy systems; supporting innovative zero-carbon housing developments and developing low and zero carbon transport systems;

Connectivity and Inclusion – which includes ensuring the LEP region is better connected and those journeys are electrified/ low-carbon.

The LIS focuses strongly on utilising D2N2's universities and manufacturing excellence to become a globally renowned cluster for zero-carbon and carbon-negative industries.

It includes a proposition for Ratcliffe-on-Soar power station to become a new, ambitious zero-carbon energy system and innovation cluster - the place to come to solve decarbonisation challenges and scale clean energy solutions in generation, saving, storage and recovery. An anchor higher education institute in low carbon future is also proposed on site.

Although hydrogen isn't mentioned specifically, it is clear that clean growth is a golden thread within the strategy, and nurturing a hydrogen economy in the region would strongly align to the LIS's aims. Indeed, the LIS positions the D2N2 region as the perfect testbed for pioneering research and innovation in new energy systems and technologies, as well as new types of jobs and employment associated with clean growth.

Source: D2N2 Draft local Industrial Strategy, March 2020: https://d2n2lep.org/local-industrial-strategy/

Regional policy overview

Derby City Council's Climate Change Strategy 2015

Derby's Climate Change Strategy is a proactive document setting out how Derby will play its part in meeting the UK's commitment to reduce emissions by 80% by 2050.

It identifies six strategic level priority themes:

1. A thriving sustainable economy – based on a low carbon economy;
2. Smarter travel options – expanding the range of sustainable transport options and examining the potential for local alternative fuels and supply chains to decarbonise motor vehicle fuels;
3. Energy efficient homes – focused on reducing energy demand as well as efficiency improvements to all Derby Homes housing stock, including upgrading to more energy efficient boilers;
4. A secure local and renewable energy supply – reducing the city's reliance on energy from fossil fuels through a locally generated, diverse and more secure energy supply, including a city-wide district heating network;
5. Being prepared for a changing environment – focused on resilience and adaption to the impacts of climate change; and
6. An active community – based on empowering local people to support and drive low carbon activities.

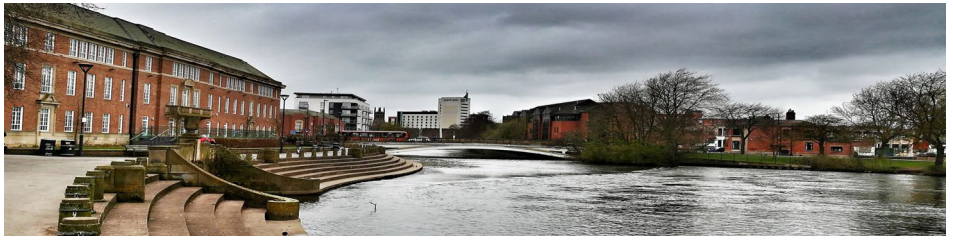
Again, hydrogen is not specifically mentioned but will be part of the solution to addressing, most notably, strategies priorities 1, 2, 3 and 4.

Source: Derby City's Council's Climate Change Strategy, June 2015: https://www.derby.gov.uk/media/alluncategorised/DerbyCityCouncil-Derbys-Climate-Change-July-2015.pdf

Regional policy overview

Derbyshire Climate and Carbon Reduction Manifesto 2019

Derbyshire County Council has also pledged to reduce greenhouse gas emissions from its own estate and operations with the aim of having net zero greenhouse gas emissions by 2032.



The pledge sets out a significant number of initiatives aimed at reducing greenhouse gas emissions and supporting renewable energy generation across its land and building stock, as well as transitioning its core and indirect vehicle fleet to low carbon and low emission vehicles. HGVs are specifically referenced as an area of potential for utilising hydrogen.

The manifesto also seeks to foster green energy entrepreneurs to develop renewable or zero carbon energy production in the county as well as generally attracting low carbon businesses.

Sources: Derbyshire Climate and Carbon Reduction Manifesto 2019: https://www.derbyshire.gov.uk/site-elements/documents/pdf/environment/climate-change/climate-manifesto-pledge.pdf
Derbyshire County Council Carbon Reduction Plan, October 2019: https://www.derbyshire.gov.uk/site-elements/documents/pdf/environment/climate-change/carbon-reduction-plan.pdf

Regional policy overview

Derby City Council's Climate Emergency Statement 2019

On 22nd May 2019, Derby City Council declared a Climate Emergency in the city. As a result, the Council has committed to:

- Establishing a Derby Climate Change working group;
- Setting a target for Derby to be carbon neutral;
- Working with others on carbon reduction projects to ensure the UK is able to deliver on its climate commitments;
- Calling on UK govt. to provide the necessary support and resources to enable effective carbon reductions.

Source: https://www.derby.gov.uk/environment-and-planning/climate-change-energy-management/climate-change/

Derby Future Fuels 2020

Derby has declared its ambition to become the UK's centre of excellence for future fuel technologies

The ambition builds on the city's advanced manufacturing and high-tech expertise to develop equipment and infrastructure to enable the generation of low carbon power as well as capture, storage and utilising by-product or waste-energy. Derby City Council is leading the initiative and assembling a partnership of leading companies and academics to drive forward the plans. Hydrogen is referenced as an area of potential.

The Council is also considering the purchase of a city site where an integrated energy approach can be launched and demonstrated, linking clean energy and by-product power sources to commercial and domestic users. It would also include a low-carbon public transport hub.

Source: https://www.derby.gov.uk/news/2020/october/citys-bid-to-become-leading-uk-centre-for-future-fuels/

Regional policy overview

Carbon Neutral Nottingham 2020-2028

In 2020, Nottingham City Council responded to the climate and environmental crisis by setting an ambition to become the first carbon neutral city in the UK by 2028.

This plan builds on Nottingham 2028 Carbon Neutral Charter by setting out high-level objectives in order to achieve a resilient and carbon neutral Nottingham by 2028, The Council have broken this down into four main areas for action:

- Carbon Reduction;
- Carbon Removal;
- Resilience and Adaption;
- Ecology and Biodiversity.

Chapter Three: Energy Generation specifically mentions hydrogen, and how it requires the need to work with partners to understand the potential for low-carbon hydrogen gas in the distribution network for heating, hot water provision and producing more renewable and low carbon energy locally.

The promotion of hydrogen powered vehicles as an alternative to internal combustion engines is stated in Chapter One: Transport.

Source: Carbon Neutral Nottingham 2020-2028 Action Plan, 2020: https://www.derby.gov.uk/environment-and-planning/climate-change-energy-management/climate-change/

Nottinghamshire Carbon Management Plan

In 2007, Nottinghamshire County Council took action on its response to climate change. It sets out the County Council's strategy for reducing CO2 emissions and carbon footprint.

The "Carbon Management Plan" focuses on one action area - mitigation of carbon through the corporate performance of the County Council, bringing together work in the areas of energy from buildings, street lighting, travel and transport, waste and procurement.

Although there is no reference to hydrogen, the County Council proposed key actions to maximise CO2 savings from activities for the short, medium and long-term, and introduce effective and comprehensive carbon accounting so that the Council can accurately quantify the contribution to climate change as a result of its activities.

Source: Nottinghamshire Carbon Management Plan, 2007: https://www.nottinghamshire.gov.uk/media/109731/carbonmanagementplan.pdf

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Appendix J

Funding Review

National funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Industrial Energy Transformation Fund (IETF)	BEIS with Innovate UK	Supporting businesses with high energy use to transition to a low carbon future, and to cut their bills and emissions through increased energy efficiency and decarbonisation technologies. N.B. Not an innovation fund – technologies must have been proven by demonstration or operation previously.	Must be led by a business that operates a manufacturing site or data centre i.e. intensive energy user (SIC codes apply) Business can collaborate with businesses, RTOs, academics and public sector organisations as partners	Projects must be completed by 2024. • Phase 1 2020 has closed. • Phase 1: Spring 2021 opens to applications on 8 March 2021 and runs to 14 July 2021 – for deployment projects. • Phase 2 (launching 2021) will fund projects that support energy efficiency and decarbonisation studies.	Grant funding	£315 million total fund. Minimum and maximum thresholds vary according to project type, but generally between 330k-£14million. Applications must be at least £250,000 and up to a maximum of £3m
SBRI Competition rail demonstrations: first of a kind 2021	DfT and Innovate UK	Accelerating innovation in the UK rail sector, enabling technologies to be readily and efficiently integrated into the railway system. Centred around three themes – theme 3 is focused on low emissions and a greener railway. Strongly supports deployment of hydrogen trains, delivery of hydrogen as a fuel and enabling sharing of hydrogen fuel by rail and non-rail vehicles.	Small Business organisations. Must include an owner of railway assets, an experienced railway organisation, and a rail organisation that has potential to become a customer.	Projects must start by July 2021 and end by March 2022. • Competition opens 8 February 2021 and closes 10 March 2021.	Grant funding for R+D	£9 million total fund. Project costs between £50,000 and £400,000.

National funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Levelling Up Fund	Treasury, DoT, MHCLG	Investing in the "infrastructure of everyday life", including local transport schemes, urban regeneration projects and cultural assets. Emphasis is on places that have received less government investment in recent years – all authorities have been categorised according to their need, with category 1 representing places with the highest levels of identified need.	Local authorities, including backing from MPs.	Prospectus for the fund released in 2021 Spring budget. Submissions must be made by 18 June 2021. Projects must be delivered before the end of 2024.	Capital	£4.8bn fund overall. Individual projects up to £20million. Bids above £20m and below £50m will be accepted for transport projects only
Shared Prosperity Fund	MHCLG, DWP	Replacement for EU Structural Funding. Focussed on government's levelling up agenda and reducing inequalities between communities, with a portion specifically dedicated to ex-industrial areas, deprived towns, and rural and coastal communities. Expected to be three strands: - Investment in people and skills, i.e. skills programmes - Investment in communities and place, including infrastructure - Investment for local business, including support for innovation, green and tech adoption. Investment should be aligned with the government's clean growth and net zero objectives.	Local areas	The government will set out further details of the UKSPF in a UK-wide investment framework published in the spring.	Unknown	Expected to be circa £1.5 bn a year. Individual project limits not yet specified.

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National funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Automotive Transformation Fund	Treasury (Innovation Funding Service), The Advanced Propulsion Centre UK	The Automotive Transformation Fund (ATF) is a long-term programme designed to enable the UK to build the world's most comprehensive and compelling electrified vehicle supply chain. ATF is dedicated to supporting the large-scale industrialisation of an electrified supply chain. The programme will support strategically important capital and R&D investments in the UK and will begin by supporting and investing in organisations involved in: 1) batteries including cells ('gigafactories'). 2) battery management systems. 3) electric machines, drives and integrated power electronics. 4) fuel cells.	Organisations/Companies with interest in the following technology areas: Batteries Motors and drives Power electronics Fuel cell Recycling of any of the above	Unknown	Grant funding	It offers a share of up to £1 billion of funding for capital and associated industrial research projects.
UK Infrastructure Bank	HM Treasury	In the Spring 2021 the government provided more details on the proposed UK Infrastructure bank – intended to be a long-lasting institution with a high degree of operational independence. The bank will provide a range of financing tools to support private infrastructure projects and strategic infrastructure projects for local authorities. Its core objectives are to help tackle climate change, meet the net zero emissions target and support regional and local economic growth through better connectedness, opportunities for new jobs and higher levels of productivity.	Private companies and local authorities	The Bank will begin operating later in spring 2021 in an interim form and then ramp up its activities in the longer term.	Debt, hybrid products, equity and guarantees to private projects. Preferential rate loans to local authorities.	£22 billion of financial capacity £12 billion of equity and debt capital and the ability to issue £10 billion of guarantees

National funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Bus Back Better	DfT	The bus strategy seeks transformational investment in bus services to support more frequent, more reliable, easier to use and understand, better coordinated and cheaper bus services. From a hydrogen perspective, the strategy sets out a commitment to: - Support the purchase of at least 4000 new zero emission buses; - Set a date for ending the sale of new diesel buses in the UK; and - transition cities and regions across England to emission-free buses, safeguarding the UK bus manufacturing industry.	Local transport authorities/ Mayoral combined authorities	Not clear but 2021-2022+	Grant	£3bn in total. £120m in 2021/22 to accelerate the delivery of zero emission buses.

National funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to decarbonisation	Alignment to economic growth	Funding Pot Size
Industrial Energy Transformation Fund (IETF)	Fund could be used by major industrially focused companies in the D2N2 region to either undertake feasibility studies or implement the application of energy efficiency or decarbonisations technologies. There is nothing in the funding guidance to suggest hydrogen is included or excluded, and indeed, the fund must be used based on proven technologies, so could only be based on existing hydrogen solutions, rather than exploring new hydrogen technologies.				
SBRI Competition rail demonstrations: first of a kind 2021	Fund could be used by railway companies e.g. East Midlands Railway, to explore potential for hydrogen innovation across their franchise. Fund is however very small (max £400k per project) so impact and scope will largely be limited to R+D studies at this point.				
Levelling Up Fund	Fund's focus is not related hydrogen or clean energy specifically; however the prospectus does state that projects should be aligned to and support net zero goals (i.e. be based on low or zero carbon practice, adopt innovative clean tech and/ or support the growth of green skills and sustainable supply chains). Equally, it is mentioned that transport investments should reduce carbon emissions and improve air quality, thereby giving potential for hydrogen solutions to be included within funding proposals. It is also worth noting that both Derby and Nottingham are classified as Category 1 areas i.e. the highest priority for funding.				

National funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to decarbonisation	Alignment to economic growth	Funding Pot Size
Shared Prosperity Fund	Fund details to be set out at the next Spending Review but focus appears broad and explicit reference made about investments needing to align to government's clean growth and net zero objectives. Potential route for hydrogen projects via upskilling programmes, infrastructure schemes or innovative.				
Automotive Transformation Fund	The Automotive Transformation Fund sets out to put the UK at the centre of the global transition to zero emissions. The Automotive Transformation Fund is a long-term programme designed to enable the UK to build the world's most comprehensive and compelling electrified vehicle supply chain. The programme will support strategically important capital and R&D investments in the UK and will begin by focusing on companies involved in: batteries including cells, ('gigafactories'), battery management systems, electric machines, drives and integrated power electronics and most importantly, fuel cells.				
UK Infrastructure Bank	The proposed UK infrastructure bank appears to be an exciting future source for borrowing for both private companies and local authorities wishing to develop infrastructure projects which meet decarbonisation aims, so although hydrogen is not mentioned, a hydrogen-aligned infrastructure project would certainly meet the funds aims.				
Bus Back Better	The bus strategy itself is very exciting and has significant potential for hydrogen buses to be funded as part of the commitment to purchase 4000 new zero emission buses. Details on how to apply for funding have not yet been shared however. The strategy also discuss the launch of the Zero Emission Bus Regional Area (ZEBRA) scheme, which will bring together LTAs, bus operators, energy companies and other stakeholders to develop financial and commercial models of delivering zero emission buses at scale. This could be a further route to test a wide-scale hydrogen bus programme in the region.				

National funding

Future national funds

The following funds do not yet have sufficient detail for assessment but are earmarked as funds that could potentially be drawn down for use on hydrogen projects in the D2N2 region:

Net Zero Hydrogen Fund (BEIS), in order to drive the growth of low carbon hydrogen, Point 2 of the Government's Ten Point Plan for a Green Industrial Revolution (November 2020). This £240 million funding commitment is to help the UK achieve its aim of developing 5GW of low carbon hydrogen production capacity by 2030, with a focus on the industrial heartlands.

Pioneering hydrogen heating trials (BEIS), a multi-year commitment up to £81 million from the 2020 Spending Review.

Previous relevant funds

The following funds have closed but are worth monitoring in case future rounds open up:

Public Sector Low Carbon Skills Fund (BEIS), managed by Salix and closed to applications in January 2021. Fund provides opportunity for public sector organisations to get 100% capital grants for energy efficiency and heat decarbonisation projects within public sector non-domestic buildings, as well as energy-saving projects.

Network Innovation Competition (Ofgem), an annual opportunity for electricity or gas network companies to compete for funding for the development and demonstration of new technologies, operating and commercial arrangements. The 2020 round funded £57.62 million and included two hydrogen projects.

Decarbonisation of industrial clusters: cluster plan competition (UKRI), a fund focused on reducing emissions across major industrial clusters and to achieve the government's ambition to establish the world's first net zero carbon industrial cluster by 2040, and a low-carbon industrial cluster by 2030. Two rounds have occurred so far and included funding for hydrogen and carbon capture storage projects. In the latest round, six projects shared £8million.

Regional funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Rural Community Energy Fund	Midlands Energy Hub on behalf of BEIS and DEFRA (Accountable body = Nottingham City Council)	Supporting rural communities wanting to set up renewable energy projects in their area. The fund specifically aims to: • Support rural communities by helping them to maximise the income generating potential of renewable energy and putting this to work locally • Increase the uptake of community and locally owned renewable energy, promote rural growth, job creation and volunteering opportunities Projects include those looking at the feasibility of biomass, solar PV and thermal, electric vehicles, anaerobic digestion, and hydro power.	Community groups	The Midlands Energy Hub review applications on a quarterly basis.	Grants	£1.8 million across Midlands Stage 1: grants of up to £40,000 for a feasibility study for a renewable energy project Stage 2: grants of up to £100,000 for business development and planning of feasible schemes Schemes
Midlands Engine Investment Fund	Midlands Engine; Delivered by British Business Bank	The Midlands Engine Investment Fund (MEIF) provides commercially focussed finance through Loans, Debt Finance and Proof of concept grants. The MEIF aims to transform the finance landscape for smaller businesses in the Midlands and to realise the region's potential to achieve broad economic growth through enterprise. The most active sector to receive investment has been manufacturing. Other key areas include agri-tech, life sciences and transport technologies.	Start-ups & Small to medium sized businesses based in the Midlands	Fund managers review each case and negotiate timescales	Debt & Equity Finance, Proof of concept grant, Loans	Loans: £25k-£150k Debt Finance: 100k-£1.5M Equity Finance: £50k-£2M Proof of Concept: up to £75k

Future funding:

The following funds do not yet have sufficient detail for assessment but are earmarked as funds that could potentially be drawn down for use on hydrogen projects in the D2N2 region:

- **East Midlands Hydrogen Innovation Zone** – the University of Nottingham is seeking to develop an East Midlands Hydrogen Innovation Zone which could generate future funding streams in the future. It is expected this would extend beyond research to include jobs and skills training also.

Regional funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to clean growth	Alignment to economic growth	Funding Pot Size
Rural Community Energy Fund	Fund could be used by community groups in D2N2's rural area to explore feasibility of hydrogen energy production schemes. Small scale fund at present aimed at feasibility studies but those could then be used to increase chances of attracting further funding for development and delivery stages of scheme. Although hydrogen doesn't appear to have been trialled yet through the fund in the Midlands, so long as it meets the renewable energy criteria, there is scope to explore a hydrogen scheme through this route.				
Midlands Engine Investment Fund	Midlands Engine Investment Fund (MEIF) collaborates between ten Local Enterprise Partnerships (LEPs) in the West Midlands, East and South East Midlands; this includes D2N2. The MEIF does support a board range of SME and start-ups across the region. Funds have not yet directly gone to hydrogen based projects or corporations, but the MEIF have supported energy firms in the past. There is potential for funding small and start-up business and projects related to hydrogen technologies.				

Local funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
DE- Carbonise Project – Derby and Derbyshire	Derby City Council, Derbyshire County Council, and the University of Derby.	Advice and grant support for reducing business carbon emissions, save costs and help them to become more sustainable.	Small to medium sized businesses (SME) based in Derby and Derbyshire	Support is available until October 2022.	Grant	Between £1,000 and £20,000; 40% of project cost.
Towns Fund	MHCLG	Urban regeneration planning and land use; skills and enterprise infrastructure; improving transport or digital connectivity. Interventions must take into account clean growth principles, and ideally support UK net zero commitment by 2050.	Town Deal Boards aligned to accountable body (local authorities)	All 3 cohorts of applications have been submitted. Announcements expected before April 2021. Projects must be delivered within 5 years of Town Deal being agreed.	Grant (90% capital, 10% revenue)	£3.6 bn fund – towns can bid up to £25m each, in exceptional cases up to £50m.
Transforming Cities Fund	DfT	Aims to drive up productivity through investment in public and sustainable transport in some of the largest English city regions. Focus on improving intraurban connectivity whilst encouraging an increase in journeys made by low carbon, sustainable modes. It also encourages the use of new mobility systems and technology which tackle air pollution and reduce carbon emissions.	City regions	The fund closed to applications in 2018. Projects must be delivered within a 5 year period to 2022/23.	Grant capital	£2.5 bn fund Derby and Nottingham have been allocated £161m.

Local funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Future Mobility Zone Fund	DfT	Supports innovation in mobility, through: - Encouraging the sharing of data to improve access and use of transport data; - Supporting new modes of transport and new mobility services, especially the development of low carbon technologies alongside reducing congestion; - Ensuring benefits are brought to society and the economy.	Local authorities or mayoral combined authorities	Bids were submitted in 2019 and announced in 2020. Projects expected to be delivered by 2023.	Grant	£70m total fund. Nottingham City Council and Derby City Council jointly secured £16.7m.
N/A – East Midlands Dev Co	MHCLG	Not a fund per se but negotiations are underway with Government for up to £235m of funding to setup the East Midlands Development Corporation and deliver a regionally significant scheme across Toton and Chetwynd innovation district (HS2 Hub station), Ratcliffe-on-Soar power station into ZERO, a global research centre that will develop real-world low-emission technologies, and East Midlands Airport, aiming to be the centrepiece of an inland freeport that will provide regional businesses with a lower-cost gateway to international trade post-Brexit.	East Midlands Development Corporation (EMDC) and Midlands Engine	Business case for three-year interim vehicle to be submitted to government at end of March 2021.	Grant	Not yet confirmed.

Local funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to clean growth	Alignment to economic growth	Funding Pot Size
DE- Carbonise Project (Derby and Derbyshire)	Small scale fund so limited in reach but could help SMEs in Derby and Derbyshire to adopt hydrogen technologies e.g. hydrogen boilers.				
Towns Fund *(Towns in D2N2 region include: Clay Cross, Long Eaton, Kirkby & Sutton-in-Ashfield, Mansfield,, Newark-on-Trent, Stapleford, Staveley)*	Although the fund's focus is not exclusively on clean growth, there is a encouragement for Towns to develop schemes which support the government's clean growth agenda. Clay Cross specifically has a very strong clean growth angle to their Town Investment Plan (TIP), and seeks to become an exemplar community for clean growth adaptation. Within their TIP, which was recently awarded £24.1m, they have included a proposal for a feasibility study for a low carbon energy network for the town, exploring ground source heat, hydrogen ready technology and a local network. Additionally, Worcester Bosch's factory is located in Clay Cross employing 300 people, are a represented on the Town Deal Board. The firm is at the forefront of new hydrogen technologies and is exploring a skills hub in Clay Cross to upskill workers on this.				
Transforming Cities Fund	Derby and Nottingham have received £161m for transport improvements, which focus on four main areas: city centre connectivity, better connecting Derby, Nottingham and EMA, and Nottingham and Derby growth corridors. There is no mention of any specific hydrogen schemes, however, there are many interventions focused on expanding the rapid electric charge point network and establishing a mass transit link across Derby by providing a high-quality electric Rapid Transit (eRT) route. The potential of hydrogen within this solution needs to be explored further.				

Local funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to clean growth	Alignment to economic growth	Funding Pot Size
Future Mobility Zone funding	Derby-Nottingham secured £16.7m across three packages. Packages A and B are focused on the creation of a data sharing platform to improve knowledge of mobility habits and spending and does not relate to hydrogen in any way. Package C will develop and pilot new e-mobility hubs that exploit the area's rapid rollout of EV charging and Ultra Low Emission Vehicle (ULEV) support services. Physical hubs (depots of the future) will be trialled across Enterprise Zones and employment growth sites, university campuses, in residential communities, and at council vehicle depots across Nottingham. The depots will focus on supporting both electric and hydrogen vehicles. To complement the work in Nottingham, Derby plan to focus on hydrogen fuel trials as a key part of their depot linked to a fleet of hydrogen vehicles (secured from Toyota) alongside learning from the deployment of electric vehicles in Nottingham.				
East Midlands Development Corporation	The EMDC is a major investment proposal for the region, and in particular the plans for ZERO – a zero carbon technology and energy hub – will bring great focus and investment to the region focused on innovative energy technology, with great potential to include hydrogen as part of this. Although the £235m investment being negotiated with government is focused on the infrastructure to unlock development, the Dev Co is likely to attract significant associated investment over the next decade that could be capitalised upon.				

Research funding

Name of fund	Body	Focus of fund	Applicants	Timescales	Type of funding	Amount of funding
Sustainable Hydrogen Centre for Doctoral Training (SusHY)	SusHy- (collaboration between the Universities of Nottingham, Loughborough, Birmingham and Ulster)	The Sustainable Hydrogen Centre has four overarching centre objectives. 1) To Deliver high quality transdisciplinary training, covering fundamental science, applied engineering, and systems issues and build an appreciation of societal barriers to innovation. 2) Through innovation opportunities, build initiative and stimulate an entrepreneurial mind-set. 3) Deliver "industry ready" doctorates who have a comprehensive skill set and experiences. 4) Co-create research ideas and undertake in partnership with our stakeholders, cutting edge investigations of hydrogen-based solutions to deep decarbonisation of the energy system.	Postgraduate Students	4 year programme	Grant	Students also receive a stipend of £16,909 per year, their tuition fees fully paid for, and a research budget to enable them to direct their research.
Energy Research Accelerator	BEIS & Innovate UK	Established in 2016 as the UK's first cross disciplinary energy research hub, the Energy Research Accelerator (ERA) brings together 1,400 researchers in eight internationally-recognised research universities from the Midlands region, including Nottingham and British Geological Survey. ERA has recently set out plans for a new phase of investment (ERA-2), over five years from 2020. It sets out six big ideas for the next research programme: 1) energy storage 2) decarbonising heat 3) data, digital and informatics 4) alternative fuels 5) integrating resource recovery within energy production 5) low carbon transport. Hydrogen-based solutions and support for a regional hydrogen economy are strongly featured in the proposal.	LEPs, Research Partners, Universities	2020-2025	Grant	Initial funding was £60million (2016-2020), with £120million match funding from universities and private sector. ERA is asking for £250 million of regional investment over five years to support energy innovation and deployment.

Local funding

Name of fund	Analysis	Alignment to hydrogen	Alignment to clean growth	Alignment to economic growth	Funding Pot Size
Sustainable Hydrogen Centre for Doctoral Training (SusHY)	This integrated PhD programme will deliver 15 doctoral level leaders each year, with a trans-disciplinary understanding of the science and engineering limits of hydrogen technologies, along with an appreciation of the barriers to the market (including legislative, economic and societal). The Universities of Nottingham, Loughborough, Birmingham and Ulster have a strong track record of outstanding research into hydrogen technologies. For example, the Hydrogen Systems Test Bed, funded by the Energy Research Accelerator and hosted at the University of Nottingham, is the largest academic hydrogen research lab in the UK and will be used to investigate hydrogen production, storage and utilisation technologies.				
Energy Research Accelerator	The ERA's next phase of its research programme is well aligned to potential hydrogen projects, with a focus on energy storage, decarbonising heat, alternative fuels, low carbon transport and resource recovery within energy production. Equally, there is explicit support for a hydrogen economy in the region.				

National funding

Lastly, there are potential private funding route options, which can provide important contributions as sole investors or through match funding proposals.

D2N2 has numerous private sector companies that could be likely to generate hydrogen related investment, with circa 1900 companies identified in the region's low carbon and environmental goods and services (LCEGS) sector in 2019/20. Additionally, alternative fuels were identified as one of five main sub-sectors within D2N2's LCEGS sector, generating £770m of sales1.

Given the potential of hydrogen across the supply chain, the following diagram outlines the types of companies prevalent in the D2N2 region that could potentially generate private investment in the future:

- Institutional bodies e.g. Health and Safety Executive, BGS, Universities
- Fuel Cell Manufacturers
- Energy Companies
- Cement and Aggregates
- Boiler Manufacturers
- Transport Equipment Manufacturers
- Automotive Companies
- Airports and Logistics Companies
- Housebuilders

[1] Derby, Derbyshire, Nottingham, Nottinghamshire (D2N2) LEP Low Carbon Environmental Goods and Services Market Snapshot Midlands Energy Hub 2017/18 to 2019/20

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Appendix K

Sites Information Capture

Ratcliffe Power Station

A 2GW coal fired power station site owned and operated by Uniper

- 273 hectares available as coal generation ends by 2025
- Power station supply capacity of 2 million homes
- Uniper Technology Services provides skills training and specialist engineering support
- Supports 1000's of high skilled jobs in the region.

Opportunities

- Power station must close by 2025 so an inherent need to repurpose
- Large plot which could form an industrial island and allow growth of production with demand anywhere from 20MW up to 100MW
- Large grid connection: 2500 MW
- Large water extraction licence
- Great transport links: rail, air, road
- East Midlands Airport nearby.
- Within logistics golden triangle – Segro and Pegasus. Potential growth in demand for hydrogen HGVs.
- Freeport bid success would kick start inward investment
- Engineering academy already exists - could host skills, engineering and R&D services. Currently in discussion with 5 universities.
- Emerge project – seeking planning permission for a heat and power energy recovery centre

Constraints

- Low heat/energy demand from neighbours
- Scale up is required to unlock a viable project and benefit from economies of scale (cost/kg)
- Policy still being developed to develop market. Industrial clusters are beginning to gain traction in this.
- Transport is potentially the early mover – forklifts/trains. Vehicles don't currently exist but this will improve over next few years.
- Ratcliffe doesn't have the same demand density as the Humber cluster. A lot of interest but still a need for policy and support.

Summary of Potential

- Size, location and existing infrastructure availability makes it an ideal site for production of hydrogen and future fuels as well as training and R&D facilities.
- Collaboration is required for developing hydrogen opportunity on site. A freeport would accelerate this.
- Timing is key – Site must start planning for the market ahead of need.

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D
HIGH POTENTIAL SITE			

Burnaston Refuelling Station

Currently a Shell fuelling station for conventional fuels.

- Located next to A38/A50 and nearby Toyota factory.
- ITM Power plan to install a standalone electrolyser which will be capable of producing enough hydrogen to fuel 60 cars a day.

Opportunities

- High traffic of vehicles in the area
- Near to Toyota factory. Toyota produces Mirai hydrogen vehicle which requires 6.5kg hydrogen daily.
- Now installing latest generation electrolyser with 270kg/day capacity
- Approximately 60 cars can be refuelled daily
- Ability to refuel MCP cylinders with high purity hydrogen – small scale industrial use
- Able to supply high purity hydrogen
- Situated near to decommissioned Willington Power Station site which could be a future opportunity to expand production and fuelling operations.
- Accessible for cars and medium sized trucks/vans

Constraints

- There are some site utility issues still to be resolved
- Lack of compressor manufactures in UK; parts and engineers must be supplied from Austria. This has caused delays due to Covid-19 restrictions.
- Will not be accessible to HGVs

Summary of Potential

- Can provide hydrogen for cars, mid-sized trucks and small industry uses.
- Lack of UK compressor technology currently a major barrier.
- Due to Covid-19, installation could take a year or more
- For a successful business case development at scale is critical

ITM Power modular hydrogen fuelling station

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D
STRATEGIC REGIONAL CATALYST			

Willington Power Station

Currently
Located next to a refuelling station as well as the Toyota production facility, a largely brownfield former coal fired power station site ripe for new investment

Opportunities

- Very well located near to Burnaston hydrogen fuelling opportunity, Toyota site, East Midlands Freeport opportunity and golden logistics triangle
- Power station infrastructure still exists – substation for electrical supply and water source
- Located next to main A50 and A38
- Adjacent rail infrastructure means site could import or export hydrogen by rail.

Constraints

- Current ownership not clear – sold to an American organisation in 2019. formerly owned by Calon Energy
- Cooling towers still exist on site which may need to be removed
- Road access to the site is complex with current layout
- Not connected to the gas network

Summary of Potential

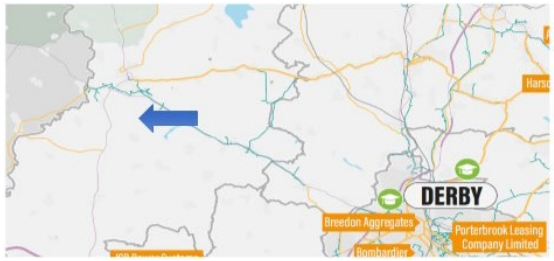
- Huge potential for development for hydrogen as a green energy hub, including hydrogen production, onsite renewables and green manufacturing.
- Location makes it a very strong untapped opportunity for green growth

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D
HIGH POTENTIAL BROWNFIELD SITE			

PEAK Resort on Birchall Estate

300-acre Birchall Estate near Unstone

PEAK is one of the country's biggest leisure developments taking place on the outskirts of Chesterfield.
Could potentially host a hydrogen production facility to provide low carbon heat and transport



Opportunities

- Large site could host production facility
- International scale gateway for the Peak District.
- Planned transport hub, hotels and leisure facilities.
- Mixed use development could allow for a heat network powered by H2.
- Now linked to A61 which has 11 million vehicle movements annually
- Adjacent road has 4 million vehicle movements annually

Constraints

- Site needs to prioritise its purpose as a leisure not an industrial facility.

Summary of Potential

- Planned transport system to the resort and into the Peak district could be hydrogen fuelled.
- Old inadequate electrical and gas infrastructure creates opportunity to develop new systems.

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D
POTENTIAL EARLY ADOPTER			

Confidential Site, Derby

A confidential site located within Derby and well positioned to serve as a production and transport hub for the city and its fleets

Opportunities

- City council looking to re-site existing vehicle fleet depot –which includes 40 refuse trucks
- In proximity of waste recycling plant, waste water treatment and incinerator
- Close to privately owned and public fleets of buses and other vehicles
- Council also has some control over approximately 500 taxi vehicles
- Nearby commercial and council owned residential heating opportunities
- Water source nearby for extraction for electrolysis

Constraints

- Inner city site so must assess traffic and access issues
- Land characteristics currently unknown

Summary of Potential

- Well placed city site central to numerous complementary industries and businesses
- Strong opportunity to become a green hub with multiple uses such as a hydrogen production facility, refuelling station, back to base fleet location or park and ride
- Could potentially allow for hydrogen for heating scheme to nearby social housing
- Next step requires industry involvement to understand the art of the possible

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D
HIGH POTENTIAL SITE			

Other regional assets

Drakelow Power Station

Potential for hydrogen production from waste and/or for waste vehicles

- A series of three now decommissioned and demolished coal-fired power stations
- Now a brownfield site ready for development
- In May 2020 Vital Energi signed a major contract to develop a new energy-from-waste facility on the site with construction of the facility scheduled to be completed by 2023 and Vital Energi having a 30-year concession to operate it, with the owners EON offering a 33 year lease.
- Drakelow is 10km from the village of Alrewas which is the NTS gas offtake point and potential site for hydrogen blending which could add to the business case for hydrogen production at Drakelow.

SITE SCORE - RAG

Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

HIGH POTENTIAL SITE

West Burton Power Station

Potential for renewable generation and hydrogen production

- West Burton A is a coal-fired power station, expected to close before 2025, West Burton B is a gas fired power station, commissioned in 2013. The station is fed by a 24" gas pipeline from Gainsborough
- Options to decarbonise gas power generation includes post combustion carbon capture with a carbon dioxide pipeline to the Humber region then offshore, or alternatively site could be powered by hydrogen supplied via a repurposed gas network.
- in 2020 EDF secured DCO for a further 300MW gas fired power at the site (West Burton C) this is currently on hold due to market conditions.
- EDF are exploring internally battery storage, renewables such as wind and solar, hydrogen development and waste to energy.

SITE SCORE - RAG

Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

HIGH POTENTIAL SITE

Staythorpe Power Station

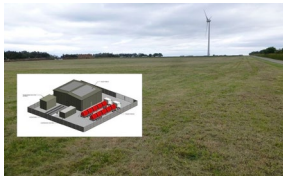
Potential for hydrogen production

- 1,735 MWe CCGT power station that runs natural gas
- Owned by RWE npower
- Once the other coal power stations in the region close, Staythorpe will be the largest point source carbon emission site in the region.
- Options to decarbonise gas power generation includes post combustion carbon capture with a carbon dioxide pipeline to the Humber region then offshore, or alternatively site could be powered by hydrogen supplied via a repurposed gas network.

SITE SCORE - RAG

Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

HIGH POTENTIAL SITE



Featherstone Farm

Potential for hydrogen for rural and agricultural use

- Strawson own 1000 acres in total
- Full planning permission has been approved for 50MWe and 3.2MWe solar farm and 1.5MW electrolyser for mostly own use. The development includes the installation of a 1.25 megawatt electrolyser adjacent to where solar farms and an 800kWwind turbine are already located.
- Once generated, the fuel from the scheme can be taken for use off-site or used to power farm vehicles. Looking for demand and supply opportunities.
- Planning permission for electrolyser given in 2020.

SITE SCORE - RAG

Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

MEDIUM POTENTIAL SITE

Other regional assets

East Midlands Freeport

Promises to develop and drive innovation, alternative energy sources and green technology

- Brings significant investment and 60,000 new skilled jobs to the region
- Based around the East Midlands Airport and Gateway Industrial Cluster, Uniper's Ratcliffe-on-Soar power station and East Midlands Intermodal Park in South Derbyshire
- The successful bid will deliver a inland Freeport at the heart of the UK with strong rail connectivity to all UK ports.
- Freeport will support SME's and large regional employers, including Rolls-Royce, Toyota, and Alstom (formerly Bombardier).
- The East Midlands Freeport bid was submitted by a consortium led by the LEP, private sector businesses and local authorities, with support from universities, business groups, local MP's and the proposed East Midlands Development Corporation.

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

HIGH POTENTIAL PROJECT

SmartParc

Plans for 155-acre high-tech food manufacturing campus in Derby which could create 5,000 jobs.

- Planning application submitted for development on the former Celanese chemical plant site near Spondon.
- £300 million, 1.8 million sq ft facility could provide manufacturing facilities, start-up units and a potential location for a Food Manufacturing Technology Centre of Excellence.
- D2N2 LEP supporting a £12 million grant -Government's Getting Building Fund
- Ambitions to develop highly integrated heating system potentially fuelled via on-site hydrogen production

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

HIGH POTENTIAL SITE

Hope Valley Cement Works

Significant emission site, with a challenging decarbonisation profile

- UK's largest cement plant located within a National Park
- 1.5 Mt/a capacity plant, providing ~£60M GVA
- Good rail network access, >1 Mt/a by rail
- Good relations with local stakeholders
- Planning permission for renewable energy or carbon capture pipelines are challenging.
- 200 employees, 50% living in the Peak District
- Hydrogen with biomass could be used to decarbonise 30% of its emissions, subject to outcome of national trials.

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

MEDIUM POTENTIAL SITE

Tunstead Lime Works

Significant emission site, with a challenging decarbonisation profile

- Large carbon emitter – 257ktCO2/yr (2016)
- Extracting between five and six million tonnes of limestone per annum in Buxton
- Better potential renewable generation for hydrogen supply being outside of national park
- Similar challenges to Hope Valley.

SITE SCORE - RAG			
Emissions Reduction	Green Growth	Hydrogen Jobs	Skills & R&D

MEDIUM POTENTIAL SITE