Doncaster Hydrogen Hub Feasibility Study

15 September 2022 updated 17 October 2022

UK Government

This project is funded by the UK Government through the Community Renewal Fund.

Beta Technology Ltd
Barclay Court, Heavens Walk, Doncaster Carr, Doncaster, DN4 5HZ, UK
+44 (0)1302 322633 info@betatechnology.co.uk

Doncaster Hydrogen Hub Feasibility Study

Proposal / Report submitted to:

Alex Dochery

Investment Team Manager

Business Doncaster

Economy and Environment

Doncaster Council

Alex.Dochery@doncaster.gov.uk

Prepared by:

Richard Wrigley

Approved by:

Jayne Evans

Contact:

Richard Wrigley

Beta Technology Ltd

Barclay Court

Doncaster Carr

Doncaster

DN4 5HZ, UK

Contents

Section 1: Feasibility Study

1 Executive Summary

This feasibility study has examined in depth the opportunity for Doncaster to be a leading borough for the hydrogen economy through the establishment of a hydrogen refuelling hub for large and off-road vehicles.

Doncaster's prime location in the UK's logistics network lends itself as an early adopter of hydrogen technology to deliver zero road transport tailpipe emissions (CO_2 and particulates) for heavier and specialised vehicles. Passenger vehicles and light vans have been transitioning at an ever-increasing pace towards hybrid and battery electric. Heavy Goods Vehicles (HGVs), buses (to some extent) and some off-road vehicles such as reach stackers do not lend themselves to easy electrification. There will be a mixture of energy solutions depending on application.

As with any new technology, and in this case fuel source, there is the issue of having the infrastructure to help create and support demand, but there is difficulty in establishing the infrastructure without the demand to justify the investment. The business models for the supply generation and supply of hydrogen are developing.

UK government is stimulating the technology development and the infrastructure and vehicle trials that will help bridge this potential impasse. Doncaster is in a position to learn from very early installations and then be part of the lead for the growth in maturity of the technology and understanding, thereby positioning Doncaster to carve a hydrogen eco-system in support of transport and logistics.

The following diagram, Figure 1, illustrates the scope of the feasibility study:

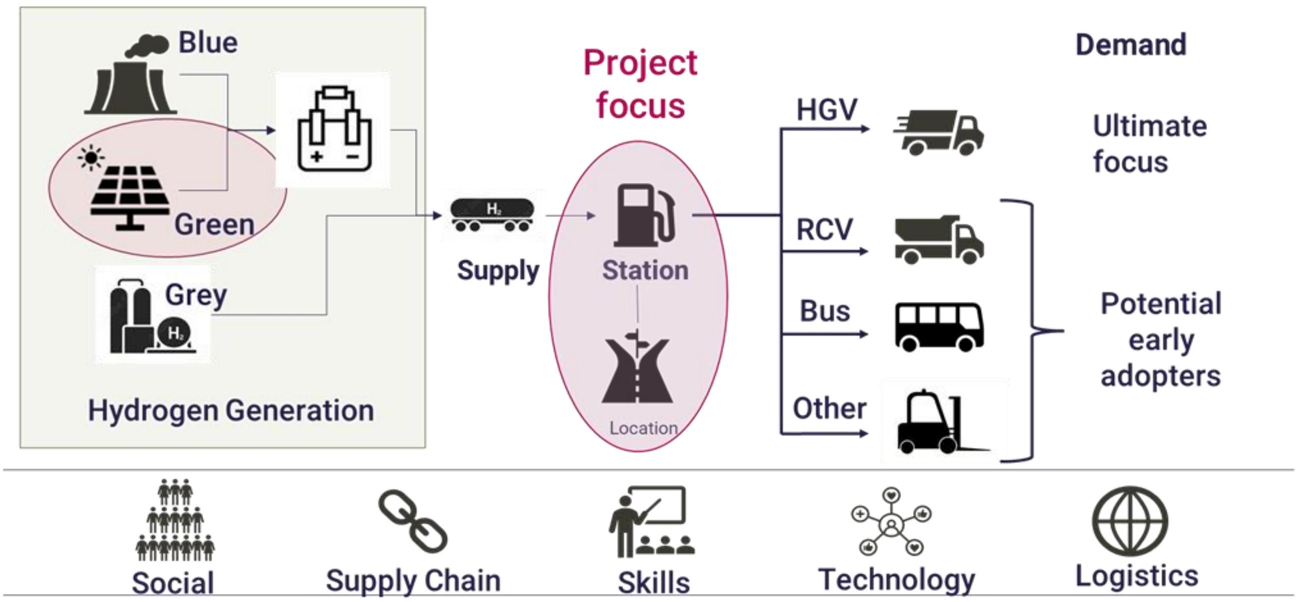

Figure1: Feasibility Study Scope

The main findings from the study:

1.1 National Policy

The UK and international goal to move to net zero emission transport by 2050 is necessitating the complete move away from fossil fuels to electricity, hydrogen and other alternatives. For heavy goods vehicles, buses and aircraft hydrogen may become the dominant energy source by 2050[1]. It is anticipated that >99% of cars and vans and 50% of HGVs and buses will be battery electric powered. The Innovate UK report predicts that by 2025 1% (4,000 vehicles) of HGVs in the UK will be powered by hydrogen and that by 2030 this will increase to 7% (28,000 vehicles). Hydrogen is also predicted to be the major energy vector for air transport accounting for upto 25%.

UK national policy is that by 2040 no new diesel HGVs will be sold and no new diesel buses will be sold, probably sometime between 2025 and 2030 although this has not been agreed by government. There needs to be an energy solution for heavier vehicles, particularly long distance lorries.

1.2 Doncaster's Location within the UK Hydrogen activity

Doncaster, within South Yorkshire, sits in the centre of developing hydrogen centres in the North East, Humber, West Midlands and North West. The opportunity to fill this gap will encourage initial fleet and vehicle trials that pass between the centres to refuel as well as those fleets that start or end in Doncaster to trial and then ultimately use hydrogen.

1.3 Demand

There is the potential for significant demand because of the concentration of HGVs in and around the borough and travelling through on the main trunk network. There are significant logistics centres in the borough such as at Redhouse and iPort and these provide potentials for locating nearby hydrogen refuelling. The study has investigated a number of transport related potential users of hydrogen including hauliers; reach stackers (as used at iPort Rail), refuse collection vehicles, buses and ambulances. Other potential users include inward investors locating manufacturing in the region associated with air transport. **The conservative daily estimate for demand is 700kg of hydrogen in 2025 rising to 4,700kg in 2035 based on a survey conducted.**

1.4 Vehicle Availability

Hydrogen powered HGV vehicles are in the development phase and there is a mixture of bespoke designs, conversions and early OEM products. Hydrogen fuel cell buses are the most developed with two manufacturers offering products and with about 60 in service. There are several Refuse Collection Vehicles (RCVs) in operation in dual fuel and hydrogen fuel cell formats. For materials handling, such as forklift trucks, there is widespread use of hydrogen particularly in the US.

HGV manufacturers have been very focussed on electric versions, but for the heavier format over 26 tonnes, then hydrogen is most likely to be the format. There are currently two manufacturers of hydrogen HGVs with most OEMs developing their own ready for deployment later in the decade. There

[1] Innovate UK: UK Transport Vision 2050: investing in the future of mobility

are UK manufacturers of hydrogen range extended battery electric HGVs below 26 tonne and this may provide a useful route to hydrogen for some end-users.

1.5 Refuelling Hub

Doncaster has several logistics centres in close proximity to the motorway network (A1M, M18, M62). These provide ideal locations for refuelling. Doncaster has development land availability that could be used for hydrogen production and dispensing, and for the generation of green electricity to supply the hydrogen generators.

Figure 2 below illustrates the main parts of a refuelling hub:

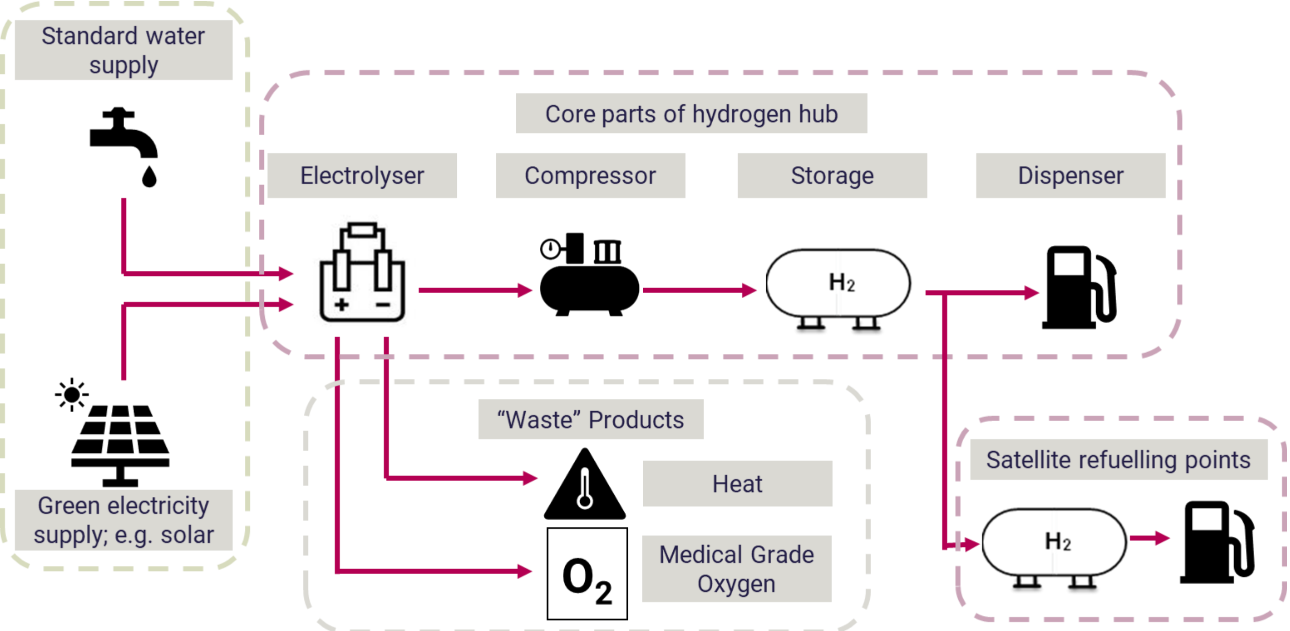

Figure 2: Illustration of a refuelling hub.

The feasibility study concludes that an initial 2MW electrolyser, capable of providing 900kg of hydrogen per day is the base case, and that this has the opportunity to scale in size to 11MW by 2030. Each electrolyser module is 1MW and produces about 450kg of hydrogen per day.

An estimate for the CAPEX cost for a 1MW electrolyser installation is £3.18 million.

A cost model was developed to understand the potential price of hydrogen produced. This resulted in a figure of £5.26 per kg of hydrogen. To compete with diesel the price per kg would need to be about £5.50 per kg. (This only refers to the fuel cost and not the cost of vehicles.) This model does have dependency of the price of electricity.

1.6 Existing Hydrogen Infrastructure

Doncaster is home to one of the leading developers and producers of hydrogen electrolysers, CPH2. Sheffield also has ITM Power/ Motive Fuels the leading UK supplier of electrolysers. This concentration does provide the opportunity to provide a showcase for the region's technology capability, attract a supporting supply chain, and enable inward investment in industries that use hydrogen.

1.7 Skills

Doncaster has a strong skills base with Doncaster College and Doncaster UTC to help skills development to support new areas of technology such as hydrogen. The National College for Advanced Transport and Infrastructure and its ownership by Birmingham University provides additional skills and knowledge development. The proximity of the University of Sheffield and the prospective additional location of an AMRC in Doncaster enable technology innovation and deployment.

1.8 Public Perception

There is low public awareness of hydrogen technology in general, although this has increased over the past decade, and varies across technology applications. Acceptance increases when it is associated with economic benefit and trusted users, such as Local Authorities are engaged with the technology.

1.9 Options for Doncaster

1.9.1 Do nothing

- Let the market fill the hydrogen supply when it feels appropriate, which is unlikely to gain Doncaster any advantage;
- Depending on timing it may slow the adoption of hydrogen as a zero emission fuel by hauliers in the borough;
- Much less likely to attract inward investment around hydrogen.

1.9.2 Support the development of a hydrogen refuelling hub

- Will enable Doncaster to gain early access to green hydrogen for transport applications. Probably accelerate the local uptake of hydrogen vehicles and therefore improve air quality. Additional support required to aid businesses to purchase equipment and to understand the opportunity;
- May support the development of local equipment and skills.

1.9.3 Proactively develop a hydrogen eco-system

- Enables Doncaster users to gain early access to hydrogen;
- Develops local equipment supply chain and local skills base;
- Develops a range of hydrogen users over time and creates a hydrogen eco-system;
- Provide an inward investment opportunity to attract hydrogen related businesses.

1.10 Funding

- Infrastructure

  Interest is developing with private investors around green energy infrastructure including hydrogen. The development of the existing hydrogen refuelling stations has involved detailed and complex arrangements to support the funding of the constituent elements of a refuelling station: land, electricity supply, hydrogen production, storage and supply equipment.

- End-User Vehicles

  As with early electric vehicles there is a considerable premium for the purchase of hydrogen fuelled vehicles. The life costs are still to be understood and only part of this is ensuring that the price of hydrogen is comparable with that of diesel for similar energy content. To help develop the demand, incentives will be required and have already been implemented for buses. HGVs are still in their infancy of availability but in order to meet the target of 2040 with no new HGV diesel sales then the UK fleet will need to start converting to emission free fuels. Early adopters will need encouragement to purchase and run these vehicles. This will in turn attract OEM truck manufacturers to progress right hand drive hydrogen or hybrid hydrogen vehicles, which will ultimately bring down prices.

  End-users will also require confidence that their vehicles can be maintained at reasonable cost and in a timely manner.

1.11 Roadmap

The following outlines the destination for the Doncaster Hydrogen opportunity:

- Catalyst for the establishment of early adopter users of hydrogen for transport related applications;
- A stepping stone towards supporting the widespread use of hydrogen by HGVs;
- Development of the business model for a hub and spoke arrangement for hydrogen production and dispensing;
- Green production of hydrogen for transport use;
- Catalyst for skills development and graduate retention;
- Support economic opportunities and investment opportunities;
- Help support the development of low carbon businesses;
- Form part of the decarbonisation of Doncaster and an improvement in air quality;
- Potential to incorporate a demonstration and learning centre activity for the region's hydrogen capability.

Figure 3 below provides an illustration of the overall roadmap for hydrogen in Doncaster.

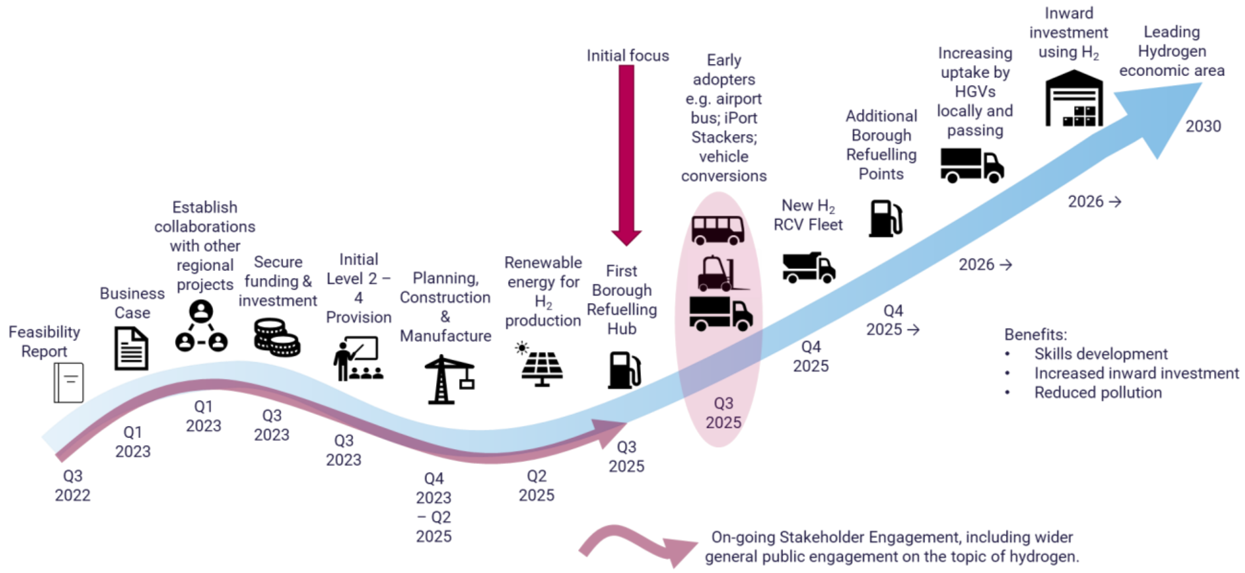

Figure 3: Overview Roadmap

1.12 Implementation Plan

The council needs to determine which of the options, outlined in 1.8, above it will support or stimulate. The following implementation plan is based on the option to proactively stimulate a hydrogen eco-system.

The following are the proposed main streams of activity:

- Profile

  Raise the profile of the hydrogen opportunity in Doncaster and South Yorkshire through 6 monthly events to bring together the spectrum of stakeholders. Perhaps create an identifiable group, such as *Doncaster Hydrogen*, to act as a focus for activity. Doncaster should engage with the regional hydrogen clusters and hydrogen pipeline projects.

- Skills

  Work with the local colleges to develop hydrogen supporting modules to be added to existing training courses around the manufacture, installation and maintenance of hydrogen infrastructure and vehicles. Initial course modules to be available from September 2023 that can support existing regional businesses to grow.

- Land availability

  Determine appropriate pockets of land by the end of Q4 2022 that could be used to site the scalable hydrogen hub and one or more dispensers.

- Hub design

  A detailed design brief for a scalable hub starting at 2MW capacity and rising to 11MW by 2030, and remote dispensers to be developed. The hub design would develop the basis of a business case to help support inward investment.

- Securing Demand

  The support for infrastructure will be dependent on securing the demand commitment in the early stages. The range of potential users consulted by this study will need to be revisited to establish their timeline, requirements and investment needs in order to be able to commit to the operation of hydrogen fuelled vehicles.

- Investment and funding
  To date funding of these projects has been complex requiring coordination by Local Authorities to bring projects into existence. A business case needs to be developed by the end of Q1 2023 to enable the opportunity to be raised with the investment community from Q1 2023.

- Incentives

  The council should work at a regional and national level to develop incentives for end-users to trial hydrogen vehicles. On-going from Q4 2022.

- Supply chain

  Work with CPH2 and ITM Power to understand their supply chain needs and how the borough and region can support.

- Visitors / Technology Demonstration Centre

  There is an opportunity to develop a visitors/demonstration/training centre alongside the hydrogen hub.

- Wider uses
  This feasibility study has concentrated on heavy commercial transport. There are potentially other transport users including rail and air. Exploring this in a widened feasibility study would add to the demand profile.

2 Hydrogen Policy and National Context

The following provides a summary of the Policy and National Context. More detail is provided in the report produced by Cenex in Annex 1.

2.1 UK National Policy Drivers

The current UK Government has demonstrated a strong commitment to hydrogen as a means of meeting environmental policy goals related to the transition to net zero, as well as economic policy related to promoting economic growth and industrial regeneration in the UK regions (the so called 'levelling up' agenda). In 2021, the UK Government published a series of strategy documents related to hydrogen with further updates expected during 2022.

The UK Government's *Ten Point Plan for a Green Industrial Revolution* [2]published in November 2020, sets out the climate targets that the UK will follow to achieve a net-zero economy by 2050. This set a target of 5GW of low carbon production by 2030. This has since be updated to 10GW in the *British energy security strategy* [3]published in April 2022. This revised target expects at least half to come from electrolytic hydrogen.

This policy push is being driven by a green growth agenda and sees measures focused on hydrogen production, hydrogen's role in industrial decarbonisation, as well as decarbonising heat and road transport, with particular emphasis on applications that are hard to electrify (such as buses, heavy goods vehicles (HGVs), rail (on rural lines where overhead catenary electrification will not be cost effective)), with aviation and maritime as later applications.

UK Government roadmaps indicate little or no role for hydrogen in passenger cars through to 2050.

In November 2021, the UK government confirmed that the UK will phase out new, non-zero emission heavy goods vehicles weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission (ZE) by 2040.

The current UK Government focus is on the feasibility of hydrogen HGVs for bulk logistics (at 44 tonne truck scale). An additional *£200 million has been announced* [4]to support the demonstration of ZE heavy goods vehicles through a set of multi-year technology trials. These are expected to include hydrogen trucks alongside battery electric trucks and electric road systems. The trials aim to create a market pull for the technologies and to inform policy decisions, before the government sets a clearer direction for UK ZE HGV policy in the mid-2020s.

Innovate UK's Transport Vision [5]forecasts a 100% penetration of ZE HGVs by 2050 and estimates a split of 50% hydrogen and 50% battery electric trucks.

---

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf

3 https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy#hydrogen

4 https://www.gov.uk/government/news/200-million-boost-to-rollout-of-hundreds-more-zero-emission-hgvs

5 https://www.ukri.org/news/innovate-uk-launches-uk-transport-vision-2050/

2.2 UK Regional activity

The role hydrogen can play in green growth for established regional industrial clusters is a key feature of UK policy and market development. These clusters will be critical for hydrogen production in new markets for decarbonisation of heat, power, industrial processes and transport.

In the UK it is commonplace for companies active in hydrogen technologies to work collaboratively within projects defined by regional industrial cluster objectives.

The north east holds the *Tees Valley Multi-Modal Hydrogen Transport Hub* [6] which comprises a set of facilities for the production, storage and distribution of green hydrogen, linked to a network of hydrogen refuelling stations that will service operational trials across transport modes in 2025-2030. This has been kick-started by £3million of government investment.

Humber Zero[7] is a project to decarbonise industry at scale in and around the Immingham area on the south bank of the Humber in North Lincolnshire. It involves hydrogen production and carbon capture utilising new technology. It plans to produce upto 173,000 tonnes of hydrogen each year. This will be initially "blue" hydrogen, that is made from methane from natural gas. The Carbon dioxide by-product will be captured and stored underground. They plan to eventually produce "green" hydrogen which is from renewable sources.

In the North West, the *HyNet*[8] project will enable fossil fuels to be replaced with low carbon hydrogen through upgrades to existing infrastructure and developing new infrastructure. This includes underground pipelines, hydrogen production plants and storage facilities to produce, transport and store low carbon hydrogen across the North West and North Wales. HyNet aims to deliver 80% of the UK's clean power target for transport, industry and homes by 2030.

In the Midlands, the Midlands Engine policy is directed toward supporting the region as a manufacturing centre for hydrogen technologies, covering transport, heat and power generation, rather than a region seeking to be a large-scale hydrogen producer (as in the case of the North East and North West). A notable part of the Midlands Engine strategy is a link to a hydrogen pipeline from the north east of England that is routed through Doncaster. The strategy also highlights the *H2GV-Mids*[9] project that delivered a feasibility study for hydrogen powered fuel cell 44t articulated HGVs in the Midlands. The project identified the necessary components for a trial and the future development and deployment of this technology, from the supply chain through to vehicle development, deployment, and infrastructure requirements. The H2GV-Mids feasibility study has identified a freight test route running from Birmingham to Immingham. This route passes along the M18. There has been some dialogue with the H2GV-Mids project team and Doncaster is not part of their plans for refuelling, however the fact that a route is being proposed could stimulate other users.

---

6 https://www.gov.uk/government/news/uks-first-ever-hydrogen-transport-hub-kick-started-by-3-million-government-investment

7 https://www.humberzero.co.uk/

8 https://hynet.co.uk/

9 https://www.era.ac.uk/H2GVMids

2.3 Regional opportunities for Doncaster

The central positioning of Doncaster between the Tees Valley, Humber, East Midlands and North West, offers opportunities for the region when it comes to the distribution of hydrogen, whether by road, rail or pipeline. See Figure 4 below.

Figure 4: Location of regional hydrogen activities

As hydrogen refuelling stations (HRS) scale in size (as expected to support truck and bus operation) the amounts of hydrogen dispensed will increase and this will require either large-scale on-site electrolyser deployment or high frequency refuelling by road tanker, or pipeline supply. This planning is already underway for energy intensive industry users where tube trailer distribution is not expected to be a practical solution once volumes ramp up.

Industry stakeholders including Cadent Gas and National Grid have been studying the options for hydrogen pipeline networks for regions of the UK.

One of the key considerations for the business case for a pipeline will be the ability to link candidate end users with routing options for a hydrogen pipeline network to be able to match hydrogen supply and demand.

Doncaster is likely to have early access to pipeline hydrogen based on its close proximity to the East Coast Hydrogen project and accounting for the potential for spurs from this pipeline that feed industrial sites.

The potential for hydrogen HGVs would pave the way for hydrogen pipeline spurs to fuel HRS on the strategic road network (A1, M18, M180, M1).

Doncaster should engage with the regional hydrogen clusters and hydrogen pipeline projects and develop a vision of its place in the value chain for supporting the transition to hydrogen transport through the provision of hydrogen refuelling stations, transportation of hydrogen and locations for draw-off from the UK proposed pipeline networks.

There is opportunity to use land in and around Doncaster to establish solar electricity generation that can be used to produce green hydrogen.

3 Refuelling Location

More detail is provided in the supporting report produced by Market Infra in Annex 2.

3.1 Bringing the stakeholders together

As shown by the illustration below (Figure 5), several stakeholders must be brought together to establish a Hydrogen Refuelling Station (HRS). These parties must be brought together to agree the operating model for the HRS – which will be largely determined by site and stakeholder specific considerations. A catalyst should be sought to instigate dialogue between stakeholders (for example, CAPEX for vehicle purchase or HRS build, or on-site renewable electricity generation).

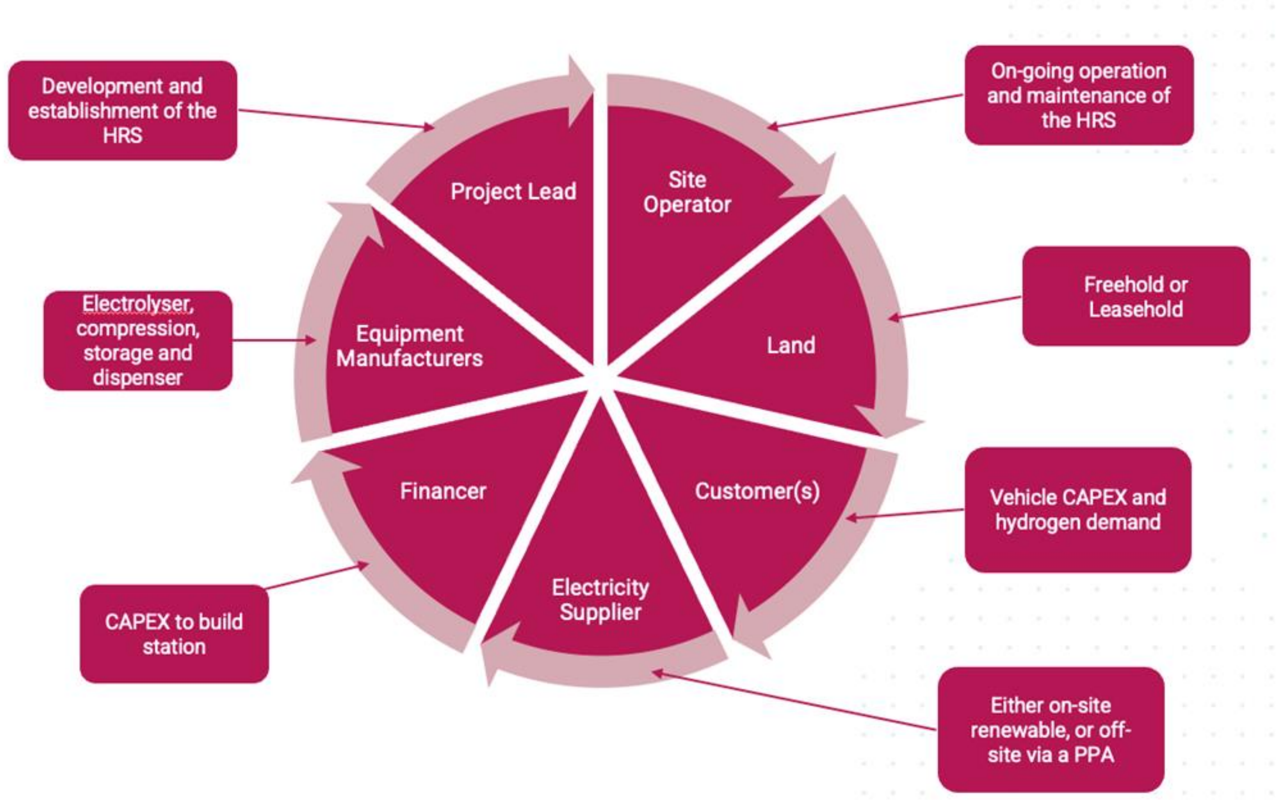

Figure 5: Hydrogen Refuelling Station Stakeholder roles

3.2 The right solution for the right site

At present, there is no 'one size fits all' solution for HRS. Hydrogen Refuelling Stations typically follow one of two operating models:

1. A single site operator who acts as owner, builder, operator and maintainer of the station. The site operator typically invests the CAPEX for site establishment and manufactures much of the equipment themselves (referred to as the 'OBOM' model in this report)

2. A site operator who provides the CAPEX to purchase equipment from the supply chain and engages a provider to manage and maintain the site (referred to as the 'integrator' model in this report)

The UK's existing HRS see considerable variation in how these models are applied in practice, most notably in the contractual and commercial arrangements between the site operator and customers. Consistently applied operating models are still to emerge in this sector, and bespoke models are still being developed on a site-by-site basis.

Examples of finding the 'right solution for the right site' is shown in Table 1 below:

Site	Site Consideration	Possible Catalyst	Solution
DSA Gateway East (Airport)	• Lots of space for a station (including possible 'multi use' and visitor centre) • No capacity for HGVs from off-site site to access the station	• Airport converts its fleet to hydrogen • Doncaster Council secures funding to run a hydrogen bus service between city centre and airport	• Generate hydrogen on site for Airport and bus fleet • Deliver hydrogen to other Doncaster dispenser sites on a 'hub and spoke' model
Micklebring	• Lots of space for a station (including possible 'multi use' and visitor centre) • On site renewable electricity • Potential HGV demand from nearby industrial park and truckstop	• Solar farm owner sees potential demand for hydrogen in Doncaster and invests CAPEX for a HRS	• Generate hydrogen on site • Deliver hydrogen to other Doncaster dispenser sites on a 'hub and spoke' model
iPort and Thorne North	• Limited space for a station • Lots of capacity for HGVs to access the station	• A local hydrogen supply becomes available (from the Airport or Micklebring) which gives confidence to logistics operators to invest in hydrogen HGVs or Logistics Equipment (e.g. warehouse forklifts / stackers)	• Smaller dispenser station on site, with hydrogen delivered from off site (from Airport or Micklebring)

Table 1: Right Solution for the Right Site example

3.3 Costings

A cost model has been developed based on discussions with supply chain companies. The following is very much a budget cost and detailed costings would need to be developed for specific sites and equipment providers. The cost in Table 2 below is for a 1MW installation.

Site Establishment	
Site clearance and hard standing Security fencing DNO Connection (Electricity)	£50,000 £50,000 £50,000
Sub-total	£150,000
Equipment Purchase	
1MW Electrolyser	£1,400,000
Compression, Storage and Dispenser	£1,000,000
Integration / Control Equipment	£100,000
Sub-total	£2,500,000
Project Management and Design	
Project Management	£265,000
Design	£265,000
Sub-total	£530,000
Total CAPEX	£3,180.000

Table 2: Estimate site establishment costs

A figure for the generated price of hydrogen has been developed with a cost model described in Annex 2. This model includes:

- Station productivity
- Unit costs for water and electricity
- Inputs to the station – power and water usage
- Outputs from the station – hydrogen, oxygen and heat
- Site maintenance costs
- CAPEX Repayment
- Land rental

This model generates a cost per kg of hydrogen as **£5.26**

In the current market key input cost influence is from the electricity price. For this model it was assumed to be £0.50 per kWh.

No additional income has been accounted for from the potential sale of the oxygen or heat. The oxygen can for example be used to enhance the efficiency of wastewater treatment works. The heat could be used to heat nearby warehouses or homes.

The costs of the hydrogen production could be further subsidised through the trading of Renewable Transport Fuel Obligations (RFTOs).

3.4 Example 'Hub and Spoke' Model

As part of this study the Climate ER Mere Flats solar farm at Micklebring was identified as a potential site for hydrogen production (and possible location of a HRS). This site has the benefits of being adjacent to a new, low carbon source of electricity (the solar farm) as well as having lower land rental costs compared to other more developed sites along the Strategic Road Network (SRN). Micklebring is close to Junction 1 the M18, meaning that any potential HRS would be well placed to benefit from future "passing trade". Additional land could also be available at Micklebring to accommodate future expansion of hydrogen production.

If hydrogen was produced at Micklebring, transportation and dispenser facilities would be required to move the hydrogen to its point of use (a hub and spoke model).

The map below, Figure 6, shows the Micklebring 'hub' alongside the Doncaster RCV and iPort 'spokes':

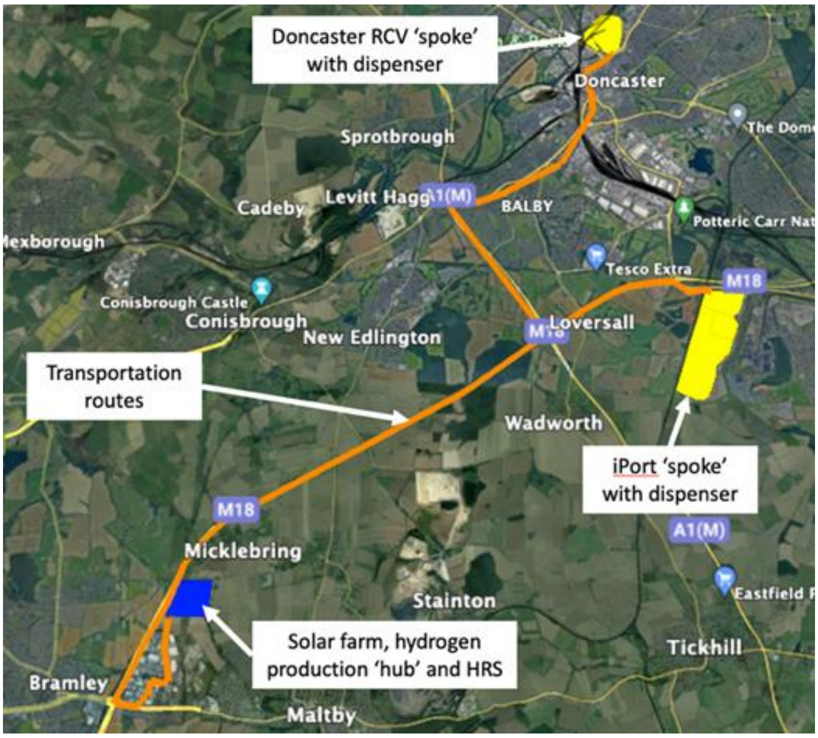

Figure 6: Micklebring site

3.5 Example of a 'Medium' sized site using a 3MW PEM Electrolyser located at Tysley Energy Park, Birmingham

The Tyseley Energy Park[10] is the UK's first multi-fuel, open access, low and zero carbon fuel refuelling station is now open and ready to receive commercial fleet, public transport fleet and private vehicles.

Offering a Hydrogen Refuelling Station, Compressed Natural Gas, Biodiesel and Electrical Vehicle charging options, the unmanned facility is available 24/7 for refuelling with integrated pay at pump options that accept credit, debit and fuel card payments.

Commissioned in 2021, the HRS refuelling station is the largest green hydrogen refuelling station in the UK. It takes power from a dedicated offshore wind turbine and generates zero carbon, fuel cell grade hydrogen. The site comprises of a car refueller operating at both 700 bar and 350 bar, two bus refuellers operating at 350 bar and a tube trailer refueller operating at up to 450 bar. The site can generate over a tonne of hydrogen per day which is enough to fuel up to 40 buses a day.

Hydrogen is produced on site using a 3MW ITM Power Proton Exchange Membrane (PEM) electrolyser, which splits water into hydrogen and oxygen. The hydrogen generated is very high purity, meeting all requirements for Fuel Cell Electric Vehicles (FCEVs). The hydrogen is dispensed at 700bar and 350bar ensuring a very quick and efficient refuel that can provide a 300 to 350-mile range.

The HRS refuels 20 hydrogen double decker busses purchased by Birmingham City Council. The Tyseley Energy Park refuelling station is part of the Birmingham Transport Plan, supporting the introduction and supply of cleaner fuels to improve air quality across the city.

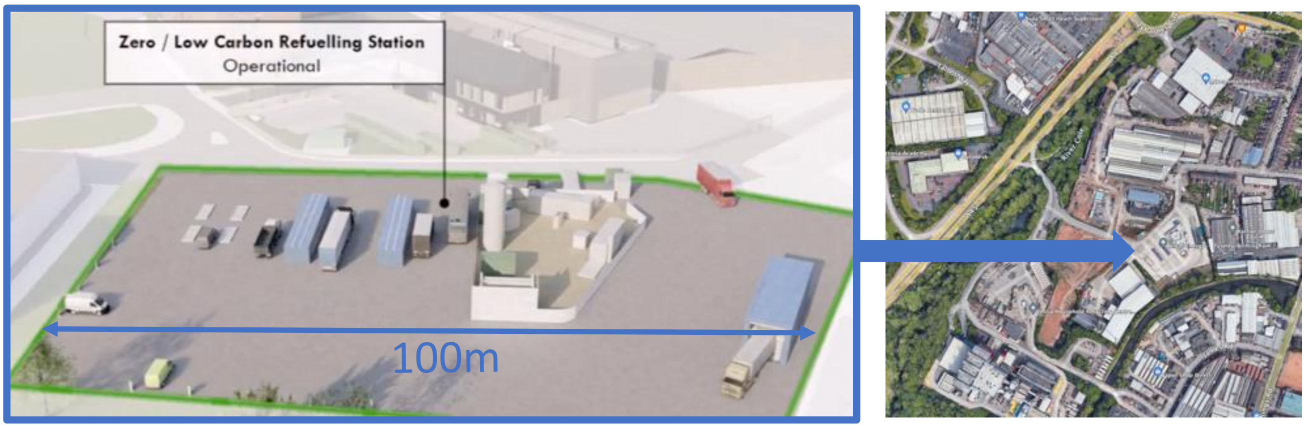

Figure 7: Tyseley refueling site[11]

This refuelling hub has gained £10 million of public and private investment and is part of helping to support the City's reduction in air pollution.

---

[10] https://www.tyseleyenergy.co.uk/
[11] https://www.tyseleyenergy.co.uk/tyseley-refuelling-hub/

3.6 Alignment to Zero Carbon Humber

Zero Carbon Humber aims to create the UK's first net zero carbon industrial region by developing low carbon hydrogen (H2) technology and carbon capture usage and storage (CCS or CCUS), supported by a shared regional infrastructure. The establishment of HRS in Doncaster, combined with its location on the SRN and rail links, could make the city a vital component of the UK's emerging hydrogen network.

As such, the future establishment of HRS in Doncaster should be considered alongside alignment to Zero Carbon Humber.

3.7 Potential Role of Doncaster Council

Doncaster Council can play an important role in the establishment of HRS(s) in the area, including:

- Making council owned land available for the initial site(s) to demonstrate the viability of HRS and encourage uptake from private landowners
- Make renewable power generation part of planning requirements for future development sites

4 Local and National Demand

More detail is provided in the report produced by Beta Technology in Annex 3.

The demand activity of the project consisted of the following activities:

- Development of a list of locally based hauliers
- Identify national brands that have logistics operations within the borough
- Develop a survey to be completed by interested organisations
- Hold a haulier Stakeholder roundtable to discuss the project and the opportunities
- Analyse the data provided by the hauliers

4.1 Local demand – through survey and stakeholder engagement

The purpose of the survey was to gain specific data on the current local HGV fleet and its fuel consumption and then translate that into equivalent hydrogen demand. The survey covered the following questions:

- General about the business and its operation
- Types of vehicles, number and mileage
- Typical routes for the vehicles
- Refuelling strategy
- Skills

In total 17 local companies were approached to undertake a survey including haulage companies, companies with their own fleet, bus and coach operators and the Doncaster Council refuse collection service.

Only a small sample responded (3 HGV operators and 1 RCV operator) to the survey but this did provide useful data. The vehicle data, analysed by Cenex, yielded the numbers detailed in Table 3.

Total number of vehicles in the fleets	582	Equivalent hydrogen consumption if all vehicles are converted to hydrogen (kgs)
Total annual mileage (kms)	34,020,000	
Total Large Vans (>3.5t)	31	52,785
Total Rigid Truck 2 axles (7.5t)	20	34,305
Total Rigid Truck (18t)	172	423,751
Total Rigid Truck 3 axles (26t)	41	128,140
Total Rigid Truck 4 axles (32t)	0	0
Total Tractor Unit 4 x 2 (36t)	0	0
Total Tractor Unit 6 x 2 (44t)	189	1,381,260
Total Tractor Unit 6 x 4 (44t)	130	536.953
Total hydrogen if all vehicles were hydrogen (kgs)		2,557,194 per year

Table 3: Demand projected from survey responses

If the focus is to be mainly on 44 tonne HGVs then the numbers are:

319 vehicles with a potential hydrogen usage of 1,918,213 kgs per year which equates to 5,255 kgs per day. This represents about 0.3% of the articulated HGVs in the UK.

The Doncaster Council RCVs, operated by Suez, number 39 Rigid Truck 3 axle 26t for waste collection. These would have an equivalent 122,527 kgs of hydrogen per year.

4.2 National demand created by "passing" HGVs

"Passing" HGVs are those that are using the road network through Doncaster but do not originate or stop within the borough. The main arterial routes of the A1 and M18 were analysed by Cenex to understand the existing flow of HGVs at three points using publicly available statistics. The three locations used were:

- Redhouse
- iPort
- Hatfield

This analysis showed that iPort is the best location due to its proximity to both the A1 and M18.

The daily estimated number of rigid articulated HGVs passing the iPort is 19,983. It could be assumed that 4% of these are hydrogen powered: 800. For a 2MW electrolyser site to be viable then 2.6% (21) of passing hydrogen fuelled trucks would need to stop and refuel with an average refuel of 48kg.

(Note: The analysis referred to publicly available HGV movement data and the *Innovate UK's 'Transport Vision'*[12] roadmap for the growth of hydrogen trucks. This estimates

4,000 articulated H2 HGVs in 2025 (4% of total articulated HGV parc)

24,500 articulated H2 HGVs in 2030 (25% of total articulated HGV parc))

There are a number of assumptions, for example that hydrogen powered HGVs are distributed evenly across the UK; the initial spread of refuelling points will be limited in the UK therefore each station will have a higher volume initially.

4.3 Growth in demand in Doncaster

The analysis of potential "passing trade" and the results from the survey provide a conservative estimate of hydrogen demand as follows:

2025: Daily consumption 698 kg (Would require a 2 MW hydrogen production unit)

2030: Daily consumption 4712kg (Would require a 11MW hydrogen production unit)

The above is based on the following assumptions:

- Only 44tonne HGVs
- The take up of demand from respondents is in line with Innovate UK's Transport Vision document which indicates 1% of 44T HGV in 2025 and 7% in 2030 will use hydrogen. It could be assumed that as early adopters they may increase their fleet quicker and spread to other vehicle sizes in their fleet.
- Refuse Collection Vehicles are included with 2 in 2025 and half the 39 vehicle fleet in 2030.
- Reach Stackers at iPort are included with 1 in 2025 and half the fleet in 2030.
- The demand analysis does not account for other potential users including:
    - Local buses
    - NHS ambulances, who expressed an interest in the project
    - Other local hauliers that will move towards hydrogen
    - National fleets that deliver into Doncaster including Next, Amazon, Ikea, etc

4.4 Other sources of demand

Other stakeholders were consulted about the opportunity and availability of hydrogen in the borough.

1. iPort Rail has already been mentioned as a potential user for their reach stacker fleet. A hydrogen facility at the iPort may encourage other larger tenants of the site to use hydrogen for some of their off-road activities, such as fork-lifts.
2. A discussion was held with a potential aviation inward investor where hydrogen may be an option for certain aspects of their operation.

[12] https://www.ukri.org/news/innovate-uk-launches-uk-transport-vision-2050/

3. Another potential user mentioned but not able to be contacted was Doncaster Sheffield Airport who may have been looking at zero emission fuels for their ground fleet. As there are discussions about the future of the airport on-going then this is probably not an option.
4. Rail is another possible user of hydrogen for use where electric feed is not possible. For rail freight this is still difficult due to the energy demand to start moving a loaded train. Ballard are developing a freight locomotive in Canada. Passenger and possibly light rail freight does have more activity with demonstrators from companies such as Siemens and trials in the West Midlands (Centre for Rail Decarbonisation) with Porterbrook.

5 Vehicle Availability

5.1 Vehicle technology

Three hydrogen technologies have been considered:

- Hydrogen fuel cell, where hydrogen is used to create electricity which is then used in an electric drive train.
- Hydrogen dual fuel vehicle, a bridging technology.
- Hydrogen internal combustion engines (ICEs), which burn pure hydrogen. None have yet been deployed and do not fit with the current UK government policy of zero emissions vehicles.

5.2 Vehicle availability

More detail is provided in the report produced by Cenex in Annex 4.

HGVs

Most of the major truck manufacturers are developing battery electric trucks first with fuel cell variants to follow later this decade, but some series production fuel cell trucks are available (Hyundai; Hyzon) and a number of prototypes have been demonstrated (Daimler; Renault; Scania). In the UK, several municipal fleets have trialled hydrogen dual fuel vehicles.

Buses

Hydrogen fuel cell buses are still a developing technology, but this is the most developed vehicle type, with two manufacturers (Wrightbus; Caetano) offering series production vehicles and 60 in service in the UK.

Refuse Collection Vehicles (RCVs)

Several dual fuel hydrogen RCVs are in service in the UK, with one fuel cell RCV in service and 19 more to follow later this year. Vehicle producers are: Hyzon and Ballard Motive. ULEMCo – undertake vehicle conversions.

Materials handling

Hydrogen fuel cells are a well-established alternative to batteries for electric fork-lifts (and other materials handling vehicles) but are only economically viable in larger fleets with significant economies of scale.

5.3 Hydrogen vehicle cost and maturity

The UK's Advanced Propulsion Centre has produced a roadmap for the development of different propulsion technologies in transport, including hydrogen. This includes:

- Smaller urban HFCVs coming into use in niche applications with very high vehicle utilisation almost immediately;
- Larger, long-range HFCVs in high mileage applications coming into use from around 2025;

It envisages that Hydrogen Fuel Cell Vehicles (HFCVs) won't reach Total Cost of Operation (TCO) parity with Internal Combustion Engine (ICE) or Battery Electric Vehicle (BEV) until around 2040 due to the higher capital cost, higher overall energy requirement and therefore running cost.

HGVs - The UK's ZERFT (Zero Emission Road Freight Trials) funding programme launched a multi-year competition in August 2022[13] that will part fund the demonstration of heavy H2FC trucks in the UK. The demonstration would see vehicles on the road in around 2024 and last until around 2028, after which we may start to see general subsidies to encourage vehicle purchase from the UK government. H2FC road vehicles and refuelling infrastructure for heavy vehicles is currently taking its first steps in market deployment, with mass market adoption not expected to start until at least 2030+.

Buses – Towards the end of the 2020s, it is likely that Fuel Cell Electric Vehicles (FCEVs) will be the technology of choice for coaches and buses that travel long distances with the TCO of these vehicles likely to be competitive with diesel and infrastructure developing throughout the country.

Refuse Collection Vehicles (RCVs) – Trials of H2 refuse collections vehicles have started in the UK and re-power options are available from UK companies. Similar to HGVs, early trials require public funding, vehicles are of low maturity and early commercialisation of the technology is not expected until around 2030.

Materials handling – Electric solutions are now well developed for warehouse materials handling equipment (fork-lifts and other lifting equipment) and port/air-side vehicles (tugs etc.). In some large operations with around 100+ vehicles, the H2 solution can out-compete batteries due to reduced downtime. The requirement for relatively expensive refuelling infrastructure dictates that this is only economic at scale.

[13] https://apply-for-innovation-funding.service.gov.uk/competition/1240/overview/21154276-86f4-46ea-9202-92e0543188b4

6 Skills

More detail is provided in the report produced by Cenex in Annex 1.

The background on skills development for hydrogen technologies reflects the journey being made from technology development through to commercialisation and wider societal adoption.

Phase 1 - The first phase of skills development has focused on leveraging expertise within UK universities and industry in the fundamental research needed to understand and advance the materials science and engineering of fuel cell systems. This phase has a secondary development push linked to the need to scale up the manufacture of components, systems and certified products.

Phase 2 - The second phase of skills development has and will focus on building expertise to deploy, operate and service and maintain fuel cells and hydrogen technologies in end use applications.

6.1 Skill requirements for the deployment of vehicles and stations

The H2FC Supergen Economic Impact report[14] reviewed skills training for a hydrogen economy. The study concluded that workers looking to upgrade their skills to be able to work with hydrogen would not be starting from scratch. Existing skills within industries that involve the handling of gaseous fuels, as well as the manufacture and repair of vehicles, particularly hybrid and electric vehicles, already provide important and highly relevant skills bases for working with hydrogen and hydrogen technologies. From this perspective, in most cases we find that the hydrogen skills need may be more a case of a modular 'upgrade' than of a complete reorientation.

Safety standards and regulation, and availability of training and accreditation programmes are crucial to protect not only public consumers, but also the independent and semi-independent workers such as gas technicians and vehicle mechanics, who will be required to engage with hydrogen and its related technologies.

The most relevant skills opportunities to support the deployment of vehicles and refuelling stations in the Doncaster region are outlined in Table 4 below.

Skill Area	Typical Areas for Skills Development
Hydrogen vehicle and refuelling station awareness	Training for drivers and operational staff who come into contact with hydrogen vehicles and refuelling stations. Basic training for hydrogen awareness may include: an understanding of hydrogen production and supply chains, environmental drivers, safe vehicle operation and refuelling, economical and safe driving, components of H_2 vehicles and refuelling stations, assessing risks, properties of hydrogen as a transport fuel, hazards.

14 https://www.h2fcsupergen.com/

Vehicle servicing and repair	Training for technicians servicing vehicles. Training may include areas highlighted above plus general training on component operation, servicing, replacement and hazard awareness, risk assessment, safe shut down and restart, workshop design/staff storage of hydrogen vehicles.
Fleet planning	Awareness training for fleets and businesses to aid the transition to hydrogen vehicles. Training may include hydrogen vehicle legislation and policy drivers, introduction to hydrogen as a fuel (production, supply), hydrogen vehicle and station types and availability, assessing the case for hydrogen vehicles in fleets, environment, cost and operational performance, hydrogen safety, workshop set up and basic maintenance and skills requirements.
Blended learning	The opportunity for hands on experiences through a demonstration trial development in Doncaster to allow tours around an operational hydrogen refuelling site.
Specialist engineering design skills.	Key companies are CPH2, an electrolyser supplier in Doncaster, and ITM Power in Sheffield. A review of opportunities for hydrogen in the South Yorkshire Region[15] highlighted local skills requirements for ITM Power as they develop Gigafactory production capability. Skills include technical project managers, electrical engineers, system design, integration and controls, chemists (polymer and electro), manufacturing engineers, pressurised system engineers, process automation, field engineers – including those with experience of equipment installation, commissioning and servicing.

Table 4: Hydrogen skills requirement

Key candidates to develop courses to upskill the local industry in servicing and maintaining alternatively fuelled vehicles and infrastructure are **Doncaster College** and the **National College for Advanced Transport & Infrastructure** (NCATI). Both institutions offer practical courses in engineering, with NCATI currently focusing on rail and civil engineering and Doncaster College offering electrical and mechanical engineering and motor vehicle maintenance. The college's North Lindsey site provides HGV training. The college covers the Humber through to Doncaster and is well positioned to link with the Humber hydrogen activity.

---

15 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjw66uei9r3AhUFXcAKHaf5CbEQFnoECAMQAQ&url=https%3A%2F%2Fwww.shu.ac.uk%2F-%2Fmedia%2Fhome%2Fresearch%2Fcresr%2Freports%2Fs%2Fsector-summary-hydrogen.pdf&usg=AOvVaw0xZ9hbFc7kumzI7lr42GJI

Doncaster University Technical College (UTC) is developing a strong reputation for 13 – 18 year olds in technical and scientific subjects. The UTC is keen to support new technologies to help attract young people into technical subjects such as hydrogen.

As shown previously, a consolidated regional approach to developing hydrogen cluster activity is a successful method of creating investment, jobs, skills development and opportunities. Whilst there is potential to develop courses for hydrogen at the Doncaster colleges is clear and appears to build on the existing skills sets, the South Yorkshire Mayoral Combined Authority should take a leading role in developing a regional hydrogen strategy.

NCATI is owned by the **University of Birmingham** and therefore provides a direct link to the university's activities in hydrogen. These include involvement in the Tyseley Energy Park and a joint activity with Siemens Mobility on rail research that includes hydrogen.

The **University of Sheffield** has a Chief Engineer Hydrogen in the Advanced Manufacturing Research Centre (AMRC). They have interests in all aspects of hydrogen including hydrogen for aircraft and airport operations. The AMRC is considering establishing a site at the Gateway East development which will enable further close links with the university to be developed.

Doncaster is connected to a range of skills and knowledge development links that would be able to support a hydrogen eco-system in the borough and South Yorkshire.

6.2 Examples of UK Regional Training Activity

Table 5 illustrates two examples of skills development in support of hydrogen.

Midlands
In the Midlands, the key initiative that has supported skills for technology development has been the EPSRC funded Centres for Doctoral Training (CDT) for hydrogen. These have been collaborations between the Universities of Nottingham, Loughborough, Birmingham and Ulster. The latest Sustainable Hydrogen CDT aims to deliver industry-ready doctoral students with a comprehensive skill set and experiences. The research themes for the cohorts of students have covered all aspects of hydrogen technologies from production, storage, distribution and systems integration. The programme has been supported by industry partners including Arcola Energy, BP, Bosch, Intelligent Energy, Johnson Matthey, ITM Power, HORIBA-MIRA and Shell. Launched in January 2022, the latest skills initiative in the Midlands Engine region is the HyDex programme, which is a collaboration between the Midlands Universities that are partners in the Energy Research Accelerator and key industry stakeholders in region. The HyDEX programme aims to coordinate hydrogen innovation across the Midlands, linking commercial, academic and education partners by establishing a series of interrelated work programme related to i) Innovation, ii) Demonstration, iii) Skills, iv) Policy v) International Engagement and vi) Commercialisation, all essential building blocks of a successful Hydrogen Knowledge Transfer Programme (KTP).

Scotland
In **Scotland**, the North East Scotland College has joined forces with major players in green hydrogen, the education sector and supply chain to launch the Hydrogen Skills Partnership[16]. The partnership comprises ScottishPower, ITM Power, Arcola Energy, NESCol, Robert Gordon University, Energy Transition Zone Limited, Skills Development Scotland, Aberdeen University and the University of St Andrews based Hydrogen Accelerator. Working together, the partners will collaborate in assessing the readiness of the UK supply chain to support green hydrogen projects and highlight the potential economic value for the domestic supply chain.

Table 5: Examples of skills development in UK regions

7 Public Perception

More detail is provided in the report produced by Brunel University in Annex 5.

7.1 Background

A limited exercise was undertaken to review the scholarly research on the issues around introducing hydrogen into urban areas. The review focussed on the opinions and attitudes of communities and lay people. It was interested in both the baseline attitudes and level of awareness, and how attitudes changed when people received new information about hydrogen.

Most focus was on peer-reviewed and published articles that examined public attitudes and the drivers of public acceptance. A total of 20 studies were reviewed, which were published between 2008 and 2022. They draw on a variety of methods, and report on data collected from several countries (including the United Kingdom).

The findings are summarised around the following broad themes:

- What are the key factors relating to knowledge of hydrogen?
- What are the key drivers of social acceptance of hydrogen?
- What are the key drivers of community acceptance of hydrogen?

The findings also recommend future work that would aim to assess awareness and attitudes in local communities where hydrogen may be introduced, and the social science research tools that could shed new insights for Doncaster going forward.

[16] www.nescol.ac.uk/hydrogen-skills-partnership-launched/

7.2 Main points arising on public perception

- There is low public awareness of hydrogen technology in general, although this has increased over the past decade, and varies across technology applications.
- Greater knowledge of hydrogen technology is associated with greater support for its use.
- Social acceptance of hydrogen technology is a function of socio-political acceptance, market acceptance, and community acceptance.
- Key drivers of community acceptance are demographics, local level benefits, suitable infrastructure, subjective perceptions, good information, and trust in local government, industry, and science and technology.
- We can differentiate the general public based on their initial attitudes – for example as 'supporters', 'opposers', 'indifferent' or 'not in my backyard' – and outreach can be tailored to different group needs.
- It is essential to address subjective perceptions fully and sympathetically, regardless of whether those perceptions are based in objective truth.
- It is essential that the local economic benefits of the adoption of hydrogen technology are clear, and long-lived. Failure to address this, risks losing community acceptance.
- Trust in local government, industry, and science and technology is essential for community acceptance.
- Credible knowledge brokers and endorsements can help generate community trust. Trusted 'messengers' play an important role.
- It is essential to have proper communication strategy between different stakeholders – not just producers and consumers.
- Local authorities and industry can help build community acceptance through the adoption of visible hydrogen technology in the form of buses and fleet vehicles.

8 Roadmap towards a hydrogen refuelling hub in Doncaster

The following outlines the destination for the Doncaster Hydrogen opportunity:

- Catalyst for the establishment of early adopter users of hydrogen for transport related applications;
- A stepping stone towards supporting the widespread use of hydrogen by HGVs;
- Development of the business model for a hub and spoke arrangement for hydrogen production and dispensing;
- Green production of hydrogen for transport use;
- Catalyst for skills development;
- Support economic opportunities and investment opportunities;
- Help support the development of low carbon businesses;
- Form part of the decarbonisation of Doncaster and an improvement in air quality;
- Potential to incorporate a demonstration and learning centre activity for the region's hydrogen capability.

The following diagram, Figure 8, illustrates the destination or objective for developing a hydrogen hub in Doncaster.

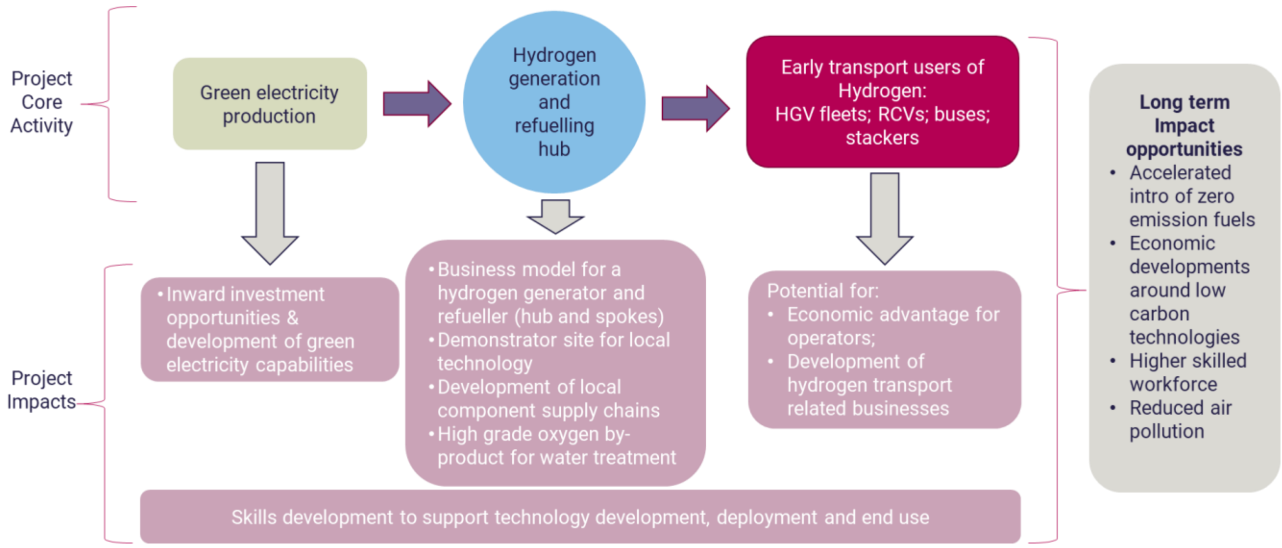

Figure 8: Destination /objective for developing a hydrogen hub in Doncaster

A simple roadmap illustration of the journey towards a hydrogen hub in Doncaster that provides the basis for developing a hydrogen eco system in the borough is presented in Figure 9.

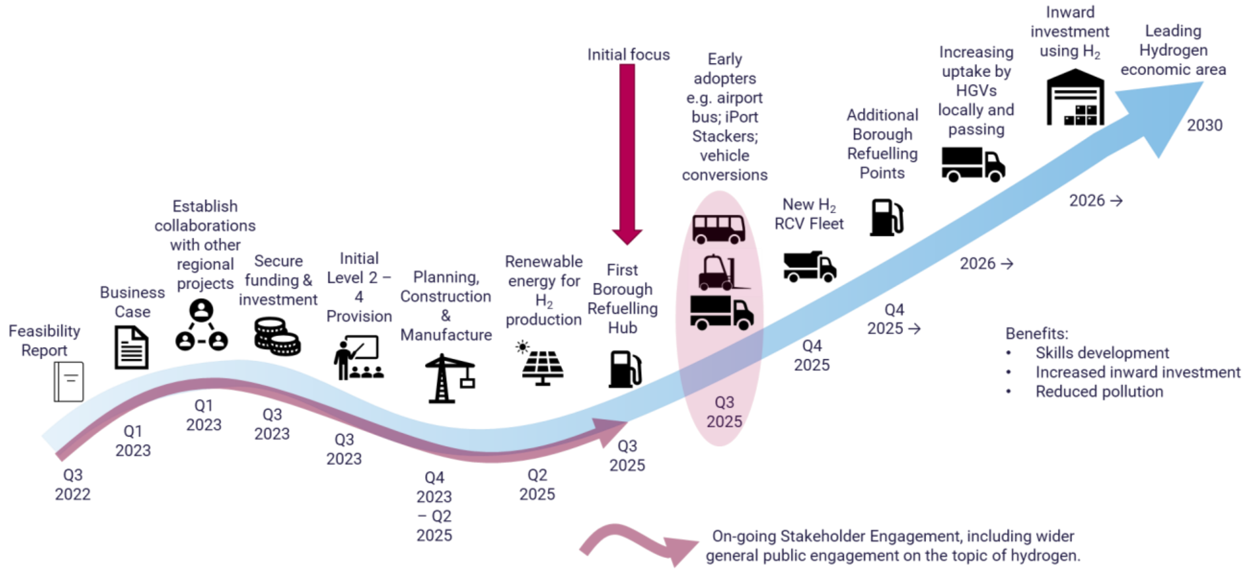

Figure 9: Overview roadmap towards a hydrogen hub in Doncaster

9 Implementation Plan

Doncaster is a major logistics hub with significant arterial roads passing through with considerable numbers of HGVs travelling to, from and through the borough. There will be an impact on local businesses by the UK government's timeline to remove new fossil fuel vehicles, starting as soon as this decade for buses through to 2040 for the largest HGVs. There is an immediate need for the borough to improve air quality and the stimulation of zero emission commercial vehicles will help this strategy.

The council needs to determine which of the options, outlined in 1.8, above it will support or stimulate. The following implementation plan is based on the option to proactively stimulate a hydrogen eco-system.

Key streams of activity as the next steps for this project are:

9.1 Profile

Raise the profile of the hydrogen opportunity in Doncaster and South Yorkshire through 6 monthly events to bring together the spectrum of stakeholders.

9.2 Skills

Work with the local colleges to develop hydrogen supporting modules to be added to existing training courses around the manufacture, installation and maintenance of hydrogen infrastructure and vehicles. Initial course modules to be available from September 2023 that can support existing regional businesses to grow.

9.3 Land availability

This study has identified a number of potential sites and ranked these in order of opportunity. There is an opportunity for the council to help stimulate the construction of a hydrogen hub and associated industry through a detailed review of land availability and accessibility.

A ready planning system and identified land opportunities will support inward investment in a refuelling hub.

9.4 Hub design

The feasibility study proposes a scalable hydrogen generation hub that will expand to meet the expected growth in demand to 2030. The initial size is 2MW and the hub would need to develop its "hub and spokes" format with satellite dispenses at potential locations such as the refuse collection vehicle depot, or at iPort Rail.

The hub design would develop the basis of a business case to help support inward investment.

9.5 Securing demand

The support for infrastructure will be dependent on securing the demand commitment in the early stages. The range of potential users consulted by this study will need to be revisited to establish their timeline, requirements and investment needs in order to be able to commit to the operation of hydrogen fuelled vehicles.

9.6 Investment and funding

During the project it was understood that private investment through the investment community or by hydrogen infrastructure companies is growing in momentum and confidence. However, it is likely that any hub will require a mixture of funding and support to cover the constituent parts from land acquisition to vehicle deployment. Newly developed hydrogen sites, as referenced in this study, have indicated that the time and complexity of aligning the necessary funding to enable a project to occur and the local council can play a pivotal role in bringing the necessary partners together.

The Doncaster Hydrogen opportunity will need its profile raising with the private investment community to support its implementation.

9.7 Incentives

There is a significant investment gap between existing diesel commercial vehicles and hydrogen, or indeed battery vehicles. To help accelerate the deployment of hydrogen vehicles incentives will need to be provided much in the same was there have been for electric passenger cars. To achieve this there needs to be engagement at national level to develop schemes that support the purchase of hydrogen vehicles.

Local schemes, perhaps around buses, refuse collection vehicles and council vehicles may be an opportunity to stimulate the market and provide a base load for the hydrogen hub. Discussions at borough and regional levels should be initiated to establish whether a fund can be established to support the ordering and initial deployment of vehicles in 2025.

9.8 Supply chain

Doncaster does have an electrolyser manufacturer, CPH2, and the region has a second, ITM Power in Sheffield. In order to support the development of the supply chain by more local businesses or inward investing businesses, an understanding of the supply chain requirements needs to be established.

9.9 Visitor / Technology Demonstration Centre

A clear message from talking to end-user stakeholders is the lack of understanding of how hydrogen works and the way it will be implemented in support of transport and other uses. The potential for a scalable hub could be an opportunity to establish a visitors and technology demonstrator centre to illustrate how hydrogen works, the main component parts and the long term benefits of zero emission transport. This centre would also provide skills and learning support.

9.10 Wider uses

This feasibility study has concentrated on heavy commercial transport. There are potentially other transport users including rail and air. Exploring this in a widened feasibility study would add to the demand profile

9.11 Next steps

The following summary Gantt chart (Table 6) provides an overview timeline of activities. Lead organisations would need to be identified for each element and could be overseen by for example Business Doncaster to ensure that the basis for a hydrogen eco-system is set.

![beta logo]

		2022	2023				2024				2025			
Activity	**Sub-Task**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Profile	Hold kick-off Stakeholder Event	■												
	Establish regular (6 monthly) stakeholder events			■		■		■		■		■		■
Skills	Engage existing local organisations to develop skills needs	■	■											
	Develop training modules to add into existing training courses		■	■	■									
	Determine national skills and knowledge gaps to support inward investment				■	■	■							
Land	Develop site specification for scalable hydrogen generation and refuelling sites	■	■											
	Identify suitable parcels land for a scaleable hydrogen generation site		■	■										
	Identify locations for refuelling requirements, eg. RCV depot		■	■										
	Identify existing and potential sites for renewable energy generation		■	■										
	Identify and develop outline commitment for renewable energy supply.			■	■									
Hub	Produce outline specification for scaleable hydrogen production		■	■										
	Raise the opportunity with the market			■	■									
	Develop detailed designs					■								
	Planning process						■	■						
	Build								■	■	■	■		
	Commission												■	■
Demand	Identify early adopters		■											
	Gain commitments to off-take hydrogen		■	■	■									
	Support early adopters on vehicle technology; deployment issues; skills requirements.			■	■	■	■	■	■	■	■	■	■	■
	Identify funding support			■	■	■	■							
Investment/ Funding	Raise the opportunity with private investors		■	■										
	Identify public funding routes that may support aspects of implementation			■	■	■								
	Support inward investment opprtunities		■	■	■	■	■	■	■	■	■	■	■	■
Incentives	Liaise with the region and national government to identify incentive options for early vehicle users		■	■	■									
	Identify specific user investment requirement for on-site refuelling				■	■								
Supply Chain	Work with the existing equipment providers to identify supply chain gaps and how these can be filled through inward investment or skills development		■	■	■	■	■	■	■	■	■	■	■	■
Visitors Centre	Develop the scope for a Visitors / Technology Demonstration Centre co-located with the hub		■	■										
	Identify funding				■	■	■							
	Tender for construction							■	■					
	Design and build									■	■	■	■	■
Wider Uses	Identify wider borough and regional users of hydrogen for transport: eg. rail, air			■	■	■	■	■	■	■	■	■	■	■

Table 6: Overview implementation Gantt chart

10 Feasibility study background and approach

10.1 Background

This feasibility study was commissioned as part of the Decarbonising Doncaster agenda developed by Doncaster Council. The focus of the study was to stimulate the introduction of hydrogen fuel refuelling for HGVs (Heavy Goods Vehicles) particularly the largest articulated HGVs at 44t. As a major UK logistics hub with multi-modal freight movements (road, rail and air) and close proximity to the Humber ports, Doncaster has increased pollution levels from freight vehicle movements. Doncaster is also at the centre of three major arterial routes: A1M; M18 and M62.

Different low and zero emission fuels for transport are being developed and trialled, some of which are stepping stones to only the sale of new fully zero emission HGVs by 2040.

This study has been initiated by Doncaster Council and the project is part-funded by the UK Government through the UK Community Renewal Fund. The supporting bodies were:

UK Government | South Yorkshire SYMCA Mayoral Combined Authority | Doncaster Council | Business Doncaster

10.2 Feasibility Study Scope

The project is to determine the feasibility for a hydrogen refuelling hub to be centred at a suitable site within the Doncaster Borough. The proposition is that for hydrogen to be taken seriously then large users will need to be engaged and large logistics centres would make sense for siting such refuelling activity. A demonstrator based at a major logistics hub would be able to draw on the development itself and the proximity to the M18 and A1.

The original objectives of the study were:

- To determine the infrastructure (land, access, hydrogen storage, accessibility to green hydrogen, safety and planning) requirements for a full-scale 250kg/day refuelling station (approximately 16 HGV refuels per day).
- To understand the demand and develop the 'roadmap' for the demand development in Doncaster from logistics hubs and hauliers.
- To 'recruit' one or more HGV OEMs to be partners in the subsequent roll out of the technology in the UK.
- To examine the feasibility of attracting service or development capability of hydrogen HGVs into Doncaster, thereby developing a new skill base for the borough.

Beta would lead the feasibility study and proposed working with the following partners to undertake this feasibility:

- Cenex – to provide the understanding of the vehicle duty cycles required, the OEM technology available, transport planning and sites that could support local bus operations.

- Doncaster Council to support the planning analysis for a hydrogen refuelling station.

The feasibility study would comprise the following tasks:

- Assessment of the hydrogen demand within the Doncaster borough and other freight operators using the M18, A1, M1 corridors.
- Feasibility, planning and cost implications for an at scale hydrogen refuelling station.
- Engagement with local hauliers and logistics companies to determine their input on the need and obstacles for a hydrogen HGV economy. To include the impact of decarbonisation on haulage companies and the opportunity to safeguard jobs.
- Engagement with HGV OEMs to understand their roadmap for the development of suitable HGVs.
- Analysis of the developing hydrogen infrastructure in the UK, including proposed new projects to understand how the proposed Doncaster activity will fit with the national roll-out of hydrogen.
- Engage with Doncaster College and National College for Advanced Transport & Infrastructure to determine the skills development required to support the introduction of hydrogen as a fuel for HGVs.
- Analysis of other potential uses for hydrogen in transport in Doncaster including:
  - Local public transport;
  - Specialist vehicles such as refuse vehicles;
  - Off-highway specialist vehicles including those used at Doncaster airport or iPort Rail.
- Engagement with Sheffield University as the innovation partner for Gateway East, and to support the integration with the advanced manufacturing park at Doncaster Airport.
- Stakeholder engagement events to develop the necessary critical mass around the introduction of hydrogen as a transport fuel.

The feasibility study scope is illustrated in the Figure 10 below.

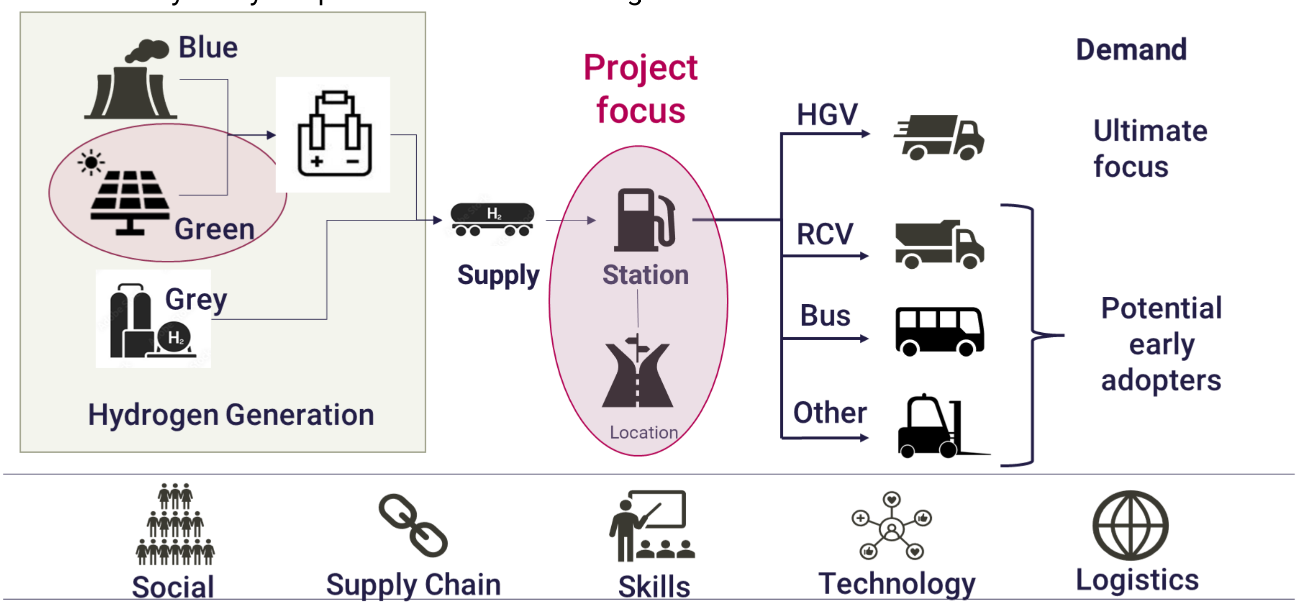

Figure 10: Feasibility study scope

10.3 Project delivery

The project was delayed from its original planned start of Autumn 2021. The project started on 14th March 2022 and was due to complete on 30th June 2022. The end date was worked towards and by mutual agreement the end date was extended to September 2022. This then allowed for further engagement with stakeholders.

Due to the constrained timescale for the original project timeline, Beta engaged the following sub-contract partners:

Cenex, the UK's first Centre of Excellence for Low Carbon and Fuel Cell technologies

https://www.cenex.co.uk/

Market Infra Consulting, provides professional strategic development and marketing consultancy services to help infrastructure businesses

https://marketinfra.co.uk/

Brunel University London – Public Policy, uses their world-leading research to help inform policy-makers, legislators and regulators.

https://www.brunel.ac.uk/about/brunel-public-policy

The project was broken into 6 work packages as illustrated in Figure 11 below.

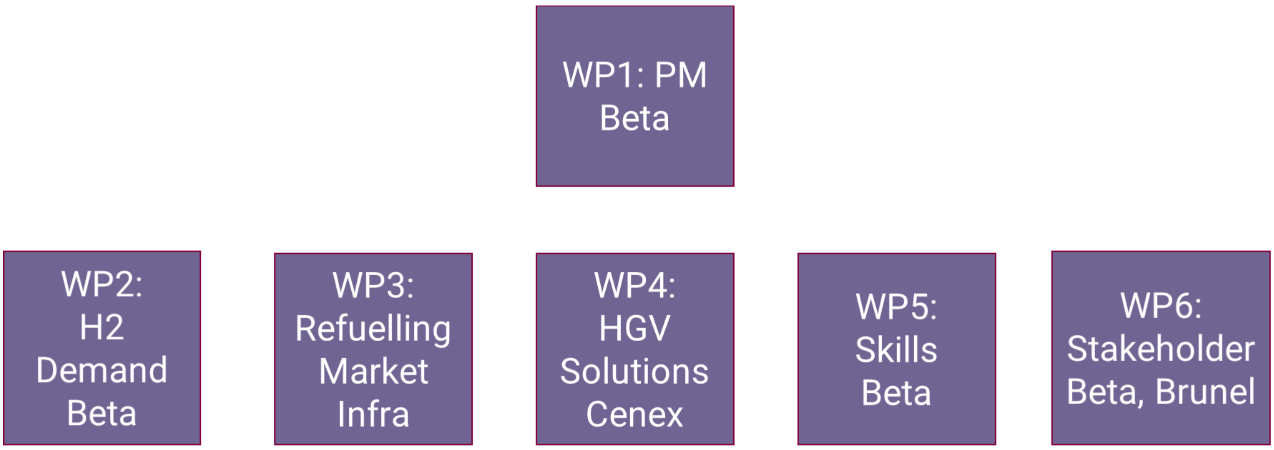

Figure 11: Project structure

10.4 Stakeholder engagement

The feasibility study needed to gain input from a range of stakeholders, including:

- Haulage companies
- Logistic hub developers
- Clean energy providers
- The hydrogen supply chain: electrolyser manufacturers; hydrogen gas suppliers; system integrators
- Council planners
- Skills and education providers
- Other potential hydrogen users including: buses, coaches, Refuse Collection Vehicles, off-road freight vehicles.

10.5 Haulier Roundtable 6th June 2022

A haulier stakeholder roundtable was held on 6th June 2022. The roundtable was to provide the opportunity to present the scope and rationale behind the feasibility study and learn from the attendees, the issues and opportunities that hydrogen might present. The event was held in person at the National College for Advanced Transport & Infrastructure (NCATI) in Doncaster.

10.6 Stakeholder Event 28th June 2022

The stakeholder event held at NCATI on the 28th June 2022 drew in a wider audience including public and private sector. The objective of the event was to raise the profile of the study and the opportunity of hydrogen.

10.7 Report presentation Event November 2022

An event is being planned for the beginning of November 2022 to present the feasibility study and engage stakeholders in the next stage of implementation.

Section 2: Supporting reports – not for public distribution

Annex 1: Cenex - Hydrogen National and Regional Strategy

Annex 2: Beta Technology – HGV Hydrogen Demand

Annex 3: Market Infra - Doncaster Hydrogen Refuelling Station

Annex 4: Cenex – Hydrogen Vehicle Availability and Future Demand

Annex 5: Brunel University – Community Acceptance of the Introduction of Hydrogen

Annex 1: Cenex - Hydrogen National and Regional Strategy v3

Annex 2: Market Infra - Doncaster Hydrogen Refuelling Station v3

Annex 3: Beta Technology – HGV Hydrogen Demand Final

Annex 4: Cenex – Hydrogen Vehicle Availability and Road Network Demand v3

Annex 5: Brunel University – Community Acceptance of the Introduction of Hydrogen