Document

Low Carbon Sector Feasibility Study

Client

Business Doncaster

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1.0 EXECUTIVE SUMMARY

The Low Carbon Sector

- The Low Carbon Sector provides a useful collective term for all those economic activities that are geared towards the delivery of goods and services whose primary aim is the generation of significantly lower emissions of harmful greenhouse gasses (predominately CO2) to mitigate and ultimately arrest the effects of climate change.
- The Low Carbon Sector, in line with the Office of National Statistics (ONS) definition, can be divided into six broad groups: low carbon electricity, low carbon heat, bioenergy and alternative fuels, energy-efficient products, low-carbon services and low-emission vehicles and infrastructure. Contained within which are a further thirteen sub-sectors.
- These sectors do not align with Standard Industrial Classification (SIC) codes used in traditional sectoral analysis, therefore assessing the full scale of the low carbon sector is difficult.
- Currently, official estimates place the aggregate size of the UK low carbon sector at 207,800 full-time equivalent employees with a combined annual turnover of just over £40 billion.
- Spurred on by UK national policy commitments to achieve net zero by 2050, the growth and development of the low carbon sector is expected to accelerate creating unique opportunities for the emergence of new products, the augmenting of existing processes, domestic supply-chain investment, and innovative approaches to transitioning established industries to a low carbon future.
- In the UK alone, the potential economic benefits that could be unlocked on the journey to net zero are expected to support an additional two million 'green' jobs by 2030, with required capital investment needing to increase to some £50 billion per year.

The Current Low Carbon Sector in Doncaster

- At the present time, the size and value of the low carbon sector in Doncaster makes up a small proportion of economic activity. According to the latest data, low carbon activities are estimated to account for less than 1% of employment in the Doncaster economy (as they do nationally), with a value of £150m per annum.
- These jobs are predominantly engaged in construction and manufacturing businesses, which represent the majority of low carbon employment nationally and are particular strengths of the wider Doncaster economy.

Future Low Carbon Sub-Sector Growth in Doncaster

- By assessing sub-sectors' expected growth nationally and Doncaster's ability to attract this activity, the study has identified the key sub-sectors which should form the principal focus for any future Low Carbon Sector Inward Investment Strategy.
- Three were considered to offer the most promising avenues for growth locally. These are Renewable Heat, Bioenergy, and Alternative Fuels (including hydrogen).
- Conversely, Onshore and Offshore Wind, Hydropower, Nuclear and Low Carbon Financial and Advisory Services have been deemed to offer relatively limited opportunities for growth in the local economy.
- The remaining sub-sectors are thought to offer moderate potential but are constrained by geographic, policy or economic factors.

Barriers to Growth

- Stakeholder consultations and a wider review of literature identified key barriers that could hamper future low carbon sector growth in Doncaster.
- A shortage of workforce availability poses a significant recruitment challenge for low carbon sector businesses, which at present is compounded by the present failure of local FE and HE providers to effectively respond to shifting sector-specific needs.
- The present period of high inflation, rising costs and zero-growth also creates a macro-economic context which mitigates against risk leading to developments and companies placing a hold on positive advances in environmental policy.
- Access to innovation finance is also constraining the development of highly innovative start-ups, scale-ups, and other innovative businesses.
- The reluctance of some elements of the public and private sector to shift investment decision-making away to a cost-avoidance approach to favour decarbonisation and renewable options, a shifting low carbon and renewable regulatory regime, and a national planning policy that does not yet adequately incentivise low carbon and renewable infrastructure projects are all also inhibitors to the introduction or scaling up of low carbon projects in Doncaster.

Opportunities Recommended for Future Inward Investment Focus

- The key findings of the research undertaken are that any future low carbon inward investment strategy for Doncaster would be advised to focus on the following sub-sectors, as the most significant opportunity areas for growth in the local authority.

Hydrogen:

- The successful development of a scaled up domestic hydrogen industry represents a key strategic priority for the UK. A sub-sector with large potential, however, is relatively underdeveloped as an industry.
- The sub-sector itself can be broken down into a number of market segments: production, storage, mass network deployment and propulsion. In each of which Doncaster has several comparative advantages which helps to position it as being at the heart of this strategically important growth industry.
- In the case of production, Doncaster has a large amount of installed renewable energy capacity, the existing presence of a key market leader in hydrogen production technology and is in close proximity to regional centres of advanced research.
- This is complemented by several significant research and development opportunities (not all of them primary inward investment opportunities) which exist in the use of redundant coal mines for hydrogen gas storage and the testing of mass network deployment through hydrogen blending across Doncaster's many large-scale residential, commercial and mixed development sites, and in the piloting of road and rail decarbonisation through the exploitation of Doncaster's strategic location.

Heat Pump Manufacturing and R&D:

- The successful development and scaling up of the heat pump industry represent a key strategic priority for the decarbonisation of the UK's heat supply. This presents significant opportunities for heat pump manufacturing and R&D activity as the technology is adapted for and deployed across the UK.
- Doncaster's connectivity strengths, pipeline of high-quality industrial developments such as Unity Yorkshire and relative affordability of labour, mean that the borough meets the key requirements of a heat pump manufacturer.
- The region's universities also are potential partners for R&D and SYMCA's historic investment support for R&D activities provides assurance of grant fund availability if required.
- Global heat pump manufacturers, in particular German and Japanese are currently exploring opportunities to develop heat pump manufacturing facilities in the UK.
- If a heat pump manufacturer were to develop manufacturing and R&D facilities in Doncaster, the area would be well positioned to become a key anchor point for the development of a 'zero carbon heat cluster' leading to further inward investment opportunities.

Bioenergy:

- Current Doncaster strengths and the forecast growth in bioenergy activity required nationally to meet future electricity, heat, and transport demand, means the sub-sector represents a very viable opportunity for future low carbon growth locally.
- Biomass is a vital resource for the key green technologies and energy carriers highlighted as necessary for net zero: low carbon electricity, hydrogen, and carbon capture.
- Although a delay in the policy which will guide the use of biomass is restricting investment in coming months, there is long term certainty that bioenergy will continue to be a major part of the net zero transition.
- Local activity in the sector, alongside land and feedstock availability, means there should be ongoing opportunities to attract investment in the sector.

Low Carbon Aviation:

- A proposal for the development of a Lightweighting UK project at GatewayEast looks to make the most of its associated aviation infrastructure.
- Alongside this proposition is an agreement for Hybrid Air Vehicles to locate the company's Airlander 10 airship production facility within the area.
- Should one or both of these proposals go ahead, Doncaster will be placed at the very forefront of clean aviation research. This will position the area to become the key anchor point for the development of a new future mobility cluster built around alternative fuels, battery technology, electrification, and light weighting technology.

2.0 INTRODUCTION

McBains and Genecon were commissioned by Business Doncaster to answer a key question for the area:

"What opportunities are presented by Low Carbon sector growth and which green technology sub-sectors provide the best economic opportunities for Doncaster?"

This report provides a comprehensive evaluation of potential low carbon growth at a sub-sector level. This has enabled an assessment to be made of which sub-sectors present opportunities for Doncaster to attract inward investment, underpinned by research into:

- Current, publicly available, UK wide and localised low carbon sector growth data.
- Supply chain intelligence for each low carbon sub-sector.
- Relevant local and national policy direction.
- Specific barriers and opportunities for growth in Doncaster, through consultation with local key stakeholders, developers and businesses, and advice from sector experts from the Department for International Trade.

The main report is structured in six sections, which aim to answer the following questions:

- **Strategic Context** – What is the low carbon sector? What is the national and local policy context? How developed are individual sub-sectors and how do their supply chains operate currently and how will they in the future?
- **Doncaster's Low Carbon Sector** – What low carbon activity is currently being undertaken in Doncaster? In which sub-sectors is Doncaster well positioned for future growth?
- **Key Inward Investment Opportunities for Doncaster** – What types of business could be attracted? What are their requirements? How likely is investment?
- **Barriers to Low Carbon Sector Growth** – What are constraints on low carbon sector growth locally?
- **Overarching Strategy for Low Carbon Growth in Doncaster -** How could the sector be supported locally to grow and attract businesses?
- **Recommendations for an Inward Investment Strategy** – How should inward investment opportunities be prioritised to maximise low carbon growth locally?

3.0 STRATEGIC CONTEXT – THE LOW CARBON SECTOR

To understand future low carbon opportunities for Doncaster, it is important to firstly establish what the low carbon sector is. The following section sets out the definition of the low carbon sector used in this study and provides a summary of its national and local context. The section also goes into detailed analysis of individual low carbon sub-sectors to understand their current composition and wider growth prospects.

3.1 Low Carbon Sector Overview

The Low Carbon Sector includes a plethora of technologies, innovations, processes, and service provisions all targeting the same objective - to achieve a substantial reduction in CO2 emissions to avoid the catastrophic effects of Climate Change and Global Warming. From a national policy point of view, this translates to initially meeting the UK's Net Zero 2050 climate change target (Climate Change Act 2008[1]) which commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050.

There are significant economic benefits that can be unlocked during the UK's journey to Net Zero, as reported by current government statistics. These include:

- **Power generation** could support up to 120,000 jobs by 2030, with £150-£270bn additional investment required by 2037.
- **Fuel Supply & Hydrogen** can support 10,000 jobs by 2030 and £20-£30bn of public and private investment scaling-up the production of low-carbon alternative fuel.
- Decarbonisation targets within **industry** by 2030 could support 54,000 jobs and require £14bn of investment by 2037.
- Reducing the emissions of **buildings** will require 175,000 jobs this decade and £200bn of investment by 2037.
- Accelerating the decarbonisation of **transport** is expected to support 74,000 jobs and £220bn in investment by 2037.

This projected growth in jobs will contribute to the wider Government ambition of 2 million green jobs being generated by 2030, alongside the UK's Climate Change Commission estimate that to achieve net zero alone, extra capital investment in the UK will need to grow fivefold to £50bn a year in 2030.

The expected continuous growth of the low carbon sector provides unique opportunities to both public and private stakeholders, especially in terms of developing new products, optimising processes, investing into local supply chains, in-house knowledge, and future proofing their businesses. This could be translated into both new business ventures and upgrading existing business models and service offerings.

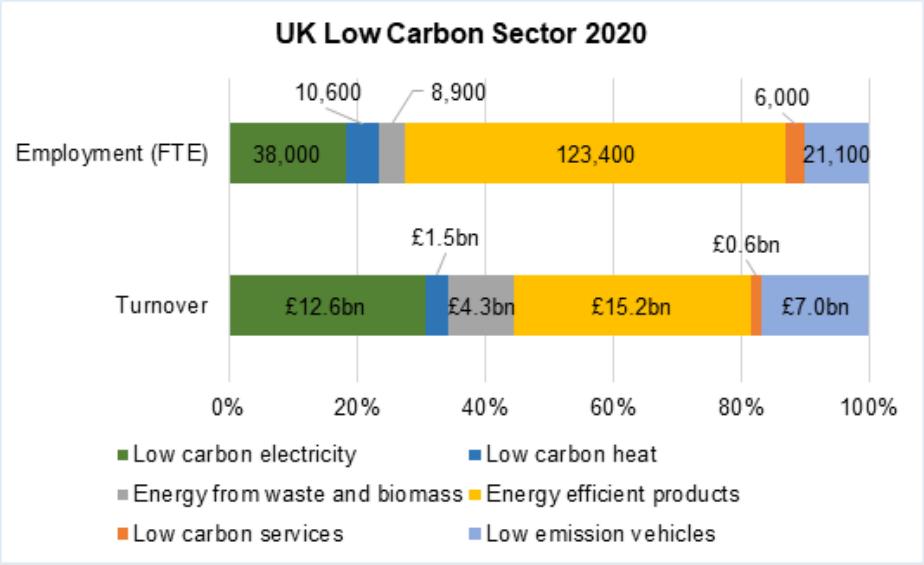
To guide this study the research team used the ONS definition of the Low Carbon and Renewable Energy Economy (LCREE)[2]. This definition divides the sector into six broad groups, which capture 13 sub-sectors as shown in Table 1.

[1] https://www.legislation.gov.uk/ukpga/2008/27/contents
[2] https://www.ons.gov.uk/economy/environmentalaccounts

Table 1 – ONS definition of the Low Carbon and Renewable Energy Economy

Low Carbon and Renewable Energy Economy	
Group	**Sub-sectors**
Low carbon electricity	▪ Offshore wind ▪ Onshore wind ▪ Solar photovoltaic ▪ Hydropower ▪ Other renewable electricity ▪ Nuclear power ▪ Carbon capture and storage
Low carbon heat	▪ Renewable heat ▪ Renewable combined heat and power
Energy from waste and biomass	▪ Bioenergy ▪ Alternative fuels (inc. Hydrogen)
Energy-efficient products	▪ Energy-efficient products ▪ Energy-efficient lighting ▪ Energy monitoring, saving or control systems
Low-carbon services	▪ Low-carbon financial and advisory services
Low-emission vehicles and infrastructure	▪ Low-emission vehicles and infrastructure ▪ Fuel cells and energy storage systems

Table 2 – UK LCREE Employment and Turnover 2020, ONS



Key points (Table 2):

- The ONS estimates that in 2020, businesses active in the UK LCREE generated **£41.2 billion in turnover** and **employed 207,800** full-time equivalent (FTE) employees.
- Energy-efficient products were by far the largest group in the sector in terms of employment supported across the UK, accounting nearly 60% of jobs in the LCREE.
- It must be noted that currently many LCREE sectors are small and for many businesses LCREE activity is secondary rather than primary.

3.2 Low Carbon Policy Context

The development of the low carbon economy has historically been driven by public policy and funding. Doncaster is leading the way locally by aiming for carbon neutrality by 2040 through the adoption of local policies and initiatives in support of low carbon growth.

Outlined below is a high-level analysis which demonstrates how the ambitions and commitments of current national and local policies provide an enabling context in which to support business growth across the different low-carbon sub-sectors.

Table 3 – Low Carbon Sector – National and Local Policy Ambitions/Commitments		
	Policy	**Commitments**
Low carbon electricity		
National	*UK Net Zero Strategy (2021)*	• Fully decarbonise the UK power system by 2035. • Invest £380m to support offshore wind supply chain • Bring forward low carbon technologies capable of replicating the role of unabated gas in the electricity system, including CCUS-enabled generation, hydrogen-fired generation, Bioenergy with Carbon Capture and Storage (BECCS), and flexible storage. • £120 million Future Nuclear Enabling Fund
	The Energy White Paper (2020)	• £1 billion to support the establishment of CCUS in four industrial clusters. • Bring at least one large-scale nuclear project to the point of Final Investment Decision by the end of the current Parliament.
	Carbon Capture, Usage and Storage (CCUS) Innovation 2.0 competition (2022)	• £20 million in grant funding available for projects developing novel CCUS technology and processes that reduce the cost of deployment.
Local	*Doncaster Delivering Together (2021)*	• Increase through policy and investment the local energy generation and usage from renewable sources, including solar.
	SCR Strategic Economic Plan (2021)	• Significantly increase renewable energy generation and storage to improve resilience. • Grow CCUS capabilities especially.
	Sheffield City Region Energy Strategy (2020)	• Increase solar PV capacity to 3.5GW by 2040. • Increase onshore wind capacity to 1.55GW by 2040
Low Carbon Heat		
National	*UK Net Zero Strategy (2021)*	• By 2035, all new heating appliances in homes and workplaces will be low carbon technologies. E.g., electric heat pumps or hydrogen boilers. • £60 million Heat Pump Ready Programme funding pioneering heat pump technologies. • 2 million homes to be using heat networks by 2035. • £270 million Green Heat Network Fund to grow the market for low carbon heat networks.
	The Energy White Paper (2020)	• Grow the installation of electric heat pumps, from 30,000 per year to 600,000 per year by 2028. • Open the market for homes not on the gas grid to utilise heat

		pumps or other clean energy alternatives • £122 millions of funding towards a Heat Network Transformation Programme.
Local	*Doncaster Delivering Together (2021)*	• Establish a long-term plan for greener homes – designing and delivering the Housing Retrofit programme.
	SCR Strategic Economic Plan (2021)	• Support the decarbonisation of heat including: 4/5th generation heat networks, hydrogen for heat, electrification of heat, and zero-carbon smart microgrids. • Support mine water energy solutions.
	Sheffield City Region Energy Strategy (2020)	• At least 5 mine water energy schemes to be operational by 2040. • Full low carbon heating penetration (or hydrogen-ready) by 2040. • No fossil fuel heating in new homes from 2025. • Work with organisations and industries who expel waste heat to connect into a heat network and establish a mechanism for payment for the waste heat.
Bioenergy / Alternative fuels		
National	*UK Net Zero Strategy (2021)*	• Deliver 5 GW of hydrogen production capacity by 2030. • Reduce emissions from the energy from waste sector. • Through use of carbon capture reduce the net emissions on biomass energy.
	UK Hydrogen Strategy (2021)	• £240m Net Zero Hydrogen Fund to 2024/25 for co-investment in early hydrogen production projects. • £60 million Low Carbon Hydrogen Supply 2 competition to develop novel hydrogen supply solutions, including storage technologies.
Local	*SCR Strategic Economic Plan (2021)*	• Build on existing advantages to grow local hydrogen economy and decarbonise existing industry.
	Sheffield City Region Energy Strategy (2020)	• Invest in hydrogen refueling stations across South Yorkshire. • 101,000 homes to be heated by biogas/hydrogen by 2040.
Energy-efficient products		
National	*UK Net Zero Strategy (2021)*	• Insulate homes to reduce energy consumption and lower bills. • Double the efficiency of four key products (air conditioners, refrigerators, industrial motors, and lighting) by 2030.
	The Energy White Paper (2020)	• As many existing homes as possible at EPC Band C or above by 2035. • All rented non-domestic buildings will be EPC Band B by 2030, were cost effective.
Local	*Doncaster Environmental Sustainability Strategy 2020-2030*	• Improve the energy efficiency of homes and other buildings.
	Sheffield City Region (SCR) Energy Strategy (2020)	• 65,000 cavity walls insulated by 2040. • 119,000 solid walls to be insulated by 2040. • Floor insulation in 512,000 homes by 2040.

		• 90% of commercial lights LEDs by 2040. • Seek opportunities where partnerships can be created between developers of energy efficient technologies and industrial companies willing to test innovative technologies on-site.
Low-carbon services		
National	*UK Infrastructure Bank (2021)*	• The UK Infrastructure Bank will have an initial £12 billion of capital to deploy and will be able to issue £10 billion of government guarantees.
	DIT Export Strategy - Made in the UK, Sold to the World (2022)	• UK Export Finance (UKEF) will offer green economy exporters access to increased lending capacity, providing its Export Development Guarantee (EDG) on extended repayment terms so they can seize new export opportunities and invest in future export capacity.
Local	*Doncaster Environmental Sustainability Strategy 2020-2030*	• Raise awareness, share best practice, support, and educate partners, businesses, and residents on how their own behaviour changes can contribute to environmental improvements, whilst also achieving economic, health and social benefits.
Low-emission vehicles and infrastructure		
National	*UK Net Zero Strategy (2021)*	• £620 million for zero emission vehicle grants and EV Infrastructure. • £1 billion Automotive Transformation Fund (ATF) to support the electrification of UK vehicles. • Electrify more railway and a net zero rail network by 2050, with the ambition to remove all diesel-only trains by 2040. • Invest £3 billion to transform bus services and £2 billion for cycling.
	The Energy White Paper (2020)	• End the sale of new petrol and diesel cars and vans by 2030. • £2.8 billion package of measures to support industry and consumers to make the switch to cleaner vehicles. • £1.3 billion to accelerate the rollout of charge points for EVs. • Half a billion to be spent by 2024 for the development and mass-scale production of electric vehicle batteries (gigafactories) and other strategic technologies.
	UK Hydrogen Strategy (2021)	• Invest up to £20 million in design trials for an electric road system and hydrogen fuel cell HGVs.
Local	*Doncaster Delivering Together (2021)*	• Invest in zero emission council fleet, public electric vehicle charging and active travel infrastructure.
	SCR Strategic Economic Plan (2021)	• Work with the University of Sheffield to develop sustainable aviation fuels. • Accelerate the transition to ultra-low emission vehicles and transport systems.
	SCR Energy Strategy (2020)	• Fully zero-emission private hire fleet by 2035. • Fully zero-emission public transport network by 2035. • Expand the network of EV charging points and hydrogen refueling stations across South Yorkshire in a strategic way to ensure full coverage.

3.3 Low Carbon Sector Composition

To identify which sub-sectors present opportunities for inward investment in Doncaster, the differences between them must be understood. Below is explanation of each sub-sector listed in Table 1, accompanied by ONS and Local Government Association (LGA) data, which provide estimates for their current and future employment (in 2030 and 2050) contributions nationally.

Low Carbon Energy

Low Carbon Energy includes small and large-scale renewable energy generation schemes, as well as the innovative technology of Carbon Capture and Storage (CCUS).

Table 4 – Low Carbon Energy – Current and Projected Employment

Sub sector	Offshore wind	Onshore wind	Solar PV	Hydro power	Other renewable electricity	Nuclear power	Carbon capture and storage
England Industry Size (2020) - ONS (FTEs*)	7,500	1,500	3,900	200	200	13,000	200
England (2030) - LGA data	33,000	14,000	43,000	140	n/a	68,000	1,200
England (2050) - LGA data	73,000	29,000	105,000	170	n/a	85,000	10,200

(*Full time equivalent (FTE) estimates are the total employment if all roles were filled by full time workers)

Offshore Wind

The UK is already the largest global player in the offshore wind sub-sector, with a current generating base of nearly 10GW – producing enough electricity to power some 7 million homes – with a further 5GW in pre-construction, and plans for an additional 11GW of capacity. The UK Government has placed a target of reaching 50GW of offshore generating capacity by 2050, far exceeding the UK's own domestic demand and thus positioning the UK as a net-exporter of renewable energy. Nearly 75% of new jobs will be directly created by the expansion of the sub-sector with the remainder coming through companies supplying other industries as well as offshore wind.[3]

Offshore wind is currently one of the fastest growing markets across the globe and having a robust and reliable supply chain is of great importance to enable the expansion of this sector. The UK supply chain can be broken down into three main elements: supply, construction, and management, with two supporting elements: consultancy and development. Contained within each element are a wide range of industries and services which contribute to the manufacture, assembly and installation of turbines and their associated infrastructure.

The supply chain into the offshore wind sub-sector continues to be dominated by a relatively small number of larger multinational companies. For example, key players such as Siemens Gamesa Renewable Energy, GE and Vestas dominate the offshore wind turbine market. Manufacturing facilities exist across the UK providing a range of offshore products such as array and export cables, wind turbine components, and installation and service vessels. However, inevitably, geographic proximity to the shoreline and appropriate port-facilities has led to the agglomeration of production facilities, expertise, and support services at coastal cluster points (there are a total of eight officially designated 'Offshore Wind Clusters' including The Humber, Newcastle and the Firth of Forth[4]).

Onshore Wind

Like offshore, onshore wind power production is one of the most cost effective and established renewable technologies in the UK. The UK being identified as having the best wind resource in Europe. There are currently more than 1,500 operational onshore wind farms across the country. In 2020, onshore wind alone contributed 11% of the UK's electricity demands, with a total 34.7TWh generated – more than enough to power 18.5 million homes for an entire year. In the South Yorkshire region, onshore wind contributes over 250GWh of electricity to the national grid. Of this total amount, the largest proportion came from the seven onshore windfarms located in Doncaster which, in 2020, were responsible for the generation of some 158GWh of electricity (according to Department for Business, Energy and Industrial Strategy figures).

Although within the UK the expansion of onshore wind capacity has been slowed in recent years due to increased regulatory impediments (a situation not similarly apparent in the case of offshore), onshore wind remains the favoured non-hydro power generation system in the rapidly expanding international market. For example, of the total 830GWh of new wind capacity installed during 2021, 93% were onshore systems. As a technology, it is now well established in 115 countries around the world, whilst offshore wind still remains at the early stage of expansion, with capacity present in just 19 countries. However, given that both onshore and offshore systems rely in a large part on the same component parts (at least for the generators themselves), the structure of the UK supply-chain and the economic opportunities (and barriers) associated with it follow largely the same pattern as that of the offshore market.

[3] Offshore Wind Industry Council, *Offshore Wind Skills Intelligence Report* (March 2022).

[4] The others being: East Anglia (centred on Harwich), Solent (Hampshire and the Isle of Wight), Celtic Sea (Cornwall), the Offshore Energy Alliance (Liverpool and Wales) and North Scotland (Highlands and Islands).

Solar PV

Solar deployment in the UK rose sharply in the early 2010s, as a result the proportion of national electricity consumption generated from solar has risen from close to 0% in 2010 to 4% in 2020. However, the installation of capacity has significantly slowed since 2016. Between 2011 and 2016 10,000 MW of solar capacity was installed nationally, whilst post-2016 only an additional 2,000 MW of capacity has been added.

Therefore, solar is an already established industry in the UK employing an estimated 3,900 people in England in 2020. The majority of employment supported by the industry is in construction related firms working on the installation of projects. There are a number of UK based manufacturers of solar panels. Most UK based firms are limited to bespoke, high-end products for more custom projects. Often the manufacture of the actual photovoltaic cells themselves will be done overseas by other manufacturing firms that specialise in cell manufacture and then imported into the UK where the solar panels are assembled by the UK based company.

There is conflicting evidence for the future growth prospects of the solar industry in the UK. To meet the UK's net zero target, it is anticipated that solar deployment will need to be expanded, growing employment significantly in the sector. However current policy uncertainty surrounding large solar farms, and dominance of solar panel manufacturing in China, could constrain growth in the sector.

Hydropower

From the perspective of the natural environment, the UK is considered to have significant hydropower generating potential due to its many topographic assets. Across England, Wales, and Scotland there are some 1,561 hydropower plants. However, despite this nominal generation capacity, current renewable energy production from this source accounts for only 2.1% of overall UK output. This has little changed since 2000. Most of this capacity was built out during the 50s and 60s with little subsequent investment in the sub-sector due to increasing environmental concerns due to the placement of sites in areas of protected natural beauty and the cost of construction often considered prohibitive.

Although operating from this extremely low base, and with a wider policy context which takes little account of hydropower as an option (the Government's recent Ten-Point Plan on decarbonisation omitted any mention of hydropower), hydropower continues to play an important role in supporting the development of the UK's wider renewable power generation through the provision of peaking, balancing and other grid services to the far more variable solar and wind sub-sectors.

Research by the International Hydropower Association and Rystad Energy, an independent energy research company, reported on the continuing global growth in hydropower generation; driven particularly by China, Brazil, and the US. However, Hydropower.org suggests that expansion in the UK will probably be limited to small-scale projects, with the exception of pumped-storage systems. For example, Torrs Hydro (Derbyshire) and Stockport Hydro.

Due to the extremely limited size and geographically concentrated domestic market, much of the dedicated supply-chain is controlled by larger utility companies (e.g., Scottish & Southern Energy PLC, SSE Renewables and Drax Group) with a handful of smaller community-based operations located at site. Opportunities do exist for non-specialist suppliers in these latter examples due to the relatively uncomplex nature of the required components, but with minimum maintenance requirements and long operating lives the sub-sector has limited potential as a vehicle for economic growth.

Other Renewable Electricity

The ONS define the other renewable electricity as the production of electricity from wave and / or tidal and/or geothermal renewable sources and the design, production, and installation of infrastructure for this purpose, including operations and maintenance.

Nuclear

Nuclear energy generating capacity in the UK has been in steady decline over recent years. At its peak in the mid-late 1990s, nuclear power plants were contributing around 25% of the UK's annual electrical generating capacity. However, as old plants have been shut down and age-related problems affect plant availability this has now reduced to just 15%. At present, the UK nuclear estate is comprised of 13 nuclear reactors located at six plants. Yet, by 2025, almost half of this remaining capacity is due to be decommissioned with only one new plant, Hinkley Point C, now under construction (due for completion in 2026). The UK Government has however committed to halting the decline in nuclear generating capacity and restoring output to around 25% by 2050.

The current main areas of development in the nuclear energy sub-sector are decommissioning, fusion research and small modular reactors (SMRs). Each of these elements has their own specific requirements (e.g., for skills) and potential economic growth opportunities/barriers. Decommissioning fission plants is an important aspect of the nuclear sub-sector, however engaging in this activity requires that the work takes place at the site of the power station. Still at the experimental stage, opportunities are limited in nuclear fusion with much of the activity being focussed on researching how to harness the process to produce electricity rather than its deployment at scale. Consequently, the development of fusion technology is mostly confined to universities and research institutes. The area with the greatest potential scope for engagement in the nuclear sub-sector supply chain is in the development of small modular reactors (SMRs).

SMRs are defined as those with a generating capacity of up to 300MW of power (enough to power 10,000s homes). These reactors are regarded as being more cost effective than large scale nuclear plants as they can be built in factories and then assembled onsite rather than having to be built completely onsite. These factors, coupled with utilising insights from similar manufacturing techniques in the aerospace and automotive sectors, are viewed as making the production process more efficient and, therefore, cheaper. As a result, SMRs are viewed as a

viable and cost-effective future technology to ensure the growth of the nuclear sector. It is envisaged that the first SMR will be operational by 2030.

Significant in scope and scale, the nuclear energy sub-sector supply chain crosses national and international boundaries. Within the UK itself, there are already a number of well-established multinational companies operating in the sub-sector, with only some limited participation by smaller companies. For example, EDF, Hitachi, Westinghouse, China National Nuclear Corporation and GF Energy represent some of the lead participants in the sub-sector. In terms of newer technologies like SMRs, a UK consortium by Rolls-Royce hopes to create up to 40,000 new skilled jobs (with some 6,000 delivered by 2025) as the programme begins to scale up, with around 80% of the components manufactured in the Midlands and Northern England. However, the opportunities for market penetration by companies at present working outside of the nuclear sub-sector supply chain face significant barriers to entry due to safety and security reasons and the sub-sector's stringent accreditation processes. Whilst these barriers are not insurmountable, they are not an instant process. For those without the industry insight or necessary clearance there will be an inability to react quickly to opportunities in the sub-sector as they may in other low carbon technologies.

Carbon Capture Usage and Storage

CCUS is the process of capturing and storing CO2 before it is released into the atmosphere. Internationally there are only around 20-30 large-scale projects in operation due to the cost and level of development of the technology. However, the sector is expected to grow significantly in the long term due to improved technology, significantly reduced costs, carbon legislation and governmental support.

There are currently a number of large-scale CCUS projects at different stages of development close to existing industrial clusters. These include Acorn CCUS, Caledonia Clean Energy, Clean Gas project, Hy Net North West, H21 North West of England, Net Zero Teesside, and a BECCUS pilot plant at Drax Power Station. The Zero Carbon Humber partnership, comprised of 12 leading companies and organisations across the Humber including Drax, have recently submitted a joint public-private sector funded bid worth around £75m to support the deployment of CCUS and hydrogen technologies in the region.

The direct employment impacts of CCUS are expected to be in installation, O&M, construction of pipelines and storage, transportation of CO2, manufacture of equipment, and consultancy and R&D. However, probably the larger economic impact of CCUS deployment will be the safeguarding and extending employment in existing carbon intensive industry plants that would otherwise be unviable because of carbon legislation.

Low Carbon Heat

The Low Carbon Heat sub-sector is defined by the ONS as the design, production, and installation of infrastructure for generating heat directly through solar, thermal, geothermal, or other means. The renewable heat sub-sector will be crucial to achieving net-zero by 2050. This is expected to result in significant jobs growth as outlined below:

Table 5 – Low Carbon Heat – Current and Projected Employment

Sub sector	Renewable heat	Renewable combined heat and power
England Industry Size (2020) - ONS (FTEs)	7,000	1,900
England (2030) - LGA data	152,000	6,500
England (2050) - LGA data	230,000	8,000

The sector is primarily made up of businesses within the Heat Pumps, Heat Networks and Hydrogen Boiler industries.

Within the UK, these three primary industries are relatively small, especially in comparison to countries within the EU, meaning:

1. The sector needs to expand in the UK to decarbonise its heat supply; and
2. Larger European businesses have already scaled-up significantly and are beginning to expand into and be the key partners in the UK renewable heat sector.

Heat Pumps

Compared to the other two primary industries within the renewable heat sub-sector, the market growth potential for the heat pump industries appears more certain, with the UK government backing the industry by setting out ambitions to install 600,000 heat pumps a year by 2028 and a total of 19 million by 2050. However, the UK heat pump industry is still emerging, with only 27,000 heat pumps being installed in 2018 (France 275,000), which supported 2,000 jobs across the whole UK heat pump sub-sector supply chain (European Heat Pump Association, 2018). The sub-sector has seen some growth in recent years, with the number of installations increasing to c.43,000 in 2021. However, significantly faster growth is required to meet the government's ambition for 600,000 by 2028. Having a robust and reliable supply chain is of great importance to enable the expansion of this industry to meet the government's ambitions and deliver a net-zero UK by 2050.

The heat pump industry can be roughly separated into four parts: R&D, manufacture, sales & distribution, and installation.

R&D and Manufacturing

At present this element of the industry is small and dominated by companies whose core R&D and manufacturing capabilities are located outside the UK nearer their headquarters, generally in Europe. Eunomia analysis for BEIS estimates that 33 manufacturers are active in the UK heat pump market, four of these manufacture air source heat pumps (ASHP), and the market leader in this area is Mitsubishi (Scotland). Kensa (Cornwall) are the market leaders for Ground Source Heat Pumps (GSHP) in the UK. It should be noted that the manufacturing activity in the UK is mostly parts assembly with individual components sourced from outside the UK.

Installations and Sales

There are 2,017 Microgeneration Certification Scheme (MCS) registered installers which includes 1,112 registered for ASHP installation and 682 registered for GSHP (significant installer overlap). To meet government targets to be installing 300,000 heat pumps each year by 2025, there would need to be almost 10,000 qualified heat pump installers (EY) in the UK in the next 4 years (from 2021), with more installers then needed to meet the 600,000 target by 2028. At present, the Independent Networks Association estimates there were just 1,200 installers qualified to fit heat pumps.

Heat Networks

Heat networks currently provide 2% of the UK's heat demand, in contrast to Denmark's (50%), highlighting the European disparities in reliance on this type of technology. However, its use elsewhere evidences its commercial potential and demonstrates the technologies' ability to contribute to reducing greenhouse gasses. Its potential role in reducing the UK's carbon emissions was recognized by BEIS in the 2017, Clean Growth Strategy which estimated c.20% of the UK's heat demand could be supplied by heat networks, which would require considerable jobs and business growth.

The supply chain for the Heat Network industry is large and fragmented, with no single business currently able to offer a fully integrated team (across the three main stakeholders, investor, developer, and operator) capable of delivering full deployment and operation of heat networks. This has resulted in the key stakeholders adopting different objectives and requirements which has resulted in the slightly fractured supply chain restricting the growth of the industry.

Developers and Operators

This part of the Heat Network supply chain is dominated by a small number of established large businesses including, Vital Energi who supplied Nottingham and Sheffield District Heating Schemes (locations in Blackburn, London, and Scotland), Vattenfall (Sweden, London, Edinburgh, Hexham, and Penzance) and Veolia (France, UK wide). With many of the developers and operators located outside of the UK, Heat Network R&D facilities are generally based outside the UK.

The core professional service supply chain for these stakeholders is dominated by large, international firms like Ramboll, Aecom and Arup who have a UK-wide presence but are largely based in major cities in the UK.

Due to the size and variety of the wider material and equipment supply chain, there is limited data or research on it (material and equipment). However, it is known that a limited number of companies dominate the district heat pipe market, including Logstor and partner business Power Pipe located in Nelson, Lancashire.

Low Carbon Hydrogen for Heat

Low carbon hydrogen is being explored as an option for decarbonising heat in buildings. The main attraction to this is the potential to use the existing natural gas infrastructure, safeguarding value of this government asset and jobs associated with maintaining this infrastructure. Its relative familiarity as a technology also appeals to existing gas boiler engineers and end users.

Before low carbon hydrogen for heating buildings can be considered as a potential option to decarbonise heat in buildings, further research is needed to understand the costs, benefits, safety, feasibility, air quality impacts and consumer experience relative to other more established decarbonisation technologies. This process will take place over the next 10 years as government works with industry, network operators and local partners on studies and test projects.

Due to the uncertainty regarding the viability and suitability of using hydrogen to heat buildings a supply chain has not yet developed around the opportunity. From an infrastructure perspective, the supply chain is likely to emerge from the existing UK gas distribution supply chain. From a boiler perspective, a supply chain is emerging, with manufacturers such as Worcester Bosch (Worcester), Viessmann (Germany and Telford) and Baxi (Warwick) making significant progress developing prototype hydrogen boilers.

The majority of investment activity over the next 10 years will be associated with understanding the feasibility and viability of using low carbon hydrogen for heating buildings.

Energy from Waste, Biomass and Alternative Fuels

Biomass is a broad term covering all organic material including that from plants, trees (for example straw, crops, or wood) and animals (for example poultry litter). Almost 40% of energy consumption from renewable and waste sources was from Biomass according to the ONS. Waste, Biomass, and Alternative Fuels are considered a renewable form of ‘fuel’ that can be used to produce low carbon energy.

Biomass can be considered a renewable form of energy and electricity generation as its growth (e.g., of plants or trees) removes greenhouse gases like carbon dioxide from the atmosphere and stores it in soil, trees, and other vegetation. Energy from waste is better than landfill, providing the residual waste being used has the right renewable content and is matched with a plant that is efficient enough at turning the waste to energy. These technologies should be reviewed on their merits as on a case-by-case scenario as they are not as straight forward to assess.

Alternative Fuels refer to the production of fuels for low-carbon and renewable energy use, which is not classified as bioenergy. This includes hydrogen but does not include compressed natural gas and liquefied petroleum gas.

Table 6 - Energy from Waste, Biomass and Alternative Fuel - Current and Projected Employment

	Bioenergy	Alternative fuels
England Industry Size (2020) - ONS FTEs	7,100	500
England (2030) - LGA data	69,000	9,000
England (2050) - LGA Data	102,000	23,000

Bioenergy

In recent years bioenergy's contribution to the UK has grown strongly, helped by a supportive policy framework. Bioenergy currently provides a significant proportion of renewable energy in the UK, providing 7.4% of total UK energy supply (11% of total electricity; 4% of energy used to produce heat; 2% of energy needed in the transport sector).

The Committee on Climate Change estimated that bioenergy could provide up to 15% of UK energy demand in a low carbon economy by 2050, and specifically highlighted the important role bioenergy with carbon capture and storage (BECCS) could play in hard to decarbonise sectors such as aviation. However, bioenergy supply chains are complex, with many possible combinations of feedstocks, conversion technologies and energy products. It involves many interactions with other parts of the bioeconomy – including agriculture, forestry, and the waste management sector.

The UK supply chains now provide a number of materials for energy purposes including energy crops from agriculture; feedstocks for transport biofuels manufacture; crops, manures and residues processed by Anaerobic Digestion; straw for thermal power generation; and wood fuel consumed in heating boilers. This demand has had a particularly beneficial impact on the rural economy, creating or securing employment and providing more diverse markets for agriculture and forestry products.

Alternative Fuels

The largest opportunity for growth in the alternative fuel sector is 'blue' and 'green' hydrogen. At present the UK produces only 27 TWh of hydrogen a year, mostly from fossil fuels ('brown' or 'black' hydrogen) which is not a renewable source of energy unless the CO2 released is captured using Carbon Capture, Utilisation and Storage (CCUS), which would make it 'blue hydrogen'. At present, there is limited carbon capture associated with hydrogen in the UK today meaning the size of the low-carbon hydrogen industry is extremely small.

Alongside 'blue hydrogen', 'green hydrogen' can be produced using electrolysis, where electricity is used to split hydrogen from water using electricity which has been renewably produced. These two types of hydrogen are low carbon.

At present, hydrogen is mainly used in heavy industry e.g., oil refining and steel manufacturing, however, it has scope (to varying degrees) to be used to power vehicles, heat buildings and store power generated by renewable methods.

As a result of its range of potential applications, hydrogen has gained significant political support, with the UK Hydrogen Strategy setting out the ambition to deliver 5GW of low-carbon hydrogen production capacity by 2030. The government estimates developing a UK hydrogen economy could directly support 9,000 jobs by 2030 and up to 100,000 by 2050 (in a high hydrogen scenario).

Recently (April 2022), the government doubled its target for UK low-carbon hydrogen production capacity, meaning they aim to deliver 10GW of low carbon hydrogen production capacity by 2030, subject to affordability and value for money. The ambition is for at least half the hydrogen production capacity to be from electrolytic hydrogen, highlighting significant potential growth for the 'green' hydrogen sector. The ambition is for 2GW of low-carbon hydrogen production capacity to be in operation or construction by 2025.

The 'green' and 'blue' hydrogen sectors are currently at a tipping point with the upscaling of production anticipated to meet growing demand. This will require significant development of the UK hydrogen supply chain, which currently has gaps and lacks the capacity to increase production significantly.

The supply chain can be split into 4 key components: production / conversion, movement and distribution, storage, and application, with wider jobs around certification, training and health and safety also available within the industry.

There are a range of firms operating within the UK hydrogen sector, comprising a mix of firms operating in different parts of the supply chain. For example, some firms are small, independent operators working within a small niche delivering a product or service within one aspect of the supply chain, whilst other large firms work across multiple aspects of the supply chain.

Many firms have supply chains that stretch to countries in Europe, China, and America. However, many firms in the UK hydrogen supply chain have developed close relationships with other UK firms as either a client or supplier.

There are emerging hydrogen clusters predominantly located around existing industrial sites where there is significant potential for CCUS required for blue hydrogen. Major UK clusters are in the North West, Humberside, Southampton, South Wales, Teesside, and Grangemouth.

Energy Efficient Products

The Energy Efficient Products sub-sector is defined by the ONS as the design, manufacture and installation of energy-efficient products including:

- insulation such as loft, external wall, roof insulation, reducing energy consumption for heat or air conditioning by minimising "leakage" of heat.
- heating and ventilation, such as condensing boilers, ventilation, and heating recovery.
- energy-efficient doors and windows.
- energy-efficient building materials or technologies.
- sustainable buildings and architecture and,
- materials with greater insulation properties or durability properties or those producing significantly less carbon emissions in their manufacture or recycling waste materials in their manufacture.

The Energy Efficient Products sub-sector is currently the largest of the Low Carbon sectors nationally, accounting for 31% (£13.2bn) of turnover and 40% of employment (81,300 FTE). However, the Energy Efficient Products sector is forecast to remain fairly static as shown below:

Table 7 – Energy-efficient Products – Current and Projected Employment

	Energy-efficient products	Energy-efficient lighting	Energy monitoring, saving or control systems
England Industry Size (2020) - ONS FTEs	73,000	19,700	12,000
England (2030) - LGA data	106,000	22,000	17,000
England (2050) - LGA data	106,000	27,000	20,000

Due to the variety of products, there are multiple supply chains in this sub-sector. For the purpose of this study, we have investigated the industries given as examples in the ONS definition of the Energy Efficient Products sub-sector which are also key products that are needed to support the UK's transition to net-zero by 2050:

Insulation

Proposed legislative changes (approved Document L) state that all new buildings must be designed to produce 31% less carbon emissions than those built to PartL1A (2013), which will help drive a fabric first approach to reducing carbon-emissions by, reducing energy usage, and enabling technologies such as heat pumps to have their intended impact.

High-quality insulation will be key to achieving this proposed legislative change and play a major role in retrofitting the UK's existing housing stock to achieve the same aim as new-build properties, to reduce domestic carbon emissions. From a retrofit perspective, recent policy focused on the Green Homes Grant (July 2020), a £2bn programme (£500m for low-income households and £1.5bn of vouchers to be given to households for insulation, low carbon heating, windows and doors and heating controls). This programme is now closed, leaving a gap in policy regarding retrofitting the UKs existing housing stock. However, to achieve net-zero by 2050, the government will need to adopt policies that support insulating the existing UK housing stock.

The insulation supply chain is made up of 6 key stakeholders: (1) material and chemical manufacturers, (2) insulation manufacture and production, (3) wholesale, (4) installation, (5) architects and building designers, and (6) building users.

There is very little dependence on location for the supply or demand sides of the supply chain. Raw materials are manufactured both in the UK and Europe. There is no insulation cluster but the main chemical manufacturers (BASF and Arpadis) are primarily found in the Northwest of England.

Energy-Efficient Building Materials or Technologies

Examples of energy-efficient building materials include recycled steel, insulating concrete forms, plant-based polyurethane ridged foam and structural insulated panels. At this time there is limited information available on supply chains for efficient building materials or technologies.

Sustainable Buildings and Architecture

Sustainable architecture is characterized by smart building and infrastructure design and the use/readiness of low-carbon technologies. Key aspects of sustainable buildings and architecture are energy-efficient lighting fixtures, appliances, heating, cooling and ventilation systems, water-saving features, the use of natural light and renewable energy sources and the use of recycled and local materials.

The architecture industry is a service industry that is dominated by large architectural firms, generally located in large metropolitan areas. However, there are a fair number of local architects located in small metropolitan areas across the UK. To support the transition to net-zero and therefore incorporation of many energy-efficient products, architects will have to adapt the approach to design to ensure buildings meet the Future Homes Standard for example modern methods of construction. The market is likely to evolve rather than experience significant growth.

Energy Efficient Doors and Windows

The Energy Efficient Doors and Windows can be broadly split out into manufacturing, distribution, and installers. There is limited information readily available on the geographical spread of businesses within the UK Energy Efficient Doors and Windows supply chain.

From an inward investment perspective Saint-Gobain, a glass manufacturer that supplies low-E windows, has recently invested £30m to build a new state-of-the-art furnace at their factory in Eggborough (North Yorkshire). This was one of the largest single investments made in manufacturing capability in the UK glass and window industry in 2021. The energy efficient doors and windows industry is likely to grow from within the existing door and window industry as policy and building regulations change, although there is room for new businesses to disrupt the existing market.

Energy Monitoring, Saving or Control Systems

ONS define energy monitoring, saving or control systems as the design, manufacture and installation of systems that reduce energy consumption through effective heat or energy management. This includes equipment and related systems for doing this e.g., smart heating controls, condensation control, control system components, energy management systems and energy management software.

To support the transition to net-zero buildings will require a combination of fabric improvements (as outlined in the insulation section of this report), new heat technologies such as heat pumps and monitoring, saving and control systems. The sub-sector is therefore likely to experience some growth, however there is limited information currently available on the size of the industry and supply chain and business clusters / distribution across the UK supply chain.

Low-Carbon Services

Financial and advisory services are quite self-explanatory and include professional services and intelligence in terms of green funding, green bonds, government incentives and performance reporting for private and public stakeholders.

Table 8 – Low-carbon services – Current and Projected Employment

	Low-carbon financial and advisory services
England Industry Size (2020) - ONS FTEs	4,600
England (2030) - LGA data	5,000
England (2050) - LGA data	13,000

Low-Emission Vehicles and Infrastructure

This sector covers the design and manufacture of vehicles with specific technology to significantly reduce or remove emissions, including hybrid, electric and fuel cell vehicles, alongside the installation of infrastructure to support these vehicles. The broad sector also includes the fuel cells and energy storage systems sub-sector, which contains the design, manufacture and installation of energy storage systems, fuel cells, batteries, and any other form of energy storage system.

Table 9 – Low-emissions vehicle and infrastructure – current and forecast employment

	Low-emission vehicles and infrastructure	Fuel cells and energy storage systems
England Industry Size (2020) -ONS FTEs	16,900	1,700
England (2030) - LGA data	89,000	5,000
England (2050) - LGA data	183,000	17,000

Electric vehicle registrations have risen significantly since 2015. In 2015, just 1.1% of new vehicle registrations were Battery Electric Vehicles (BEV) or Petrol Hybrid Electric Vehicles (PHEV), rising to 3.2% in 2019. By 2021, 18.6% and in September 2022, the market share was 22.4% - reflecting the increase in demand for electric vehicles and the corresponding decline in demand for traditional vehicles, particularly diesel. In 2020, with increased range and greater model choice, BEV's overtook PHEVs as the electric vehicles of choice.

Brexit has impacted UK EV manufacturing - most electric car batteries are made outside Europe, and with rules dictating how much of a product must be made inside Europe to qualify for lower tariffs when UK manufacturers trade with the rest of the EU, this is an obstacle. With an initial limit of 60% of components made outside Europe falling to 45% by 2027, UK manufactured EV could become prohibitively expensive, with investment not paying off for manufacturers. Ultimately all electric vehicles sold in Europe (which currently accounts for 55% of UK manufactured car sales) will have to have a European-made battery.

In terms of associated infrastructure, the UK Government has a Vehicle Charging Infrastructure Solutions (VCIS) agreement, and a dynamic purchasing system (DPS) offering customers in central government as well as the wider public access to products and services that support vehicle charging infrastructure, such as charge points, which currently includes 92 suppliers.

Analysis for the LGA predicts that by 2030 14% of low carbon jobs nationally will be directly involved in manufacturing low-emission vehicles and the associated infrastructure. These jobs will range from manufacturing electric vehicles (and hydrogen vehicles), manufacturing EV batteries from the proliferation of gigafactories in England and sustaining low-carbon mobility by installing electric vehicle charge-points and hydrogen re-fuelling stations.

The growth of these sectors is already concentrated in the areas with traditional strengths in vehicle manufacturing, such as the West Midlands where around half of automotive companies produce vehicle components. Since 2011 UK investment in electrified vehicle production, research and battery development is estimated at £11bn. The vast majority of this has been in the North West (£2.8bn), North East (£4.1bn) and the West Midlands (£2.1bn).

4.0 ASSESSMENT OF DONCASTER'S LOW CARBON SECTOR

This section aims to give an illustration of current size and nature of low carbon activities in Doncaster, and then develop an understanding of which low carbon sub-sectors provide the best opportunities for growth in Doncaster.

4.1 Doncaster's Current Low Carbon Sector

Traditionally for the mapping of sectors the ONS' Business Register and Employment Survey (BRES) has and continues to be an excellent source of data, given the detailed level of standard industrial classification (SIC) code and geographical breakdown. However, low carbon sectors do not map well to the SIC codes, and often many of the firms operating in low carbon also participate in other, non-low carbon sectors. Whilst the ONS does publish the LCREE survey data annually, this does not provide estimates for geographies below national level, therefore additional analysis has been required to understand the local low carbon sector.

By combining the information provided by LCREE survey data for the structure of the national low carbon economy and detailed BRES data for the structure of Doncaster's economy, it is possible to estimate the current levels of low carbon activity:

- In 2020, it is estimated that LCREE activities directly supported between **700 and 900 full-time equivalent (FTE) jobs** in Doncaster, approximately 0.7%-0.9% of employment in the whole economy.
- Most of these jobs are in construction (300-400 FTEs) and manufacturing (250-350 FTEs) businesses. These sectors are the largest in the low carbon economy nationally and are also relative strengths of the Doncaster economy.
- Nationally low carbon activity is also concentrated in the energy supply, and professional services sectors. These sectors are relatively small in Doncaster, and therefore data suggests fewer than 100 of Doncaster's low carbon FTEs operate in either of these broad sectors.
- Applying national benchmark figures for turnover per LCREE FTE by broad sector to the above employment suggests the value of Doncaster low carbon activities is currently in the region of **£120-£145m per year**.

Further examination of this data and analysis of business-level data, literature review and consultation has been utilised to highlight some of the existing low carbon comparative advantages and supply chains in Doncaster, which could attract and support future business growth.

Construction

Low carbon growth will support new and existing businesses in the construction sector by creating opportunities to install, maintain and decommission technology. Low carbon construction employment is heavily concentrated in low carbon electricity, low carbon heat and energy-efficient product sub-sectors. Notable existing strengths in Doncaster are as follows:

- Low carbon electricity – Doncaster is already home to companies like Ivoltz who are renewable energy installation and storage specialists and has a significant existing electrical installation (600 jobs), other civil engineering (600) and specialised construction workforce (450).
- Low carbon heat – Doncaster has a relatively large workforce working in plumbing, heat and air-conditioning installation (1,125 jobs). A number of these businesses are already established in the low carbon heat sector installing low carbon technology including heat pumps (e.g., Integrated Energy Solutions Ltd, Marvel Heating & Renewable Energy Ltd, ECO CCL Ltd.)
- Energy-efficient products – Doncaster has businesses well placed to support the installation of efficiency products in buildings, with 1,500 jobs currently in building construction, and established insultation specialists including Websters Insulation, Westdale Group, Cosyhome Insulation, and D&R Insulation services.
- Civil engineering – 2,230 are currently employed in civil engineering in Doncaster, with a particular specialism in construction of railways (900 jobs).

Manufacturing

Low carbon growth will support new and existing businesses in the manufacturing sector by creating opportunities to manufacture new technology or to be part of growing supply chains. There are already businesses in Doncaster's manufacturing base that can support growth in most low carbon sectors. Businesses currently manufacturing low carbon technology include:

- Clean Power Hydrogen - Developer and manufacturer of green hydrogen technologies utilising their membrane-free electrolyser technology.
- Zeck - Low carbon heating solutions for the food and beverage sector, utilising their CATTS (Cascade and Thermodynamic Transportation System) designed in partnership with the National Centre of Excellence for Food Engineering in Sheffield.
- Webasto UK - Manufacturer of vehicle cooling, heating, and charging solutions.

Alongside these there are manufacturers well placed to benefit from low carbon growth:

- Pegler - Leading manufacturers of advanced plumbing, heating, and engineering products.
- Doncaster Cables – Largest British owned general wiring manufacturer in the UK.
- Lighting equipment manufacturing firms who together employ 200 people in Doncaster.

4.2 Doncaster Low Carbon Sub-Sector Analysis - Key Findings

By combining the wider sub-sector analysis in section 3 with Doncaster specific consultation and research, an assessment has been made as to which sub-sectors are most likely to grow significantly in Doncaster. The table below (Table 10) sets out a high-level assessment of potential scale of growth in each low carbon sub-sector in Doncaster alongside expected UK wide sector growth. The scale of opportunity for Doncaster reflects a judgment on whether Doncaster is well positioned to benefit from the expected national growth. A more detailed explanation of each sub-sector follows in section 4.3.

Table 10 - Assessed potential growth opportunities (medium-term: 3-5 years, long-term: 5-7 years)

Low Carbon Sub-sector	Current Sector Size UK wide	Expected growth UK wide	Opportunity for Doncaster	Timescale / Maturity for Doncaster
Offshore wind	Large	Large	Small	Immediate
Onshore wind	Medium	Medium	Small	Immediate
Solar photovoltaic	Large	Large	Medium	Immediate
Other renewable / Hydropower	Small	Small	Very Small	N/A
Nuclear power	Medium	Large	Small/Medium	Long term
Carbon capture and storage	Small	Medium	Medium	Long term
Renewable heat	Medium	**Very Large**	**Large**	Immediate
Renewable combined heat & power	Small	Medium	Medium	Medium term
Bioenergy	Large	Large	**Large**	Immediate
Alternative fuels	Small	Large	**Large**	Medium term
Energy-efficient products	**Very Large**	Medium	Medium	Immediate
Low-carbon financial and advisory services	Medium	Medium	Small	Immediate
Low-emission vehicles and infrastructure	Large	Large	Medium	Medium term
Fuel cells and energy storage systems	Small	Medium	Medium	Long term

4.3 Doncaster Low Carbon Sub-Sector Analysis – Explanation of Growth Prospects

The following section explains the judgement above on the growth prospects for each of the low carbon sub-sectors investigated as part of this study in Doncaster. This is the last section of the study which comprehensively covers all the low carbon sub-sectors, because as explained below many do not represent significant opportunities locally.

Offshore Wind

Doncaster Inward Investment Opportunity – **Small, Immediate**

Despite continued growth in the sub-sector nationally, which is strongly supported by current Government policy, for geographical reasons there is little significant offshore wind related activity in Doncaster. Distance from the coast is the key barrier to large scale investment in the offshore wind supply chain in Doncaster, especially given the established manufacturing and infrastructure situated on the Humber Estuary.

Current industry participation is confined to provision of expertise in steel rope products with Bridon Bekaert Ropes Group, recently being allocated Government funding to develop and demonstrate floating turbine technology, and Certex UK winning a framework for inspection and maintenance work at the 114-turbine, 1075MW Seagreen Offshore Wind Farm off the coast of Angus in the North Sea firth. Analysis by Equity Consulting (2020) forecast that given net zero targets and current industrial specialisms, offshore wind would be expected to support fewer than 100 jobs in Doncaster by 2030.

Onshore Wind

Doncaster Inward Investment Opportunity – **Small, Immediate**

Currently, Doncaster has four onshore wind sites, with 61MW installed capacity generating by far the most wind energy of the local authorities in South Yorkshire. However, the operators and developers of these sites are not local firms, including E.ON Climate Renewables, Banks Developments and Good Energy.

Within the Doncaster Local Plan 2015-2035 there has been identified further suitable sites for the expansion of onshore wind power generation which means there is a potential for the attraction of alternative operators to the area. However, an increase in the volume of generating capacity is unlikely to translate into significant local economic or employment growth as most of the work is undertaken by operating companies using in-house teams, and the supply-chain into the onshore wind sub-sector continues to be dominated by a relatively small number of larger multinational companies. There may be opportunities (as with Certex UK and the offshore sub-sector) in the monitoring, inspection, and maintenance of the expanded operations, but these will likely to be limited.

Delivering additional onshore wind capacity in Doncaster could enable the growth of other low carbon industries including green hydrogen production. However, current central government policy does not offer support for growth in the sector.

Solar Photovoltaic

Doncaster Inward Investment Opportunity – **Medium, Immediate**

Doncaster has 7,100 solar installations of differing size with an aggregate 44MW installed capacity, the most in South Yorkshire. In addition to this there is a solar farm with permission awaiting construction at Partridge Hill, which would deliver an additional 33MW of capacity. There is a relatively mature local supply chain of solar equipment and installers, including numerous small construction businesses.

The manufacturing of solar panels globally is dominated by China, however economic opportunities in wholesale, installation, maintenance and decommissioning present opportunities for economic growth in Doncaster, given the existing and future solar generation capacity in the area.

Much like onshore wind, increasing solar capacity in Doncaster could enable the growth of other low carbon industries including green hydrogen production. However, current central government policy does not offer support for growth in sector.

Hydropower / Other Renewables

Doncaster Inward Investment Opportunity – **Very Small, N/A**

The AECON produced Renewable and Low Carbon Energy Study (2012) cited a Defra review of potential hydropower sites identified within the Doncaster area. Four large sites were located along or in close proximity to the river Don with another 18 (micro-sites) located along its smaller tributaries. However, there is no evidence that the outcome of this Study moved to the feasibility stage. Although a hydropower generator was established in Rotherham (Thrybergh Hydropower) in 2015, the unsupportive policy environment, and very limited domestic and geographically concentrated supply-chain, mean the opportunities for Doncaster appear very limited.

Also, in the context of Doncaster the production of electricity from wave and tidal sources is not possible and therefore the opportunity for developing a cluster of businesses in this sector is limited.

Nuclear

Doncaster Inward Investment Opportunity – **Small/Medium, Medium Term**

As a location for the expansion of the nuclear energy sub-sector supply chain, there are a number of key limitations confronting Doncaster across all three elements of the industry. The lack of any former nuclear presence within the boundaries of the authority presents little incentive for the relocating or expansion of companies (and basing of skills) in the nuclear decommissioning field. In terms of the knowledge economy, Doncaster's geographical proximity to the University of Sheffield and the Nuclear Advanced Manufacturing Research Centre (NAMRC) in Rotherham, both leading research centres in this sub-sector, as well as the many other UK (and international universities) which already have established reputations in nuclear research, largely mitigates against the creation of an entirely new research and development base within South Yorkshire. Similarly, in the provision of specialist components for the construction of the new generation of more conventional reactors, as well as the new SMRs, Sheffield is a recognised centre for production of forged metal products whereas Doncaster has less established expertise in this area.

To date, the only Doncaster based industry participation in the sub-sector has been Laser Additive Solutions, a specialist welding company, which has been recently successful in securing UK Government finance for the development of a new adhesion process for the growing SMR element of the nuclear energy sub-sector. However, given the small base and the highly automated adhesive processes involved, even at scale, this is unlikely to be an element within the supply-chain which would contribute significantly to economic growth.

Carbon Capture, Usage and Storage (CCUS)

Doncaster Inward Investment Opportunity – **Medium, Long Term**

Although currently a very small sub-sector, in the long term the sub-sector is very important to the net zero transition and expected to support high levels of investment and employment by 2050. It is recognised that CCUS should create economic opportunities for any area that has significant high carbon industry. Although currently major CCUS projects are elsewhere, there are significant opportunities to make links with the storage infrastructure and jobs created by CCUS in the Humber region. It is also recognised that South Yorkshire could also develop specialisms in CCUS equipment manufacture and consulting given its existing manufacturing and R&D strengths, including the UK Carbon Capture and Storage Research Centre (UKCCSRC) is based in Sheffield.

Heat Pumps

Doncaster Inward Investment Opportunity – **Large, Immediate / Medium Term**

The need for large-scale growth of the heat pump industry nationally is widely recognized to achieve local and national net zero and green jobs ambitions. Given the scale of growth required Doncaster and the wider region could establish itself as a leader in heat pump deployment. Sheffield Hallam University and the University of Sheffield research found, in South Yorkshire, there are 23 registered heat pump installers, some of which saw significant opportunities for growth and were aiming for exponential growth in the near future. However, many are small and not looking to grow. The research suggested there are between 150-200 people directly employed by installers, alongside half as many self-employed installers in South Yorkshire. For deployment to increase at targeted rates of activity the number of jobs and businesses active in installation will need to grow significantly.

If local deployment strengths can be built on, Doncaster could attract investment in other parts of the supply chain, including manufacture and R&D. In terms of attracting manufacturing investment, Doncaster could be an attractive location given transport links, logistics strengths and proximity to population centres.

Analysis by Equity Consulting (2020) forecast that given net zero targets and current industrial specialisms, heat pumps would be expected to support over 800 jobs in Doncaster by 2030, highlighting the need to attract inward investment to meet future growth and demand.

Heat Networks

Doncaster Inward Investment Opportunity – **Medium, Long Term**

Heat Network Industries Council (HNIC) claim that expansion of the sector to meet 18% of UK heat demand by 2050 could create 20,000-35,000 direct jobs. Sheffield Hallam University and University of Sheffield research into South Yorkshire Heat Network supply chains found respondents were not aware of active supply chain companies in South Yorkshire, despite capabilities in steel making. Elsewhere, the supply market appears relatively settled at present but expansion in demand across UK could create opportunities for new suppliers. The Department for International Trade (DIT) noted that investors in the sector are likely to be attracted if a strong pipeline of projects can be established.

Coal mines present a long-term option for mine water heating supply. There is growing research on developing mine water heat applications, and the University of Sheffield have developed some capacity and expertise on this theme.

Low Carbon Hydrogen for Heat

Doncaster Inward Investment Opportunity – **Small, Medium Term**

The viability and feasibility of using low carbon hydrogen for heating buildings is currently unclear. Over the next 10 years the UK government will be working with industry, network operators and local partners on studies and pilot projects to gather the evidence required to understand the viability and feasibility of low carbon hydrogen as a renewable heat supply.

Until the viability and feasibility of using low carbon hydrogen for heating buildings is proven, significant inward investment opportunities associated with supply chain development will not emerge. However, due to emerging and potential strengths in green hydrogen locally there is an opportunity for Doncaster to secure R&D investment as pilot projects emerge.

Bioenergy / Energy from Waste

Doncaster Inward Investment Opportunity – **Large, Immediate**

The sector is an existing strength for Doncaster, with a 5.4MW Anerobic Digestion facility, 13MW Landfill Gas and 3MW solid waste capacity operational. On top of this permission has been granted for a new BH Energy Gap Energy from Waste project at Kirk Sandall (34MW). Key operators locally are Refood, Eco-Power and FCC Environment.

Bioenergy is location dependent as it requires a good supply of feedstock. Proximity to large areas of productive arable farmland makes Doncaster well placed for further growth in energy from Biomass. Future growth in Energy from Waste projects is constrained by the available waste used to fuel the industry, so growth in energy from waste in the long term is expected to be lower than from other bioenergy sources.

"Bioenergy is traditionally a strong source of inward investment. There were peaks in foreign direct investment (FDI) in biomass in the mid 2010s, however currently this is dampened by industry awaiting policy direction from central government to provide certainty for direction of future growth." Department for International Trade Consultee

Despite this uncertainty, the sub-sector still represented a large share of low carbon FDI in the UK last year. There is currently strong interest in the opportunities to power hydrogen production through Biomass, and development of BECCS (Bioenergy with Carbon Capture and Storage) facilities as being developed at Drax power station.

Analysis by Equity Consulting (2020) forecast that given net zero targets and current industrial specialisms, Bioenergy would be expected to support over 1,300 jobs in Doncaster by 2030, and nearly 2,000 by 2050.

Alternative Fuels - Hydrogen

Doncaster Inward Investment Opportunity – **Large, Medium Term**

Hydrogen is a relatively undeveloped sub-sector but with very large potential, and Doncaster and the wider South Yorkshire region is in a good position to exploit it, especially given the UK Hydrogen Strategy's focus on 'blue' and 'green' hydrogen central to the future national approach. South Yorkshire is home to several hydrogen firms, including Clean Power Hydrogen in Doncaster which has developed a Membrane-Free Electrolyser to produce 'green' hydrogen more cost-effectively. In 2020, the Hydrogen Taskforce estimated that by 2035 'green' hydrogen production could support 18,000 jobs nationally, alongside 12,500 jobs in electrolysor manufacturing. Given Doncaster's high level of installed renewable energy capacity and existing businesses, the area has a comparative advantage and opportunity to scale up green hydrogen production and related activities.

"The whole hydrogen economy is buzzing in South Yorkshire… and it can be a regional hub globally for the industry." (Local Business Consultee)

Alongside this, the University of Sheffield and ITM Power have announced a collaboration to fund the National Hydrogen Research Innovation and Skills Centre and an agreement for a new ITM Power Gigafactory in the University of Sheffield's Innovation District, enhancing South Yorkshire's potential to develop a hydrogen cluster. The sector also has large export potential, with South Yorkshire firms including Clean Power Hydrogen already very active in overseas markets, in particular in some South American countries that have adopted aggressive carbon reduction policies. However, there are currently only a limited number of sub-sector firms operating in South Yorkshire, and therefore there are opportunities to better integrate and grow the supply chain within the region.

More details of the variety of opportunities in the sub-sector are set out in section 5 of this report.

Energy-Efficient Products

Doncaster Inward Investment Opportunity – **Medium, Immediate**

Although energy-efficient products are currently the largest low carbon sub-sector nationally in terms of employment and turnover, the expected growth in the sub-sector is not expected to match the future growth in other low carbon sub-sectors. Analysis by Equity Consulting (2020) forecasts that in Yorkshire and Humber energy efficient products' share of LCREE employment will drop to 15% by 2030 and fall to 9% by 2050.

Insulation, which represents the largest industry in energy-efficient products, tends to fall within an established conventional construction supply chain, and despite some local key installers (Westdale, Cosyhome, and Websters Insulation) there is no specific cluster in Doncaster or South Yorkshire. Therefore, whilst local and national targets for insulation will support future demand, the mature nature of the industry and lack of location dependence will limit the opportunity for inward investment in Doncaster.

Low Carbon Services

Doncaster Inward Investment Opportunity – **Small, Immediate**

Analysis by Equity Consulting (2020) forecasts that the number of jobs in the low-carbon service sub-sector will continue to grow to 2030 but make up a small proportion of Low Carbon jobs locally (5%). The majority of low-carbon service sub-sector businesses are expected be located in regional economic centres and large cities across the UK.

Low-Emission Vehicles and Infrastructure

Doncaster Inward Investment Opportunity – **Medium, Medium Term**

Nationally the low-emission vehicles sub-sector is expected to grow to represent 14% of low carbon jobs by 2030. These jobs will range from manufacturing electric vehicles and hydrogen vehicles, to manufacturing and installing associated infrastructure.

Doncaster and the wider Yorkshire region's lack of car manufacturing heritage mean electric vehicle manufacturing clusters elsewhere in the UK have comparative advantages over Doncaster in terms of the manufacturing electric cars and vans. Therefore, the majority of investment in their manufacture are unlikely to take place locally. Opportunities for growth will therefore be in the number of firms involved in related industries such as Energise Energy Solutions, an electric vehicle charging station contractor who employ over 100 people already based locally, and Synetiq working in car salvage are playing a role in decarbonising car parts.

Given existing and emerging strengths, the major opportunities for future investment in low emission transport for Doncaster appears in the development of hydrogen vehicles, and low carbon HGV, rail, and air transport. Work is underway investigating the feasibility of a first hydrogen refuelling hub in Doncaster, which could act as a demonstrator and engage hauliers in

the practicalities of running HGV fleets using hydrogen as a fuel. Rail manufacturers and NCATI with links to University of Birmingham (who have developed a hydrogen train) and Sheffield Hallam University, are already supporting decarbonisation in rail, which can take advantage of Doncaster' traditional manufacturing expertise in the sub-sector. Whilst the proposed AMRC light weighting facility at GatewayEast, aims to attract businesses to an innovation district focused on low carbon air travel, like Hybrid Air Vehicles who have announced plans to establish production of their Airlander 10 in Doncaster.

Fuel Cells and Energy Storage Systems

Doncaster Inward Investment Opportunity – **Medium, Long Term**

In terms of storage systems, there is no significant energy storage in the Doncaster area, although there is a site at Long Lands Lane with planning permission to deliver 12MW of energy storage capacity. Linked to the renewable energy presence in Doncaster there are some energy storage specialists in Doncaster, including Ivoltz. The fuel cells sub-sector is anticipated to grow rapidly after 2030. Development of hydrogen specialisms could support growth in fuel cell related businesses in Doncaster, however the timeframes for this are currently unclear.

5.0 KEY INWARD INVESTMENT OPPORTUNITIES FOR DONCASTER

The following section further develops what the opportunities for inward investment might be for Doncaster in the key sub-sectors identified in section 4. Below is an explanation of the nature of activity with potential to be attracted, example businesses and their requirements, judgment on likelihood of investment and, where possible, assessments of the scale economic impact.

5.1 Further Growth in the Bioenergy Sector

Current Doncaster strengths and the forecast growth in bioenergy activity required nationally to meet future electricity, heat, and transport demand, means the sub-sector represents a viable opportunity for future low carbon growth locally. Biomass is a vital resource for the key green technologies and energy carriers highlighted as necessary for net zero: low carbon electricity, hydrogen, and carbon capture. Investment into new bioenergy projects is currently constrained by businesses awaiting the publication of the Government's Biomass strategy, originally scheduled to be published in 2022.

Industry requirements:

- Reliable feedstock availability.
- Land availability for facilities.
- End users likely to be prioritised by Government Biomass Strategy, e.g., those in sustainable fuel and hydrogen production helping to decarbonise greenhouse gas (GHG) intensive sectors such as aviation and industry.

Example businesses currently active in the UK Sector –

Biogen

Acquired Tamar Energy in 2018 to create one of the largest independent anaerobic digestion (AD) operating companies in the UK. Currently has 14 AD sites in the UK including in Retford, Nottinghamshire. This is the closest site to Doncaster.

BioConstruct New Energy Ltd

Plans, builds, and maintains plants for farms, medium-sized plants for community use and waste-to-energy plants for industrial use. Owned by German BioConstruct GmbH, who have successfully commissioned over 300 AD plants in 20 years. Currently, NewEnergy operates over 12 MWe of Combined Heat and Power and production of 2,500 nm^3 biomethane and the upgrading and servicing of 20 AD plants of different sizes throughout the country.

Eco2

have developed six biomass projects across the UK, from concept stage, to securing the full funding and commencement of construction. Their development portfolio equates to a total electrical output of 217MW and a total investment raised of £915m, including a 40MW facility at Brigg, North Lincolnshire.

Judgement on likelihood of investment in Doncaster – High

Although the policy which will guide the use on biomass is restricting investment in the very short term, there is long term certainty that bioenergy will continue to be a major part of the net zero transition. Local activity in the sector, alongside land and feedstock availability, means there should be ongoing opportunities to attract investment in the sector.

5.2 Significant Growth in Low Carbon Heat

Low Carbon Heat – Introduction

To transition to an affordable, reliable, and sustainable heating supply by 2050 (the UK government's target for net-zero), the UK must quickly adopt the use of low carbon heat technologies, especially given that currently 20% of the UK's carbon emissions are created from heating buildings.

Whilst the road map for exactly how the UK will transition to renewable heat technologies remains unclear, in particular the composition of renewable heat supply, the government has outlined significant ambitions for three primary technologies, Heat Pumps, Heat Networks and Hydrogen Boilers. For the UK to transition to a renewable heat supply it will need to create a renewable heat ecosystem that incorporates all these technologies. Whilst it is likely that one of these technologies will lead the renewable heat market in the UK in the future, all have some potential to contribute to UK's transition to net-zero.

Doncaster has some natural, economic, and geographical assets and world leading universities, that lay a platform for the borough to attract inward investment associated with heat pumps and hydrogen gas networks. Outlined below are some of principle areas of opportunity:

Heat Pump Manufacturing

At present only 32% of Air Source Heat Pump (ASHP) and Ground Source Heat Pump (GSHP) purchased in the UK are manufactured inside the UK. However, Eunomia analysis for BEIS suggests there is potential to meet around two-thirds of the UK demand with heat pumps manufactured domestically by 2035, with an end-user product value of £5.5 billion.

"European and Japanese heat pump manufacturers are currently exploring opportunities to develop heat pump manufacturing facilities in the UK, in order to meet the future market demand." (Department for International Trade Consultee)

Industry requirements:

Broadly speaking the requirements of a heat pump manufacturer are relatively straight forward. Key requirements include:

- Land availability (with planning permission) for a medium to large industrial space.
- Strategic location on regional and national transport network.
- Supply of affordable labour.

Examples of potential investment partners:

Carrier

A US-based multinational heating, ventilation and air conditioning, refrigeration, and fire and security company. Carrier manufacture air-to-water and water-to-water heat pumps both of which are available to purchase in the UK. Carrier's main manufacturing facility is located in the USA but has facilities located all across the globe.

Daikin

Daikin Industries Ltd is a Japanese multinational air conditioning manufacturing company headquartered in Osaka. Daikin manufacture air-to-air and air-to-water heat pumps all of which are available to purchase in the UK. Daikin's primary heat pump manufacturing facilities are located in the Czech Republic, Belgium and Italy.

Stiebel Eltron

A German based company that manufactures central heating products including air source and ground source heat pumps, all of which are available to purchase in the UK. Their primary heat pump manufacturing facilities are based in Germany and Slovakia.

Panasonic

Panasonic are a Japanese electronics manufacturer that manufacture air source heat pumps. Their heat pumps are primarily manufactured in the Czech Republic but are available for purchase in the UK.

Judgement on likelihood of investment in Doncaster – Medium/High

Doncaster's pipeline of high-quality industrial development sites such as Doncaster North, GatewayEast and Unity Yorkshire, its position as a key road and logistics hub and relatively affordability of labour, place Doncaster well to market itself as a potential location for heat pump manufacturers to set up their manufacturing facilities.

Scale of potential economic impact

The likely economic impact of successfully attracting a heat pump manufacturing facility to Doncaster would be the creation of 100 to 400 manufacturing jobs (the majority of which will be relatively low skilled roles).

Heat Pump Research and Development

Recently, there has been an emergence of manufacturers wanting to develop heat pump R&D facilities in the UK focused on overcoming challenges associated with installing effective heat pumps in the existing UK housing stock. In 2021, Mitsubishi Electric (Livingston, Scotland) became the first heat pump manufacturer to develop such a facility in the UK. Insight from DIT also revealed an appetite from heat pump manufacturers to develop R&D and manufacturing facilities together in the UK.

Industry requirements:

- Grant funding.
- University partnerships.
- Land availability for a medium to large industrial space (with space for R&D facilities).

Examples of potential investment partners:

Potential investment partners replicate those outlined above for heat pump manufacturing.

Judgement on likelihood of investment in Doncaster – Medium

Both the University of Sheffield and / or Sheffield Hallam University have a successful track record of working with the public sector to develop partnerships with the private sector to deliver world-leading R&D facilities such as the AMRC. If a partnership between one or both of the region's universities and a heat pump manufacturer could be facilitated, Doncaster would be viewed as a preferred location for a heat pump manufacturer also wanting to develop heat pump manufacturing and R&D facilities.

Alongside this, SYMCA has a strong track-record of providing funding for the development of R&D facilities, using these facilities as a mechanism to develop a 'cluster' of business activity around a particular specialism. SYMCA's long-term commitment to funding R&D activities provides assurance that investment could be secured should grant funding be required.

Scale of potential economic impact

A heat pump R&D facility in Doncaster has the potential to serve as an R&D anchor for the development of a 'zero carbon heat cluster'. This would create opportunities for further inward investment as businesses within the heat pump manufacturing supply chain agglomerate around the R&D facility, leading to the creation of high value and high skill jobs.

Heat Pump Installation Training

In the UK there has been an emergence of heat pump installation training facilities / heat pump training courses developed with the private sector, demonstrating a growing appetite from the private sector to invest in the training of heat pump installers in the UK to address existing skills shortages. Examples include:

Octopus Energy

Recently (2021) invested £10m to deliver a heat pump research, development, and training centre in Slough (near its existing premises) which has capacity to train around 1,000 trainees a year.

EDF

Have also invested in the creation of the Heat Pump Installers Network Training Centre in Clacton-on-Sea which has capacity to train 4,000 heat pump engineers a year. The training is being delivered by CB Heating a supplier and installer of heat pumps.

NIBE

A heat pump manufacturer (UK HQ and distribution centre in Chesterfield (heat pumps manufactured in Sweden)) are currently upgrading their training centre which delivers heat pump training courses specific to their products. NIBE has also partnered with other education providers such as Prospects College of Advanced Technology (PROCAT) and South Lanarkshire Collage (SLC) to deliver heat pump installation and maintenance training modules within their existing curriculum.

Industry requirements:

- Partnership opportunities with technical colleges.
- Small industrial premises.
- Partnership opportunities with heat pump installers.

Judgement on likelihood of investment in Doncaster – Low / Medium

The main opportunity for Doncaster to secure investment associated with heat pump installation training would be as an addition to the development of heat pump manufacturing facilities. The likelihood of this happening is therefore dependent on securing investment from a heat pump manufacturer to develop a heat pump manufacturing facility.

If a partnership could be facilitated between Doncaster College and a heat pump manufacturer to develop and deliver heat pump installation training, this would increase the likelihood of securing additional investment associated with heat pump production.

Scale of potential economic impact

The economic impact of a heat pump installation training facility would be limited to a small number of jobs and skills outputs. Whilst the direct economic impact of such a facility would be limited, it would help to address the existing shortage of heat pump installers in South Yorkshire, facilitating more and high-quality heat pump installations across the region.

Low Carbon Hydrogen for Heat

Over the next 10 years, the UK government plans to work with industry, network operators and local stakeholders to undertake trails and test projects to establish whether the use of hydrogen to heat buildings is a viable option for decarbonising the UK's heat supply. Therefore, the only short-term inward investment opportunities associated with green hydrogen gas networks will be associated with R&D. For long-term inward investment opportunities to emerge the technology must first be proven as a viable solution to decarbonising the UK heat supply.

Through the introduction of injection or blending of hydrogen into the natural gas pipeline network it is possible to displace a proportion of fossil fuel consumption, improving the sustainability of the gas network, whilst at the same time providing an additional outlet for surplus energy created from renewable energy systems (e.g., wind and solar PV). Providing it is used at a relatively low concentration, between 5%-20% hydrogen by volume, the risks associated with the utilisation of the gas blend in end-use devices (such as household appliances), overall public safety, or the durability and integrity of the existing natural gas pipeline network are considered to be minimal.

Industry requirements:

The requirements associated with R&D activities focused on understanding the viability of green hydrogen gas heat networks will vary depending on the nature of the R&D activity, however key requirements are likely to include:

- Public sector investment.
- Specialist skills in using hydrogen as a heat supply.
- Availability of large-scale test sites.
- Local hydrogen production capability.
- Renewable energy generation capacity.

Examples of existing green hydrogen gas heat network R&D activity:

Hy4Heat Programme – A programme led by ARUP+ that aimed to establish if it is technically possible, safe, and convenient to replace natural gas with hydrogen in residential and commercial buildings and gas appliances. The programme included the development of a 'Hydrogen Home' in Gateshead.

H100 Fife Neighbourhood – H100 Fife is a first-of-a-kind £32m research and demonstration project funded by SGN, Cadent, Northern Gas Network, Wales & West Utilities, Ofgem and the Scottish Government. The project will use clean offshore wind power to produce green hydrogen at a dedicated facility in Fife. The hydrogen will then be connected to around 300 households via a new gas network. The project is due to be delivered in 2023.

Hydrogen boiler prototypes - are being developed by boiler manufactures at their existing R&D and manufacturing facilities which are considered fixed to their existing location. No large boiler manufacturer has production or R&D facilities in Doncaster, therefore there are no inward investment opportunities associated with hydrogen boiler R&D in Doncaster.

Examples of inward investment partners

Based on the composition of investors for the H100 Fife project the primary investment partners for green hydrogen gas heat networks research and development projects appear to be gas distributors. In Great Britain there are eight regional distribution networks owned by four companies, Cadent Gas Ltd, Scotia Gas Networks Ltd, Wales and West Utilities Limited and Northern Gas Networks Ltd.

Judgment on the likelihood of investment in Doncaster – Medium

This technology has now been successfully demonstrated at a number of pilot sites by Cadent and Northern Gas Networks (using equipment from Sheffield based hydrogen producer ITM power), but the industry is keen to trial across a larger scale area.

Doncaster has a number of large-scale residential, commercial and mixed development sites situated across the authority, many of which are seeking to meet the very highest standards in ESG through innovative construction and sustainable design. For example, Unity Yorkshire is one of the UK's largest mixed-use regeneration schemes covering an area of approximately 618 acres. The iPort boasts some 6 million sq. ft. of development space. The Doncaster North site aims to deliver 3.5 million sq. ft. of employment space at Thorne (with the construction phase due to start in the first quarter of 2023). This is all in addition to the 11 million sq. ft. and 10,000 homes promised at the Gateway East site. With elements of these sites yet to be built out, these sites could well prove attractive testbeds for a more fully scaled-up pilot across both the commercial and residential sectors.

The suitability of such sites is further enhanced by the ready availability of local renewable energy generating capacity (through onshore wind and solar PV) and expertise in hydrogen power production. The arrival of test-site operators further serving to enhance the attractiveness of both these industries as potential investment opportunities.

Doncaster is ideally placed to market itself as a potential base for green hydrogen production (see section 5.3.1). If Doncaster successfully attracts inward investment that results in green hydrogen production, the borough will be one a handful of places in the UK capable of producing green hydrogen. This would position Doncaster well to market itself as a test bed (similar to Fife) for further green hydrogen gas network research and demonstration projects.

Given the interest of central government in hydrogen use as a renewable heat supply, it is likely all hydrogen R&D projects will receive funding from central government. However, should further grant funding be required, SYMCA has a strong track-record providing funding for the development of R&D facilities, using them as a mechanism to develop a 'cluster' of business activity around that specialism. SYMCA's long-term commitment to funding R&D activities provides assurance that SYMCA investment could be secured should grant funding be required.

Scale of potential economic impact:

H100 Fife will be the first community to be supplied by 100% green hydrogen. As a result, limited information is available on the economic impact of green hydrogen gas network research projects. It is likely that a number of high value, high skill jobs would be created by a green hydrogen gas network research project.

In the longer-term, should green hydrogen gas networks emerge as a viable solution to decarbonising the UK's heat supply, Doncaster would be in a position to use the green hydrogen gas network project as an anchor to market itself as a location for the wider green hydrogen gas network supply chain to develop.

The UK is home to an already world-leading gas network, a network that the country is hugely reliant upon. More than three-quarters of all homes and businesses use the fossil-fuel 'natural' gas for their heating, cooking and hot water. In order to meet the net zero commitment, emissions from domestic heating alone need to drop from almost 3 tonnes a year today to just 138kg by 2050. In blending just 20% hydrogen into the gas grid could save around 6 million tonnes of carbon dioxide emissions every year; a figure which will extrapolate quickly as increased volume testing allows for the proportions to be raised.

This technology remains very much in its infancy. But the economic potential is not only significant, it is vital to achieving a decarbonised future. In providing suitably large-scale mixed sites for the further piloting, there exists the potential for the creation of a nationwide testbed for the rollout of this technology. Accompanying this would be capital investment in infrastructure, and the further catalysing of renewal energy production across the area through the provision of a secure demand base.

5.3 Future Opportunities in Hydrogen

Please note that at the time of writing this report, the commercial application of green hydrogen generation, storage and distribution is at its 'infancy.' Caution is advised as the emerging technology / approach is not yet completely tested and there is a risk that it does not scale to the expected levels as per current policy predictions.

Hydrogen – Introduction

Ensuring access to affordable, reliable, and sustainable energy is an essential outcome in the transition to a low carbon future. This requires the UK to make major changes in how it produces, manages, and consumes energy.

The development of hydrogen as an energy vector represents one of the key renewable alternatives which will support the successful transition to a low carbon future. As a renewable energy source (vector), hydrogen is one of the most versatile. Its use in theory can be employed across multiple sectors, including transport, industry, and heating. It is also considered to be of particular interest in energy-intensive sectors which are proving difficult to decarbonise.

Doncaster has many of the ingredients needed to become a major national and international centre for the development of the hydrogen economy, and its application across multiple sectors. Outlined below are some of principle areas of opportunity.

Hydrogen Production

A fundamental requirement for the up scaling of hydrogen production is sufficient energy capacity. Hydrogen does not exist in nature in its pure state, it is an entirely synthetic energy vector. The production of hydrogen is essentially one of energy transformation. The electrical or chemical energy found in hydrocarbons is transferred to the chemical energy of hydrogen through either electrolysis (the reversal of the hydrogen oxidation reaction in water) or through reforming (the extraction of hydrogen from hydrogen-rich energy carriers like methane or methanol). In the case of the latter, theoretically, no external energy is required to affect this process.

However, in reality, the quantity of hydrogen energy which is able to be derived from the reforming process is always less than the energy content of the original hydrocarbon fuel from which it is drawn. It is therefore in the former process, electrolysis, that has attracted a greater level of industry interest. But this process carries the drawback that the necessary energy consumption required to drive this process is high. Ideally, the energy input equals the energy content of the synthetic gas. To compound this, high-grade electrical energy is used not only to produce hydrogen, but also to compress, liquefy, transport, transfer or store the medium.

Industry requirements:

"In order to scale up hydrogen production we need multiple facets: engineers, land, factories, money coming in, local government on board, and government to provide funding" (Local Business Consultee).

Other key requirements:

- Sufficient energy generation capacity.
- Specialist skills in electrolysis process.

Examples of potential inward investment partners:

BOC, a Linde company

A UK-based multinational industrial gasses company. BOC is currently actively developing technologies to increase the share of renewably produced hydrogen with the long-term aim to significantly increase the sustainable share in the hydrogen mix using renewable energy sources such as wind, water, and biomass.

Vertex Hydrogen

Currently operating across Northwest England and North Wales, this new joint venture company was formed by Essar Oil UK and Progressive Energy (an energy supply-chain consultancy) in order to catalyse the decarbonisation agenda across this region through the production of low carbon hydrogen. At present, production is confined to the Stanlow Manufacturing Complex (owned and operated by Essar Oil) located in Ellesmere Port, Cheshire.

Progressive Energy

Founded in 1998, Progressive Energy's purpose is to develop new low-carbon technologies from concept to commercial deployment. Having partnered with Vertex Hydrogen (see above) and Cadent, this company has led a demonstration programme in the use of hydrogen (both pure and blended) to fuel production at Unilever's Port Sunlight personal care and home care products factory in the Northwest. Part of the wider Government-backed 'HyNet Industrial Fuel Switching' Programme, the demonstration of hydrogen technology at Port Sunlight will provide critical evidence to enable decarbonisation of a range of industry sectors, thus making a critical contribution to the UK's journey to Net Zero. The HyNet partners are also supporting wider industry sites in the glass, food and drink, paper, chemicals, automotive and metals sectors to enable switching from fossil gases to low carbon hydrogen. In August 2021, as part of the same programme, NSG-Pilkington in St Helens achieved a global first in the production of flat glass using hydrogen.

Judgment on the likelihood of investment in Doncaster – Medium/High

There exists significant onshore wind and solar energy capacity (with the potential for further expansion) in Doncaster, but output is currently limited due to statutory barriers on surplus production. This excess electricity from renewable generation could be used in the manufacturing process for green hydrogen. This would not only help to address the existing

concerns surrounding the capacity to meet existing industry demand for energy, but it would also act as an attractive proposition for developers and other operators in the sector.

Doncaster is already home to the Clean Power Hydrogen Group, one of the UK's most innovative and fastest growing producers of green hydrogen technology. This existing market participation already provides exposure within the wider sub-sector. It can also form the network anchor point for the attraction of new investment into the sector, and as a base from which to design and develop a more sub-sector bespoke skills offer in collaboration with industry.

Scale of potential economic impact

At present, both nationally and globally, almost all hydrogen that is produced and used is derived from high carbon processes, that is coming from the unabated burning of fossil fuels (that is without a carbon capture facility). There is a very small fraction of production that can be called low carbon; produced using the same fossil fuel-based process but with the addition of carbon capture, usage, and storage technology (called 'blue' hydrogen). It is for this reason that much of the existing UK hydrogen production capacity is located within the immediate vicinity of concentrated areas of carbon-intensive industries ('clusters').

Driven by the need to secure a reliable alternative energy source for these critical chemical and industrial sectors within the UK (and globally), this creation of 'brown' or 'black' hydrogen has provided a source of reliable alternative energy for use in these critical industrial sectors where electrification is not feasible or is simply too costly, and other decarbonisation options are limited. Securing a properly managed low carbon transition in these sectors is vital to ensure that the huge number of skilled jobs located in these sectors (often highly geographically concentrated) are secured into the medium and long-term and ensures the continued viability of such sectors in the UK.

However, if hydrogen is to fully contribute to the transition to net zero all current and future production will need to be low carbon ('blue' or 'green' hydrogen). This is both the challenge, and the opportunity. The UK Government has set a goal to deliver up 5GW of domestic production capacity by 2030. As pressure builds to deliver against this agenda, existing operators will seek to expand into the 'green' hydrogen sub-sector and will look to places with the available expertise, experience, and infrastructure as locations for engagement, collaboration, and investment.

Doncaster is well placed to seize this opportunity due to its abundant renewable energy generation capacity and it already being home to one of the most innovative 'green' hydrogen technology companies operating in the sub-sector.

Hydrogen Storage

Being able to store intermittent energy from renewable generation significantly increases the viability of these sources. This is achieved in the better enabling of integration of the renewables into the utility industry grid infrastructure through its balancing effect during times of peak demand. In addition to this, the use of surplus electrical power generated through onshore wind and solar PV, at times when the grid is operating at full load capacity, for the production of hydrogen (through electrolysation) creates yet another reserve supply of clean energy if there is a readily available method (and sufficient capacity) for storage. Storage represents the most critical of the many challenges still facing the development of hydrogen as key component in a fully decarbonised UK energy mix.

There are a number of hydrogen storage methods currently in operation, each of which have their advantages and disadvantages. Three of the most common are: high-pressure gaseous storage, low-temperature liquid storage and storage alloys. High-pressure gaseous storage is relatively low-cost and allows for the fast filling and discharge of the gas, however a significant amount of energy is required for the compression process and the high-strength, pressure-

resistant and corrosion-resistant containers are subject to risks such as leakage and bursting. In the case of low-temperature liquid storage it is also possible to achieve relatively high densities of storage, but the cooling equipment required to prevent the volatilisation of the liquid hydrogen and the storage and transportation process quickly drives up unit costs. Storage density and safety performance is comparatively higher in the hydrogen storage alloy, although this performance can be unstable, and the service life span is not ideal for repeated uses.

In contra-distinction to the above methods of hydrogen storage, the use of underground hydrogen storage offers considerably more in the way of advantages: high storage safety and low possibility of sudden fire risks; smaller land footprint and convenient connection with ground equipment; low equipment cost, high applicability, and suitable for the geological conditions in many countries and regions.

Industry requirements:

- Availability of significant redundant but accessible sub-terranean void space.

Examples of potential inward investment partners:

Storenergy UK

A subsidiary of the French multinational ENGIE, Storenergy is the developer and operator of the Stublach Natural Gas Storage site in Cheshire, the largest storage facility of its kind in the UK.

LAVO Hydrogen Storage Technology Pty Ltd

Spun out of the University of New South Wales' Hydrogen Energy Research Centre, LAVO's innovative hydrogen storage system contains both a water purifier and electrolyser, so that solar energy can separate the hydrogen from the water, release the oxygen, and store the hydrogen safely as a solid material by combining it with a patented metal hybrid. Since earlier this year, LAVO has partnered with the professional services company GHD to create a new demonstrator l*ocation for this technology at the Thornton Science Park in Cheshire*.

Gravitricity

Based in Edinburgh, Gravitricity plans to add hydrogen and heat storage to their underground gravity energy system. Purpose-built shafts will serve as a large, sealed pressure vessel. The shaft will be used to hold significant quantities of gas, which will be more economic and safer than above-ground storage pressure vessels. The company plans to build single or multiple shafts and co-locate them with a green hydrogen electrolysis plant. The dual function would be to store excess electricity for use by the electrolysers when needed, and to store the plant's output as a buffer into the gas grid. They are currently looking to identify sites for a new 4-8MW single weight project which will deliver up to two-megawatt hours (MWh) of energy storage.

Judgment on the likelihood of investment in Doncaster – Low/Medium

The focus of most recent underground hydrogen storage investment in the UK (and the US) has been in the utilisation of redundant salt caverns. The UK's geology is also well suited to addressing storage needs, with suitable geology for salt caverns in areas such as the Wessex Basin, Cheshire Basin and East Yorkshire and some caverns already used to store natural gas or liquefied petroleum gas.

At present there exists little, if any, storage capacity across the South Yorkshire region for hydrogen energy. There does exist some methane storage capacity in Doncaster (in a depleted gas reservoir at Hatfield Moor and Hatfield West), but there is the potential for the use of sites such as this for the storage of hydrogen.

Abandoned coal mines represent another storage solution with significant potential. However, despite research pointing to the advantageous mineral properties associated with these former mines, the use of these assets remains very underdeveloped in the UK. Doncaster has upwards of a dozen redundant coal mines which could prove ideal research and development sites for the further exploration into the use of these assets for hydrogen storage.

This presents various medium to long-term opportunities for the supply chain to support the development of storage facilities in former coal mines and provide top-side facilities. There could also be opportunities to attract UK companies and investment to develop specialist skills and capabilities in the design and engineering of storage infrastructure.

Scale of potential economic impact

The provision of available domestic hydrogen storage capacity will play a crucial role in supporting the early-stage development of the wider hydrogen economy. As with all new industries, demand will take time to scale-up and build and there may be changes in the profile and nature of off-takers. In particular, as hydrogen begins to be deployed as a heat source energy, the need for strategic underground storage will grow and become a more desirable investment opportunity.

In a recent report published by the National Grid ('Future Energy Scenarios 2021'), it is suggested that if the UK is to meet its net zero targets, across all scenarios, by 2050 then anything between 12TWh and 51TWh of hydrogen storage will be required. In a similar report published by Aurora Energy Research ('Hydrogen for a New Zero GB') the projected national storage capacity was placed at 19TWh by 2050.

At the present time, the UK has seven salt caverns and depleted gas fields being used to the storage of national gas. The combined storage capacity across these seven sites is approximately 1.5b cubic metres, or 145TWh. However, although it would be possible to repurpose some of this capacity for the storage of hydrogen, it will not be possible to provide the same level of dedicated hydrogen capacity given that hydrogen has only a third of the energy density of natural gas. It will therefore be necessary to source alternative locations for dedicated sub-terranean storage capacity for hydrogen, with those locations close to existing production facilities likely to be those that are most favoured.

Hydrogen in Propulsion

Hydrogen for propulsion will play an increasing role in the decarbonisation of transportation. The use of fuel cell electric vehicles, powered by energy dense hydrogen, is ideally suited to heavier vehicle fleets with back to base journeys that have long-range requirements.

Industry requirements:

- Strategic location on regional and national transport network.
- Renewable energy generation capacity.
- Proximity to R&D facilities.

Some examples of potential inward investment partners:

Ryze Hydrogen

Founded in 2020 and based in Oxford, Ryze Hydrogen is a supplier and distributor of hydrogen and the operator of hydrogen infrastructure primarily for the transport sector, with particular expertise in heavy duty vehicle and long-range fleet operations. A fast-growing business, the company is already providing hydrogen for 20 Transport for London (TfL) hydrogen powered double-decker buses and is the partner to Northern Ireland based Wrightbus; the manufacturer

of the world's first hydrogen powered double-decker bus. The company is looking to increase its presence within the hydrogen industry with a further expansion across the UK.

Ceres Power

A manufacturer of innovative climate technologies. The company's business model is to act as an enabler to other companies in accelerating their own clean energy agenda through the licensing of its technologies. It has already established itself as a leading market participant in the production of hydrogen fuel cells (both nationally and internationally) and, through its Solid Oxide Electrolysis Cell (SOEC) technology, a pathway to produce highly efficient, green hydrogen, at a cost at which electrolysis becomes competitive with blue and grey hydrogen produced using fossil fuels. Based in Horsham, the company has ambitions to scale up and grow its pilot manufacturing operations in the UK.

Haskel

A world leading provider of high-pressure industrial gas and liquid handling equipment. Haskel offers a range of hydrogen refuelling solutions, including complete hydrogen fuel stations, hydrogen compressors and transfer equipment and a range of hydrogen rated valves and fittings to support a growing global refuelling infrastructure for hydrogen mobility.

Judgment on the likelihood of investment in Doncaster – Medium/High

Doncaster's position as a key road and rail logistics hub, serving both the region and the wider UK, places the authority in a strategically significant location to support the development and testing of hydrogen for propulsion. A large or series of large hydrogen refuelling stations, located at existing or proposed motorway service areas, combined with retrofitting capacity, would help support the transition of the logistics sector. Similarly, there is scope for the large-scale trialling of hydrogen-powered trains that focusses on replacing diesel on lines that are challenging to electrify.

"Doncaster can be a good demonstrator area and does tend to get missed out. Whilst there are a lot of places developing technology, Doncaster can be a place that demonstrates the scaling up of technology, utilising logistic hubs and multi-modal infrastructure." (Local Business Consultee)

Existing onshore wind and solar PV energy generation capacity is already large. However, there remains significant scope for the expansion of supply with several large-scale sites already identified in the Local Plan and a number of shovel-ready projects awaiting regulatory approval.

The wider South Yorkshire region is the location of already well-established research and development capabilities via the University of Sheffield, Sheffield Hallam University and the Rotherham-based Advanced Manufacturing and Research Centre (AMRC).

Situated in Doncaster itself is also the Doncaster UTC and the National Centre for Advanced Transport & Infrastructure (NCATI) (sponsored by the University of Birmingham). In taking the lead in encouraging the better alignment of these research institutions with local industry needs, Doncaster could further build on the existing advanced materials and manufacturing capability and quickly develop into a recognised global leader in the decarbonisation of transport.

Scale of potential economic impact

With a UK Government commitment to phase out the sale of all new petrol and diesel cars by 2030 and to ensure that all new cars and vans are to be zero emission at the tailpipe by 2035, the radical up-scaling in the use of hydrogen for propulsion will be fundamental if the UK Government is to meet its longer-term goal of a fully decarbonised transport sector.

By positioning Doncaster as a base for the development, production and scaling-up of hydrogen for propulsion, there is a rare opportunity to increase economic growth and create new, highly skilled jobs within a very specific key strategic sub-sector of the wider green industrial transition. This will help to ensure sustainability of sub-sector growth (scaling-up proportionately to meet increasing demand) into the medium-long term.

The need to expand the necessary innovation spaces and infrastructure requirements to meet this demand will mean the potential for very high levels of capital investment in new manufacturing and production facilities within the city.

By significantly increasing hydrogen production (whether in its blue or green form) there will be a requirement for an expansion in the capacity of the local electricity grid to handle this sustained growth in demand. This will serve as a catalyst for further inward investment in Doncaster's own renewable energy production capacity. Which, as the proportion of Fuel Cell Electric Vehicles (FCEV) increase nationwide, will become an increasingly valuable asset for operators and investment funds.

5.4 Opportunity in Low Carbon Aviation Technology

Aviation represents one of most difficult challenges in decarbonisation. Despite widespread industry commitment to this agenda, the delivery of solutions remains at varying stages of technological and commercial development. Generally speaking, there are around six different market segments which require action if the ambition of 'Jet Zero' is to be achieved. These are:

- System efficiencies; the improvement in the efficiency of the existing aviation system (airports, airspace, and the aircraft we use).
- Sustainable aviation fuels; the establishment of this industry in the UK.
- Zero emission flight; the development and commercialisation of advanced aircraft designs which offer the potential for zero carbon tailpipe emissions.
- Markets and removals; the foundation of new carbon markets and investment in greenhouse gas removal.
- Influencing consumers; the consumer incentivisation of sustainable aviation travel choices.
- Addressing non-CO2; collaborating across industry and the academy to develop a more advanced understanding of the science and potential mitigations of non-CO2 impacts.

The development of greater system efficiencies and the production of sustainable aviation fuels have been identified as being the elements which offer the quickest 'wins' against the low carbon ambition. It is for this reason that progress in terms of development and commercialisation are the furthest advanced in these two market segments.

Industry requirements:

- Appropriate sites and infrastructure to support an aviation-based industry.
- Proximity to centres of industry specific research and development.
- Sufficient supply of low carbon/renewable energy.

Some examples of potential inward investment partners:

ZeroAvia

A UK-based Anglo-American hydrogen electric aircraft engine designer. Founded in 2017, the company is developing hydrogen-fuelled powertrain technology which will provide a zero-emission alternative to conventional propeller engines. Already at a stage of advanced prototype testing, the company is keen to explore options to increase the availability of suitable demonstrator sites.

SkyNRG

Headquartered in the Netherlands, the company works to source, blend and distribute sustainable aviation fuels (SAF) to airlines around the worldwide. Until recently, their operations have been based solely in the Netherlands, but the company is now looking to increase production capacity outside of its home-country. A new facility has been built in the Pacific North West region of the US, but they are also looking to expand activity in Europe (they are yet to have a UK operation).

Marshall Slingsby Advanced Composites

Part of the UK-based multinational Marshall Group, the company produces complex composite structures that are used in the construction of components for ships, submarines, and aircraft (primarily for the defence sector, but all with civilian applications). The company are continually looking to establish research and development partnerships in the co-development of advanced materials and new manufacturing techniques.

SABIC

Saudi-based multinational diversified petro-chemical company (with an existing UK presence) engaged in the manufacture of different kinds of products: chemicals, commodity and high-performance plastics, agri-nutrients, and metals. These products are designed for applications in construction, medical devices, packaging, agri-nutrients, electrical and electronics, transportation, and clean energy. Has committed to identifying and developing opportunities in key end-use applications. The company has begun to move into the lightweighting sector with the development of new thermoplastics or thermoplastic compounds for aircraft interiors.

Solvay UK

Belgian-French multinational chemical company (with five sites operating in UK) specialising in advanced composite materials and specialty chemical solutions which are used in the aerospace and automotive sectors. Already well established in lightweighting, the company has identified this area as a priority growth sector for the business.

Judgment on the likelihood of investment in Doncaster:

One of the most effective ways to deliver an increase in energy efficiency and reduce fuel consumption is in the reduction of the mass of an aircraft; a process known as 'lightweighting.' The principle is a relatively simple one. To achieve a lightweight design through the use of less material or materials with a lower density but to ensure that the technical performance of the aircraft remains consistent or improved. For example, for the Boeing 787, a 20% weight saving results in a 10%–12% fuel efficiency improvement.

A proposal for the development of a Lightweighting UK project to be based at GatewayEast, Doncaster Sheffield Airport (AMRC Doncaster) seeks to take advantage of the existing on-site aviation infrastructure. This will be complemented by the construction of a large-scale, open access R&D facility as well as the acquisition of an extensive industrial development plant and equipment to enable research to be conducted at scale. The availability of such a facility will unlock the potential for the development of new products and processes for the direct application into aviation and automotive manufacturing businesses.

The development of this site could form the key anchor point for the establishment of a future mobility innovation cluster at GatewayEast built around alternative fuels, battery technology, electrification, and light weighting technology (wings and fuselage). It would provide an attractive location for companies like ZeroAvia and SkyNRG to expand their UK operations and for new research and development partners, like the University of Nottingham's Propulsion Futures project, looking to showcase their output through new demonstrator sites.

A recent announcement by the innovative low-carbon aviation company Hybrid Air Vehicles pointing to Doncaster as a potential home for their new Airlander 10 airship production facility would further catalyse the establishment of such a cluster and help position Doncaster at the very forefront of clean aviation research, manufacturing, and alternative fuels.

"Hybrid Air Vehicles Ltd is delighted to confirm that we have been working with the South Yorkshire Mayoral Combined Authority (SYMCA), Doncaster Council and other local and national stakeholders on a proposal to establish the Airlander 10 production line within a new, green aerospace manufacturing cluster within the South Yorkshire Region." (Hybrid Air Vehicles, Feb 2022)

Scale of potential economic impact

The UK has the largest aerospace and aviation sector in Europe. As a sector, it contributes around £50 billion to the UK economy and provides around a million jobs (many of them highly skilled). Meeting the challenge of 'Jet Zero' is therefore vital if the UK is to ensure that it retains its global competitiveness in the sector (including in more advanced technologies like UAV/drones) and secures the continuation of the aviation sector's role in supporting the wider national economy.

The decarbonisation of aviation presents unique opportunities to create new jobs, industries, and technologies across the entire sector in addition to improving the sustainability of air travel. If successful in securing the Lightweighting UK project and the Airlander 10 factory, Doncaster will be ideally placed to capitalise on this emerging market, attracting significant new investment in research and development and promoting the agglomeration of the broader aviation supply-chain (including in the advanced manufacturing of components).

Such an agglomeration will further serve to accelerate the demand for expanded innovation spaces and new sector-specific infrastructure requirements drawing in significant capital investment in new manufacturing, testing and deployment facilities across the local authority area.

6.0 BARRIERS FOR GROWTH FOR DONCASTER'S LOW CARBON SECTOR

Although there is potential to attract new low carbon businesses to Doncaster, it must be recognised that there are currently significant barriers to growing the sector. Through consultations with local businesses and other stakeholders a number of key barriers were commonly mentioned. If inward investment in the sector is to be maximised, the barriers below must be overcome.

Skills and labour supply across all low carbon sectors

Consultees from across the sector, as well as much of the surrounding literature, identify a lack workforce availability with relevant skills. A situation which is compounded by the present failure of local FE and HE institutions (and private providers) to effectively respond to the shifting sector-specific needs through the better market orientation of their curriculum and training syllabus.

There is also little evidence of employment support agencies working with (or via local authority planning/procurement agreements) low carbon energy employers to broker opportunities for those most in need of employment opportunities.

This is an issue reflected across multiple educational levels:

University level

Lack of specific sector-focused academic topics within local syllabus which is leading to outward migration of potential Research & Development interest to institutions which provide this offer or shift to alternative research avenues. There is also little evidence of the alignment between research institutions and local industries to direct research on overcoming specific technical barriers.

Technical level

Similarly, there is lack of sector-focused engineering opportunities which deprives local green industries of management level recruits. For example, in larger-scale low carbon project areas such as heat networks or CCUS deployment, there are specific shortages of project managers and those with specialist high-level technical skills.

Practical training

Failures in the skills and education market are most keenly felt in vocational skills training. Providers are simply failing to upskill local people in practical skills to a sufficient degree to meet the requirements of industry. For instance, welders are being trained to basic standard, but in green industries, the requirement is for a higher level of training in this same skill.

In the case of the heat pump sector, there is no sector-specific apprenticeship provision across the entire South Yorkshire region, and with only limited manufacturer training for reskilling/upskilling which is not sufficient to provide the necessary skills for heat pump system design and installation.

This lack of sufficient training opportunities for heat pump installers means that there is an inability of local businesses to capitalise on expanding demand.

The inadequacy of skills training provision must also be set within a wider national context in which there are general shortages across all sectors relating to construction and engineering skills and labour availability.

A situation which has only become more acute with significant construction growth across the UK post-Covid and specific demands like insulation replacement after Grenfell leading to an increasingly competitive market for the already limited pool of workers with appropriate skills; many of whom are older and approaching the end of their working lives.

Although FE colleges and Universities can play an important role by incorporating zero carbon technology training there is a wider need to encourage retraining and entry to the industry for those with transferable skills. For instance, nuclear, hydrogen, CCUS and to a lesser degree heat networks have similar construction and skill and safety training needs, while insulation also requires similar construction skills.

Retraining will be important to ensuring that people working in carbon-intensive industries can adapt to low carbon sectors. At present, there is a general feeling that this need is not widely felt nor understood by those workers or the companies they work for.

Lack of confidence in long term policy and funding, and changing regulations

There are certain inhibitors to the effective introduction of new, or the scaling up of existing, low carbon and renewable policy initiatives in the area. This includes competing demands for available investment funds, contractual limitations, and increased running-costs.

Financing

Changes to banking regulations over the last decade have meant long-term debt financing has been more difficult to secure. There continues to be a marked reluctance on the part of some elements of the public and private sector to shift their approach to investment decision-making away from a simple principle of profit-loss (finance-driven) to one which instead elevates the importance of cost avoidance as being a consideration of equal (if not actually primary) value.

Cost avoidance has to do with any action that avoids having to incur costs in the future. In a business setting, cost avoidance is a measure that lowers potential increased expenses as a way of decreasing a company's future costs. In the case of the finance-driven approach, decarbonisation and renewable options are far less likely to be favoured due to their higher initial cost and longer-term return.

The Organisation for Economic Co-operation and Development (OECD) has previously highlighted that lack of a financial framework around climate change investment has led to a difficult market to drive change.

Macro-economic situation

The present period of high inflation, rising costs and zero-growth creates a macro-economic context which mitigates against riskier or financially more costly investment decisions.

In such circumstances developments and companies can often reverse, pare back or place on hold, any positive advance in ESG policy in order to remain economically viable and competitive.

Planning

Local planning authorities are responsible for consenting (and overseeing compliance with conditions) in respect of smaller renewable energy projects (those with an installed capacity of 50MW or less) under the terms of the Town and Country Planning Act, 1990.

However, many have refused to include specific policy commitments within their local planning frameworks which incentivise the bringing forward of low carbon and renewable infrastructure projects through dedicated application pathways or streamlined processes e.g., the presumption in favour of development.

Shifting regulatory background

Changes within the existing low carbon and renewable regulatory regime can have a negative impact on the effectiveness of certain policies and inhibit further growth. For example:

Solar power generation at the DSA site cannot be fully exploited due to an imposed limitation of 10% on sale of excess energy into the National Grid. This leads to significant wastage of surplus supply. This effectively places a break on the further expansion in photovoltaic power generation capacity.

Introduction of new biodiversity targets would see an improvement in the sustainability of developments, but at the increased cost of delivery which places downward pressure on housing supply and reduces investment resource in other low carbon initiatives.

Demands for increased resources to expand existing public transport infrastructure (e.g., Network Rail) reduces available investment whilst delivering only partial advance in sustainability.

Business awareness, understanding and appetite to pursue low carbon opportunities

The local authority and the business community both have different starting points in terms of their carbon baseline and their strategic understanding of the size and dimension of the challenge.

An inconsistent and haphazard approach to cross sector communication combined with silo-based working practices means that key public and private sector partners are unaware of each other's capabilities, skills, resources, and ambitions.

"A challenge is the need for decent meaningful guided collaboration between local businesses, with clarity on what's available from other organisations, government and the local authority, which can draw more businesses into low carbon activities." (Local Business Consultee)

Such poor information-sharing contributes to the under-exploitation of value-added partnering resources and makes the development of a consolidated industrial growth strategy extremely difficult to achieve.

Without a regular and consistent data-gathering process, the sharing and analytical commentary on that data will often be outdated or inaccurate. But even with such processes in place, to turn that data into useable knowledge requires a body of staff who possess the necessary level of technical, analytical and software skills. It is not clear that the local authority has this capacity.

Available finance for innovative firms

A recent report[5] by BEIS highlights various barriers in the access to innovation finance which is serving to constrain the development of highly innovative start-ups, scale-ups, and other innovative businesses (particularly in the clean tech sector).

"Public funding is often available for initial studies and research, but then finding additional funding to keep momentum and growing it through other pots is difficult. Public applications are very time consuming, and the success rate can be low, finding private investors interested in your sector is also difficult and it's a case of a lot of trawling around. Some chief executives have to spend the majority of their time briefing potential funders." (Local Business Consultee)

These barriers can be attributed to market failure and a national financing eco-system which is systemically geared towards the Southeast.

[5] BEIS, *Evidence for the UK Innovation Strategy, October 2021*

In terms of market failure, this can be broken down into three aspects:

Positive externalities

Low carbon innovations are a good example of where the benefits of innovation are not solely defined in terms of financial return but through the spillover benefits which will accrue to wider society.

However, there remains a continued reluctance on the part of private investors to properly consider these wider spillover benefits when determining their investment decisions. As a result, projects with a high social value (which include almost all within the clean tech sector) remain consistently underfunded.

Imperfect information

There is often a significant misalignment of understanding between a potential investor and an innovative business. Financiers endeavour to overcome this lack of understanding through the due diligence process.

Due to the often highly technical nature of product/service developed by innovators, lenders and financiers are obliged to draw in specialist advisors to undertake this work. This can dis-incentivise potential investors who will gravitate towards relatively less-complex sectors or deals with shorter exit periods and lower transaction/scaling costs.

Coordination failures

Highly innovative companies traditionally rely on Venture Capital (VC) investment in order bring their product to market. However, the supply of capital through the UK VC sector is limited due to their inability to attract institutional investors (e.g., pension funds) because of their relatively small size (compared to US equivalents). As a result, UK companies often struggle to raise follow-on funding rounds at sufficient scale.

Existing Market Dominance

In addition to existing industrial clusters, there are areas of the low carbon and renewable sector which are already dominated by larger established companies whose market penetration would be difficult to challenge.

For instance, two-thirds of the existing market in the manufacture and delivery of electric vehicle charge points is dominated by just three providers:

- urbitricity (headquartered in Germany, it is now owned by Shell),
- Pod Point (UK-based but acquired by EDF Energy) and
- BP Pulse (UK-based, formerly known as Chargemaster before its acquisition by BP).

The production of the batteries required for the powering of Electric Vehicles is another case in point. At present, the battery manufacturer market is dominated by players from just three countries – China, Japan, and South Korea.

Barely 3% of total global demand for this product came from companies based outside of these three countries, and of this only 1% came from those based in Europe.

Despite projected battery demand from European produced vehicles being five times the volume of current European production capacity, the long lead time (between five-seven years) for the building of battery production facilities means that many domestic EV manufacturers have already negotiated long-term contracts with battery suppliers outside of Europe, diminishing the chances of securing UK gigafactories (and hence the chances of sustaining an EV production industry in the UK).

Table 11 - Industrial clusters and competition

Industrial Cluster	Key findings
The Black Country Industrial Cluster	The Black Country remains at the heart of the UK's metal processing industry, with this sector remaining the largest in the local economy. The Black Country Industrial Cluster brings together more than 3000 energy-intensive manufacturing businesses spread across four of the region's metropolitan authorities: Wolverhampton, Walsall, Sandwell, and Dudley, who will be collectively implementing strategies to reduce their carbon dioxide emissions to as close to zero as possible using low carbon energy sources and new technology like carbon capture and Zero Carbon hubs.
Grangemouth Industrial Cluster	The anchor point for this cluster is a chemical plant and a crude oil refinery. The objective is to build up the necessary infrastructure to allow for the harvesting of carbon dioxide from these activities at Grangemouth and channel this by-product through a pipeline to St. Fergus in Aberdeenshire and into the Acorn CCS (carbon capture and storage) project.
Teesside Industrial Cluster	Representing one of the UK's most highly concentrated centres for industrial production (steel and chemicals), the focus of this cluster is the construction of a new gas fired power station employing Carbon Capture, Utilisation and Storage (CCUS) technology as a source of stable energy supply to industry. This could also include the powering of 'clean hydrogen' production.
Humber Industrial Cluster	Sharing many of the same characteristics as the Teesside area, CCUS features heavily in the development of this cluster. In addition to this, there are ambitions for the area to become one of the world's first at-scale low carbon hydrogen production centres. This resource would then be used as a means of powering the many industrial sites across the cluster via a new pipeline network.
South Wales Industrial Cluster	Alongside CCUS and hydrogen production, this cluster is looking to explore the development of carbon dioxide shipping. This would be an entirely new industry for the UK and would provide a powerful boost to the regional economy. Once sufficiently scaled up, this industry would enable the UK to manufacture low or net-zero carbon cement and steel products, support the development of low carbon construction as well as applications in defence and vehicle manufacture.
Southampton Industrial Cluster	Being one of the UK's busiest ports, Southampton has ambitions to become a leading platform for hydrogen production and distribution, and its use for the decarbonisation of transportation and the production of hydrogen delivery infrastructure e.g., pipelines.
Merseyside Industrial Cluster	Unique among the UK's current industrial clusters, the core plank of the Merseyside Industrial Cluster is the construction of a barrage across the river Mersey to capture tidal waters to generate stable and reliable renewable energy. This will also complement the development of CCUS and hydrogen production capacity at this location.

7.0 OVERARCHING STRATEGY FOR LOW CARBON GROWTH

To maximise low carbon growth in Doncaster and attract future investment, it is clear from consultation and research, a strategy to enable low carbon growth across the whole economy is required. Frequently consultees stated the need to grow demand for low carbon products and services through changing the decisions made by businesses and individuals to enable sector growth. Below are high-level recommendations for a strategy to support this change.

Outcomes

The strategy should aim to achieve the following key outcomes:

- The cultivation of **an attractive, responsive, and enabling business environment** for low carbon and renewable sector growth.
- Local educational and training providers with a strong sector-led curriculum supporting the development of **a pool of suitably skilled labour**. This is to be complemented by good opportunities for continuing professional and skills development.
- The creation of a **shared culture of awareness** across businesses and residents as to the benefits and obligations of transiting to low carbon technologies.
- Doncaster to establish itself as a **market leader** in low carbon sectors.
- A greater capacity to identify, to understand and to develop **mitigations to risks** associated with the low carbon sector.

Vision

Achieving these objectives could ensure local economic growth delivers prosperity for residents and Doncaster's Net Zero ambitions. At the heart of this will be the development of an ecosystem of local employment, education, and innovation, which will attract new investment into Doncaster whilst encouraging existing businesses to achieve sustainable futures.

Key Drivers

Given this ambition, the overarching strategy must therefore consider how local partners can exploit opportunities and overcome barriers to affect positive change. The key levers identified to drive this change are:

1. **Policy** – enabling and progressive policy with net zero at the heart.
2. **Partnerships** - stronger and robust partnerships and networks connecting the low carbon sector to the wider economy.
3. **Business support** – focusing on supporting the sustainability and decarbonisation of all businesses, whilst targeting support to areas of opportunity.
4. **Labour Supply** – placing net zero requirements at the centre of skills provision, whilst connecting businesses to providers.
5. **Finance and funding** – proactive and strategic approaches to overcoming financial barriers.
6. **Showcasing** – promoting what Doncaster is doing well to a local and wider audience, through branding and validation of success.

8.0 RECOMMENDATIONS FOR FUTURE LOW CARBON INWARD INVESTMENT STRATEGY

The analysis set out in earlier sections demonstrates attracting low carbon businesses to Doncaster is dependent on a wide range of factors, and many sub sectors to do not present realistic opportunities. Given the research it is recommended that particular focus is given to the following activities. As noted throughout the document, due to the emerging nature of many activities in the low carbon sector uncertainty regarding their long-term viability remains and this risk cannot be ignored in future planning.

Primary Opportunities

Given the analysis set out in earlier sections, the following opportunities have been identified as most important priorities in a future low carbon inward investment strategy for Doncaster. This is due to the likelihood of investment and scale of opportunity.

Hydrogen production

A sustained uplift in the scale and volume of domestic hydrogen production represents a key strategic priority if the UK is to realise its low carbon/carbon neutral ambitions within the timeframe currently specified. With an abundant supply of onshore wind and solar PV energy generation capacity, coupled with the existing presence of one of only a very small number of 'green hydrogen' technology companies operating in the sector, providing unique incentives for investment, Doncaster is ideally placed to market itself as being the potential base of a new national hydrogen production industry.

Low-Carbon Aviation

Although still subject to sign-off by the University of Sheffield, the Lightweighting UK project would establish Doncaster as a principal location for low-carbon aviation research and development. With the ready availability of the necessary on-site aviation infrastructure, the project could form the centre-point for the emergence of a new future mobility cluster at the GatewayEast development. Coupled with the possible arrival of Hybrid Air Vehicles, this would encourage the agglomeration of the full range of low carbon propulsion related industries e.g., alternative fuels (SkyNRG), low-carbon propulsion (ZeroAvia), electrification as well as lightweighting itself, in Doncaster. It could also form the basis of new research and development partnerships with already established centres of excellence e.g., University of Nottingham.

It would also allow for the development of products and processes with a direct application into the existing aviation and automotive manufacturing sectors. This would assist in the effort to ensure a sustainable and inclusive transition throughout the wider UK economy.

Bioenergy

Once government policy is established through the publication of the Biomass Strategy, there will be an opportunity to assess where new bioenergy projects could be viable in Doncaster. The number of businesses already active in the sector means that there is a large pool of developers and investors who can be engaged for future projects. These projects will take time to establish and require identification of feedstock supply and end users but can provide a significant stream of low carbon investment over the next decade.

Heat Pump Manufacturing and R&D

Global heat pump manufacturers, in particular German and Japanese have been exploring opportunities to develop heat pump manufacturing facilities in the UK. Doncaster's connectivity strengths, pipeline of high-quality industrial developments such as Unity Yorkshire and relative affordability of labour, mean that the borough meets the key requirements of a heat pump manufacturer. Alongside meeting the requirements of just a manufacturing facility, the region's universities also are potential partner for R&D development facilities and SYMCA's historic investment support for R&D activities provides assurance of grant fund availability if required. If a heat pump manufacturer were to develop manufacturing and R&D facilities in Doncaster, the area would be well positioned to become a key anchor point for the development of a 'zero carbon heat cluster', leading to further inward investment opportunities.

Secondary Opportunities

Given the analysis set out in earlier sections, the following opportunities have been identified as the next most important priorities in a future low carbon inward investment strategy for Doncaster. These are not considered primary opportunities either due to the underdevelopment of the sectors and uncertainty surrounding their viability, or the limited scale of economic impact associated with attracting these businesses.

Hydrogen in propulsion

Strategically located on both the regional and national UK road and rail network, located close to existing centres of advanced research and development in the decarbonisation of transportation and with significant renewable power generating capacity, Doncaster is advantageously positioned to support the development, larger-scale deployment, and manufacture of hydrogen-based propulsion technologies. Specifically, opportunities exist in the logistics sector and in the replacement of diesel-powered trains on those railway lines in which electrification is not deemed a viable option.

Heat Pump Installation Training

There is an opportunity associated with securing further investment from a heat pump manufacturer locating their manufacturing and / or their R&D facilities in Doncaster for the delivery of heat pump installation training facility. Whilst the economic impact of this investment would not be significant, it would be an important piece of infrastructure to facilitate South Yorkshire's transition to a renewable heat supply.

Tertiary Opportunities

The following opportunities have been identified as deserving on attention for future inward investment activity, as they may present future growth opportunities for Doncaster. However, there is uncertainty surrounding the likelihood of investment in the near future.

Hydrogen Storage

Critical to the successful transition of the UK (and globally) to a decarbonised future is the development of large-scale hydrogen storage capacity. A yet untested (at least in the UK) storage solution with significant potential is the use of now redundant coal mines. With a strong basis in academic evidence that points to the positive geological properties of such locations, the physical remains of Doncaster's now long ceased coal-mining industry could once again provide the basis for the establishment of UK's first research and development base for the storage of hydrogen in these subterranean void spaces. The successful launch of this industry would serve to open up opportunities in the supply chain (through the provision of surface level facilities and monitoring equipment) and new skills development in storage infrastructure.

Hydrogen in commercial and residential sectors

Still at a relatively early stage in its development as a low carbon technology, the extent of regeneration (residential, commercial, and mixed use) across the Doncaster local authority area presents the promoters of hydrogen blending schemes with significantly larger-scale pilot deployment areas. It is only through the real-world testing of this low-carbon technology at such a scale can this process be advanced to a sufficient level of development for its widespread adoption and integration into future gas infrastructure design and the manufacture of compatible downstream appliances.

ANNEX A - RECOMMENDED INTERVENTIONS TO SUPPORT WIDER LOW CARBON SECTOR GROWTH IN DONCASTER

As noted in section 7, to attract inward investment to Doncaster, it is recommended that interventions in the wider economy are utilised to attract and sustain sector growth. Below are a series of suggested interventions categorised by theme and timeframe to support low carbon growth in Doncaster.

Short Term Interventions (immediate to 3 years)

Table 12 - Short term interventions - Doncaster LCREE assessment matrix

	Impact	Cost	Risk	Deliver-ability
Driver: Policy				
Use of Council Procurement Policies support local low carbon business activity	H	M	M	M
Establish a Housing Stock Retrofit Database to support current, and the expansion of, retrofit programmes	H	L	L	H
Promotion and support of community energy schemes	M	M	M	M
Driver: Partnerships				
Establishment of a virtual Doncaster Net Zero decarbonisation hub to provide information and resources, and provide a platform for knowledge sharing	H	L	L	H
Run a programme of 'Meet the Buyer' events with low carbon businesses to communicate the opportunities in their supply chain	M	L	L	M
Driver: Business Support				
Establish a framework of approved businesses to assist other businesses adapt to low carbon growth opportunities and the net zero transition	M	M	L	M
Development of a low carbon business support strategy which clearly sets separate approaches for attracting businesses and growing businesses	M	L	L	H
Driver: Labour Supply				
Labour Market and Skills Assessment to support the transition to net zero	H	M	L	H
Collaboration between education providers and businesses to design vocational courses	M	M	M	M
Green Tech Centre of Excellence Feasibility Study	M	L	L	H
Driver: Finance and Funding				
Bid for start-up capital for accelerators (grant funding available via national Gov)	H	M	M	M
Driver: Showcasing				
Incentivise exemplar businesses to offer tours for other businesses	M	L	M	M
Development of a brand and promotional material for Doncaster's low carbon ambitions	M	M	M	M
Community engagement to promote the importance of low carbon technology and the economic opportunities it presents	H	M	L	M
H = High; M = Medium; L = Low				

Medium Term Interventions (3 to 5 years)

Table 13 - Medium term interventions - Doncaster LCREE assessment matrix

	Impact	Cost	Risk	Deliver-ability
Driver: Policy				
Inclusion of an environmental audit section within planning policy	M	L	M	M
Evaluation of Retrofit Programmes to review progress (ensure targets on track, identify issues and solutions)	M	M	L	H
Driver: Partnerships				
Identify and support opportunities for clustering of low carbon businesses	M	L	L	M
Support Hydrogen supply chain activity, and inform other businesses of the supply chain opportunities	M	L	L	L
Driver: Business Support				
Support for small hydrogen businesses and establish a Green Business Incubator focused on Hydrogen businesses	H	H	H	L
Support to attract occupiers to the GatewayEast development surrounding the proposed AMRC facility	H	M	H	M
Attract a boiler or heating pump manufacturer to Doncaster (Unity or Doncaster North may be a suitable site with capacity)	H	M	L	L
Driver: Labour Supply				
Establish a specialist Hydrogen training centre	H	H	M	M
Develop the Doncaster UTC's Engineering course with the necessary skills required for Low Carbon Heating jobs	H	M	L	H
Driver: Finance and Funding				
Investigation of possibilities around Council covenants on investments to drive low carbon sector growth	H	H	H	M
Investigate Community Municipal Investment fund for specific low carbon projects to improve stakeholder buy in for Low Carbon Sector projects	M	M	H	M
Establish a wholly council-owned property development company which can borrow on the commercial market (releasing it from more stringent public sector financial controls) for development of low-carbon housing.	M	H	H	L
Enabling infrastructure investment to support low carbon developments, with particular focus on energy supply.	H	H	M	M
Work with SYMCA to deliver and advertise a pipeline of long-term funding and finance support for low carbon sector businesses to increase investor confidence.	H	M	L	H
Review of Community Infrastructure Levy (CIL) schedule to introduce penalisations for failing to meet a threshold of sustainable design (any resultant revenue could be ring-fenced within a dedicated Carbon Offset Fund).	M	L	M	L

Driver: Showcasing				
Doncaster Green Excellence standard	M	L	L	M
Establish a local awards event	L	L	L	H

Long Term Interventions (5 to 7 years)

Table 14 - Long term interventions - Doncaster LCREE assessment matrix

	Impact	Cost	Risk	Deliverability
Driver: Policy				
Use of planning system to stipulate use of heat pumps in new builds	M	L	L	H
Support implementation of Hydrogen Rail Services	H	H	H	M
Support and development of Hydrogen Bus Services	H	H	H	M
Driver: Partnerships				
Work with AMRC and Peel to grow innovation facilities at GatewayEast to extend beyond air travel focus	H	M	M	M
Engage Cadent and Northern Gas Networks in the scaling up of green hydrogen blending at GatewayEast, Riverdale Park, and Pheasant Hill development sites	H	M	M	M
Establish a commercial relationship with specialists in the exploitation of mine-water heat sources and the development of subterranean hydrogen storage capacity.	H	H	H	L
Driver: Business Support				
Explore the possibility of creating a Low Carbon-specific business support facility as part of a future Bradholme site development.	H	H	M	M
Driver: Labour Supply				
Doncaster UTC to become Centre of Excellence in LCREE skills training	H	M	M	M
Driver: Finance and Funding				
Secure long-term funding for Hydrogen refuelling Infrastructure	H	H	H	M
Driver: Showcasing				
Develop Doncaster's brand as a Hydrogen leader nationally and internationally	M	M	M	L
Evaluate and share success of Council procurement and planning policies, showcasing to businesses, investors and local authorities	M	L	L	M
Expansion of decarbonisation hub work with businesses and stakeholders at a wider geography	M	L	L	M

ANNEX B – LOW CARBON SECTOR GROWTH KEY DEVELOPMENT SITE ANALYSIS IN DONCASTER

Cited throughout the study have been references to the various key development sites across the Doncaster authority and their potential as locations for growing the low carbon sector. Below is a site-by-site analysis of these development areas outlining specific sub-sector opportunities related to each site.

Development Site	Unity
Current Facilities & Activity	• 350 ha mixed-use development site (including 60 ha dedicated commercial/industrial space and 85 ha ringfenced for solely housing). • Benefits from a direct new link road connecting the site to junction 5 of the M18 motorway (where the M180 joins the M18). • Significant planned industrial and warehousing capacity across varied range of spaces – 25,000 sq. ft to 400,000 sq. ft.
Sub-Sector Opportunities	• Availability of medium to large industrial space for development of heat pump research & development sites and significant manufacturing facilities. • Flexible development space will allow for co-location of heat pump installation training facility. • Dedicated housing zones present an opportunity to install proto-type community low carbon heat network/use hydrogen for heating on a meaningful scale at time of build. This could also be extended to non-residential developments. • Roll-out of hydrogen refuelling stations and onsite storage for provision of industrial and residential private vehicle use and to power localised public transport options.

Development Site	GatewayEast
Current Facilities & Activity	• 647 ha (including 650-acre innovation district). • Industrial, manufacturing and distribution capacity available at existing development sites. • Planning permission granted for new Central Plaza mixed development site. • Positioned on regional and national strategic highway network (via the Great Yorkshire Way). • Anchored around available airside infrastructure and unconstrained airspace. • Already home to 100 businesses (2020) including aviation-linked cluster (Cessna, Trextron's UK Service Centre, 2Excel, National Police Air Service and Redline Assured Security). • GatewayEast Academy – offering job and support opportunities from over 70 businesses already located on the site.

Sub-Sector Opportunities	• Availability of medium to large industrial space for development of heat pump research & development sites and significant manufacturing facilities. • Creation of specialist low-carbon aviation research, innovation and testing/demonstrator site centred around a 'living lab' of airport facilities through collaboration with universities and research institutes e.g., University of Nottingham 'Beacon of Excellence - Propulsion Futures' project. • Suitable airside facilities and industrial space for entry into sustainable aviation fuel (SAF) supply and distribution industry. • Similarly, the development of hydrogen fuel infrastructure testing to support zero-carbon flights. • And in the development, manufacture, and assembly of aviation-related components. • Location on strategic road network provides ideal location for roll-out of hydrogen refuelling stations and onsite storage.

Development Site	**Doncaster North (Thorne)**
Current Facilities & Activity	• 72.84 ha prime development site. • Positioned on regional and national strategic highway network (adjacent to J6 of the M18 and J35 of the M62). • Site is designated solely for industrial and warehousing developments. • Existing outline planning permission for 3.5m sq. ft of manufacturing and B8 warehousing space. • Unique opportunity to develop a single unit of 1.15m sq. ft. • Commitment from developer that facilities across the whole site must deliver 'market leading ESG credentials.'
Sub-Sector Opportunities	• Availability of medium to large industrial space for development of heat pump research & development sites and significant manufacturing facilities. • Flexible development space will allow for co-location of heat pump installation training facility. • Close proximity to renewable energy generating capacity combined with flexible scale industrial premises presents an opportunity to base clean hydrogen production at the location. • Commitment to highest standards of ESG provides context for development of a new, larger-scale testbed for hydrogen generated heat. • Location on strategic road network provides ideal location for roll-out of hydrogen refuelling stations and onsite storage.

Development Site	iPort Doncaster
Current Facilities & Activity	• 6m sq. ft of logistics space. • Significant planned and speculative warehousing capacity ranging from 50,000 sq. ft to 1.2m sq. ft. • Benefits from a direct new link road connecting the site to junction 3 of the M18 motorway (via the Great Yorkshire Way). • Served by integrated iPort Rail, a state-of-the-art intermodal terminal and modern rail freight handling facilities. • iPort Academy established to support recruitment and training for prospective tenants.
Sub-Sector Opportunities	• Suitable rail infrastructure for an at scale research & development facility/demonstrator site in the use of hydrogen propulsion as a replacement for diesel powered rolling stock. • Conversion of logistics space into hydrogen production and storage capacity to serve rail test-bed facility. • Roll-out of hydrogen refuelling stations for use by haulage industry and to power localised public transport options. • Opportunity to install proto-type low carbon heat network/use hydrogen for heating within a non-residential context on a meaningful scale at time of build.

ANNEX C – CONSULTATION DETAILS

The following consultees have kindly inputted their knowledge and expertise to this study:

- Beta Technology
- Cambridge Science and Policy Consulting
- Clarks Vehicle Conversions Limited
- Clean Power Hydrogen Group
- Department for International Trade:
    - *David Beasley - International Trade Advisor*
    - *Victoria Zastava - Head of Sector: Energy Transition and Infrastructure*
    - *Francesco Migneco - Project Manager, Energy & Infrastructure, Investment Services Team*
- Doncaster Chamber
- Doncaster Council
- Go Green Limited
- Harworth Group Plc
- National College for Advanced Transport and Infrastructure
- Peel Group
- Sheffield Hallam University
- Synetiq
- Waystone Developments Limited

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