West Yorkshire Combined Authority

Towards a zero-carbon Leeds City Region

Energy Delivery Plan

Work Package 4: Final report
December 2018

Executive Summary

The aim of this document is to provide a coherent, evidenced, strategic delivery plan to allow the West Yorkshire Combined Authority (the Combined Authority) and the Leeds City Region Local Enterprise Partnership (the LEP) to articulate how it aims to work towards creating a zero-carbon economy in the Leeds City Region (City Region). This Energy Strategy and Delivery Plan (ESDP) also highlights what the Combined Authority will need to target in terms of investment and innovation in the City Region.

This Delivery Plan is part of a series of different work packages that make up the City Region ESDP. Work has previously been undertaken to provide a qualitative assessment of the potential of a range of energy technology options across the City Region. In addition, a spatial assessment to identify energy technology areas has been undertaken and provide a suitable location for the deployment of these technologies.

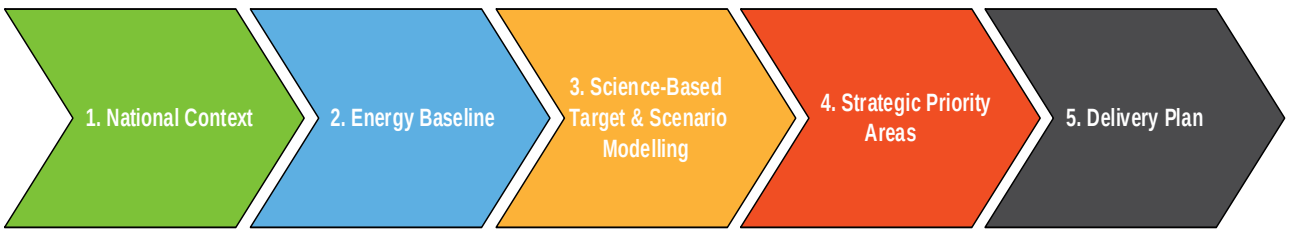
As part of this ESDP, we have undertaken an energy baseline assessment of the current and forecasted energy state of the City Region to 2036, to complement the baseline work focussed on jobs, skills and GVA. We have also explored the opportunity for the City Region to set a science-based target and carried out future energy scenario modelling to assess the economic impacts of meeting the proposed science-based target; two distinct transition pathways have been developed for this: the 'high hydrogen' and the 'high electricity' scenarios.

The strategic priority areas underpinning this Delivery Plan have been identified in light of the LEP vision in its Strategic Economic Plan (SEP) for the City Region "to be a globally recognised economy where good growth delivers high levels of prosperity, jobs, and quality of life for everyone". This vision is underpinned by four inter-connected strategic investment priorities: (i) growing business, (ii) skilled people and better jobs, (iii) clean energy and environmental resilience, and (iv) infrastructure for growth. Guided by the SEP, an in-depth stakeholder engagement exercise of interviews and workshops, and the energy baseline modelling exercise, five strategic priority areas have been identified, setting out the role of energy in supporting economic growth across the City Region:

1. Resource efficient business and industry
2. New energy generation
3. Energy efficiency and empowering consumers
4. Smart grid systems integration
5. Efficient and integrated transport

In considering these five strategic priorities, we have identified existing and future energy strengths and opportunities for the City Region, as well as a 'long list' of potential projects that could help the Combined Authority in realising these.

This document follows the structure shown below:



Abbreviations

aGVA	Approximate Gross Value Added
BECCS	Bioenergy Carbon Capture and Storage
BEIS	Department for Business, Energy and Industrial Strategy
BHY	Better Homes Yorkshire
BRT	Bus Rapid Transit
CAZ	Clean Air Zone
CCC	Committee on Climate Change
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CHP	Combined Heat and Power
CIL	Commmunity Infrastructure Levy
CNG	Compressed Nature Gas
DFT	Department for Transport
DNO	District Network Operator
DSR	Demand Side Response
ECO	Energy Company Obligation
EFW	Energy from Waste
EIB	European Investment Bank
ELENA	European Local Energy Assistance
EPC	Energy Performance Certificate
ERDF	European Regional Development Fund
ESOS	Energy Savings Opportunity Scheme
EV	Electric Vehicle
FIT	Feed-in Tariff

FTE	Full Time Equivalent
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIB	Green Investment Bank
GLA	Greater London Authority
GVA	Gross Value Added
KPI	Key Performance Indicator
LCR	Leeds City Region
LNCP	Low Carbon Neighbourhood Plans
LED	Light Emitting Diode
LEP	Local Enterprise Partnership
LGV	Light Goods Vehicle
LIS	Local Industrial Strategy
LNG	Liquid Natural Gas
H21	Hydrogen 21
HGV	Heavy Goods Vehicle
HNDU	Heat Network Delivery Unit
HNIP	Heat Network Investment Project
HSE	Health and Safety Executive
HVAC	Heating, Ventilation and Air Conditioning
ICE	Internal Combustion Vehicle
IEA	International Energy Agency
IEEA	Industrial Energy Efficiency Accelerator
IHRSP	Industrial Heat Recovery Support Programme
IPCC	Intergovernmental Panel on Climate Change
IPPR	International Public Policy Research
IRR	Internal Rate of Return

ISCF	Industrial Strategy Challenge Fund
LPA	Local Planning Authority
MRV	Measuring, Reporting and Verification
NEC	Not Elsewhere Classified
NEYH	North East, Yorkshire and Humber
NGN	Northern Gas Network
NIC	National Infrastructure Commission
NISP	National Indsutrial Symbiosis Programme
NPPF	National Planning Policy Framework
NYLTP	North Yorkshire Local Transport Plan
OECD	Organisation for Economic Cooperation and Development
OFGEM	Office for Gas and Electricity Markets
ONS	Office for National Statistics
PPA	Power Purchase Agreement
PV	Photovoltaic
R&D	Research and Development
RCP	Representative Concentration Pathway
REF	Resource Efficiency Fund
RERF	Recycling and Energy Recovery Facility
RHI	Renewable Heat Incentive
SBTI	Science-Based Targets Initiative
SDA	Sectoral Decarbonisation Approach
SIC	Standard Industrial Classification
SMEs	Small and Medium Enterprises
SMETER	Smart Meter Enabled Thermal Efficiency Ratings
SPA	Spatial Priority Area
STEM	Science, Technology, Engineering and Mathematics

TINA	Technology Innovation Needs Assessment
ULEV	Ultra Low Emissions Vehicle
V2G	Vehicle to Grid
WRAP	Waste and Resources Action Programme
WSNF	Whole Systems Networking Fund

Context

National context

Following the publication of the UK Industrial Strategy in November 2017, the Government asked all Local Enterprise Partnerships (LEPs) to produce Local Industrial Strategies to translate the ambitions and activities of this national strategy into local economies and activities. In response to this, Leeds City Region (the City Region) Local Enterprise Partnership (the LEP) and West Yorkshire Combined Authority (the Combined Authority) are producing a Local Industrial Strategy (LIS) for the City Region.

To feed into this, the Energy Strategy and Delivery Plan (ESDP) for the City Region will provide the LEP with a valuable local evidence base and action plan. The LEP and Combined Authority are aiming for a single, bold City Region strategy, as a key component of an agile, long-term strategic policy framework aimed at driving growth and boosting productivity and earning power for a post-2030 economy. The LIS will build on the Strategic Economic Plan (SEP), recognising that the SEP's headline priorities have a strong fit with the overarching objectives of the national Industrial Strategy. Work has commenced to identify a number of emerging proposals and ideas such as:

- Transformative private sector leadership in the City Region to tackle the growing productivity gap.
- The City Region transformed by technology
- Maximising the impact of HS2 and Northern Powerhouse Rail through the development of inclusive growth corridors in the City Region.

Additionally, the Department for Business, Energy, and Industrial Strategy (BEIS) are delivering a Local Energy programme intended to improve the ability of LEPs and local authorities to promote and deliver energy projects. The first phase of this programme provided funding to all LEPs in England to support them in developing an energy strategy, which includes the identification of investable projects. Following this, BEIS have provided £4.8 million to establish five Local Energy Hubs across England to provide capacity support and help bring projects to implementation from summer 2018.

The City Region, via the Combined Authority, will be a member of the North East, Yorkshire, and Humber (NEYH) Energy Hub, covering six LEPs. There will be full time staff located in each of the LEP areas: North East, Tees Valley, York, North Yorkshire and East Riding and Sheffield City. There will be a part time resource in the Leeds City Region due to the presence of the Energy Accelerator. The NEYH Energy Hub will be hosted by the Tees Valley Combined Authority who will act as the lead accountable local authority for the consortium of six LEPs. The LEP will have the opportunity to influence the pipeline of projects that the NEYH Energy Hub will be considering, and secure support for those local opportunities highlighted in its Energy Strategy.

It is also worth noting that the evidence resulting from this Energy Strategy has the potential to influence future national policy-making. BEIS will be undertaking a review of LEP local energy strategies, and using the findings and recommendations to influence the future of the local energy programme and to shape future policy.

There are varieties of national policies, strategies, and reports that provide important context for local energy planning. These indicate national priorities and analysis that may prove useful for local energy planning, and, it is important to identify the number of ways the City Region and local authority could access such national opportunities:

- By aligning local City Region and Combined Authority objectives with national opportunities.
- Responding to national government consultations.
- Working through the NEYH Energy Hub to promote the City Region's agenda.
- Through their energy strategies and LIS, local authorities will be able to influence the national agenda, as well as align their future actions with national priorities to unlock opportunities and additional resources.

Industrial Strategy

The UK's Industrial Strategy sets out the government's plan to create an economy that boosts productivity and earning power throughout the UK. It positions five foundations for growth; these are Ideas, People, Infrastructure, Business Environment, and Places.

It sets four Grand Challenges where Britain can lead the global technological revolution:

- AI and data economy: putting the UK at the forefront of AI and the data revolution.
- Clean growth: maximising advantages for UK industry from the global shift to clean growth.
- Future mobility: being a world leader in shaping the future of mobility.
- Ageing society: harnessing the power of innovation to help meet the needs of an ageing society.

These challenges have strong links with the energy and low-carbon sectors and with economic growth. The Industrial Strategy highlights several ways in which we will need to consider energy in order to build an economy that works for everyone. These include:

- Upgrading energy infrastructure to enable growth and support new technologies;
- Delivering affordable energy and keeping energy costs down for businesses;
- Delivering clean growth and securing the economic benefits of the transition to a low-carbon economy;
- Investing in science, research and innovation, including energy storage and grid technologies; and
- Supporting businesses to start and grow.

The strategy recognises that LEPs play an important part in supporting local growth. Throughout 2018, the government will work with LEPs to more clearly define activities and objectives, define a strategy for national and local partnership, and to agree appropriate accountability structures for LEPs.

The strategy emphasises the importance of collaboration between LEPs and recognises the need for policy flexibility at the regional level. In terms of funding, government recognises that LEPs require financial support in order to be effective. Additional financial resources will be made available to LEPs that demonstrate ambitious levels of reform. Key policies outlined in the Industrial Strategy report include:

- Raising total Research and Development (R&D) investment to 2.4 percent of Gross Domestic Product (GDP) by 2027;
- Increase the rate of R&D tax credit to 12 percent;

- £725 million investment in new Industrial Strategy Fund programmes to realise the value of innovation in the UK;
- Additional £406 million investment in education for Science, Technology, Engineering and Mathematics (STEM) based subjects; and
- £20 billion worth of investment in innovative and high potential businesses.

The government will also launch a UK Shared Prosperity Fund following the UK´s departure from the EU. Government also confirmed its commitment to guarantee funding for any EU projects signed whilst the UK is still part of the EU. Support will continue even if a project continues after the UK´s departure, if the project provides good value for money and aligns with domestic priorities.

Clean Growth Strategy

The Clean Growth Strategy provides an ambitious blueprint for Britain's low carbon future, outlining how investment in green energy goes hand-in-hand with economic growth and placing clean growth at the centre of the Industrial Strategy. Core to the strategy is the actions we will take to cut emissions, increase efficiency and lower the amount consumers and businesses spend on energy.

Key Policies and Proposals in the Strategy include:

- Accelerating Clean Growth, developing world leading Green Finance capabilities;
- Improving Business and industry efficiency, improving energy productivity and commercial building standards, delivering industrial energy efficiency, investing in industrial innovation;
- Improving our homes, upgrading energy efficiency across a million homes, strengthening building standards, rolling out heat networks, phasing out of high carbon heating;
- Accelerating the shift to low-carbon transport, supporting the take-up of ultra-low emission vehicles, developing electric vehicle charging network, shifting freight from road to rail and innovation in Connected and Autonomous Vehicles and electric batteries;
- Delivering clean, smart, flexible power, phasing-out of coal, developing new ways of balancing the grid through electricity storage and demand response;
- Enhancing the benefits and value of our natural resources, supporting agriculture, a new network of forests, zero avoidable waste by 2050, managing emissions from landfill; and
- Leading in the public sector, setting a voluntary 30 percent public sector carbon reduction target by 2020 and funding for energy efficiency improvements in England.

In support of the last proposal, BEIS released an 'Emissions Reduction Pledge 2020' guidance document, which provides measurement and reporting guidance for public sector bodies in England that wish to join the scheme and target a 30 percent reduction by 2020/21 (against a 2009/10 baseline).

The Clean Growth Strategy recognises LEPs as an important stakeholder in driving future decarbonisation.

The Clean Growth Strategy touches upon a number of ambitions particularly relevant to the City Region. These include delivering smart grid systems integration; accelerating the

shift to low-carbon transport; improving business and industrial efficiency; accelerating energy efficiency and new energy generation.

BEIS will be consulting with the public sector throughout 2018 to inform the development of a Future Action Plan for the Public Sector, due to be published in 2019 and to determine the future of the Emissions Reduction Pledge beyond 2020. It is recommended that the City Region and local councils take part in this consultation process to feedback local requirements that arise from the engagement surrounding the development and implementation of this Energy Strategy.

Industrial decarbonisation and energy efficiency roadmaps

The industrial decarbonisation and energy efficiency roadmaps to 2050 are a national resource that is relevant to the development of energy strategies such as the City Region energy strategy planning. The roadmaps focus on eight of the most carbon intensive sectors (Iron and Steel, Chemicals, Oil Refining, Food and Drink, Pulp and Paper, Cement, Glass and Ceramics) and highlight technological pathways that could be pursued to reach decarbonisation targets. Each roadmap states current and future potential decarbonisation measures that may be undertaken by specific sectors.

The City Region is home to particularly strong groupings of Chemical, Glass and Ceramics and Food and Drink businesses, with supply chains that stretch across the region as well as further afield across northern England. Specifically, the region has over 11 times more manufacturers of margarine and similar edible fats, and over five times more manufacturers of macaroni, noodles, couscous and similar farinaceous products than the national average. Similarly, the region has 8.5 times as many manufacturers of hollow glass and almost six times as many manufacturers of pesticides and other agrochemical products as the national average.

National Infrastructure Commission

The National Infrastructure Commission (NIC), established in 2015, provides the government with impartial, expert advice on major long-term infrastructure challenges. The NIC report “Congestion, Capacity, Carbon: Priorities for National Infrastructure” is an interim assessment in preparation for the 2018 National Infrastructure Strategy which identifies key infrastructure priorities. Of the seven areas identified, two relate directly to energy. They stress that technology plays a key role in eliminating carbon emissions from energy and waste. The report highlights the importance of smart meters, advances in batteries and storage, consideration of the case of tidal, carbon capture and storage, nuclear, and consideration of the barriers for different renewable energy technologies.

The necessity of a revolution in road transportation is also identified. This focuses around how technologies can be introduced, and how they can be funded through models that involve road users paying a fair price in the future. Digital connectivity, smart motorways, electric vehicles (EVs), smart charging networks, roadway sensors, and automated light management will play important roles in transportation. The NIC report sets forth the common challenges that the country faces with respect to infrastructure and provided an early indication of how the government will seek to address these issues. In July 2018, the NIC issued the first National Infrastructure Assessment that sets out the Commission’s plan of action for the country’s infrastructure over the next 10-30 years. The recommendations in the assessment set out a pathway for the UK’s economic infrastructure:

- Nationwide full fibre broadband by 2033;
- Half of the UK’s power provided by renewables by 2030;

- Three quarters of plastic packaging recycled by 2030;
- £43 billion of stable long term transport funding for regional cities;
- Preparing for 100 percent electric vehicle sales by 2030;
- Ensuring resilience to extreme drought; and
- A national standard of flood resilience for all communities by 2050.

Government, regulators, industry, citizens, and others will all need to contribute to making this vision a reality. Over the coming months the Commission will work to build consensus around its recommendations, and the ESDP and LIS both have a role to play in contributing towards these objectives. For example, the H21 Hydrogen project dovetails with the Commission's recommendation that hydrogen is trialled at community scale by 2021, and subsequently rolled out to at least 10,000 homes by 2023.

LEP review

The 'Strengthened Local Enterprise Partnerships' review proposes a number of reforms to the leadership, governance and accountability of the 38 LEPs to boost their performance, increase diversity and ensure transparency. This includes:

- Up to £20 million of additional funding between 2018-2019 and 2019-2020 to support implementing these changes and embed evidence in Local Industrial Strategies;
- Supporting LEPs to consult widely and transparently on appointing new Chairs and improving diversity;
- Aiming for women to comprise at least one third of LEP boards by 2020, with equal representation by 2023; and
- Mandate for LEPs to submit proposals for revised geographies including removing situations in which two LEP boundaries overlap.

This vote of confidence from the government to push forwards with the LEP programme and ensure its robustness for delivering change encourages this document, and its proposed works, to be ambitious.

Local context

Economic context

The City Region includes 10 local authorities, has a population of over 3 million, and is home to more than 125,000 businesses. The number of businesses has increased by 19.5 percent over the last five years. Of the 3 million inhabitants, the workforce in the City Region amounts to 1.4 million people. It is the largest City Region economy outside London, with an economy worth over £66.5 billion, representing 5 percent of England's total economic output. The City Region has strengths in the financial and professional services, manufacturing, health and digital sectors. The City Region is the largest manufacturing centre in the UK.

The energy sector makes a small but significant contribution to economic output in the City Region, with employment accounting for less than 1 percent of total employment. Production of electricity accounts for the largest share of employment in the energy sector within the City Region, representing 40 percent of total employment. Trading of gas accounts for the next highest with 30 percent of employment in the energy sector.

The impact of the energy sector on the economy is greater than sum of its parts. Whilst the sector constitutes a relatively modest share of economic output, its impact on the economy is far greater than this direct contribution. Beyond the delivery of direct outputs such as heat, light and power, energy is deeply linked to other sectors and is an input into almost all goods and services. For this reason, stable and affordable energy prices are central to sustaining and expanding economic growth. Rising energy costs impact the bottom line of business, affect household spending power, and influence public sector investment decisions.

Energy sector employment is heavily concentrated in the three districts of Leeds, Wakefield, and Selby. Leeds alone accounts for around half of total sector employment in the City Region. The key activities in Leeds are gas trading and electricity generation and distribution.

Wakefield and Selby each account for around one in seven of total energy jobs in the City Region. Wakefield is the location of the Ferrybridge multi-fuel generation plant. In Selby, employment reflects the presence of two major power stations in the district: Drax (coal and biomass) and Eggborough (converting from coal to CCGT since March 2018).

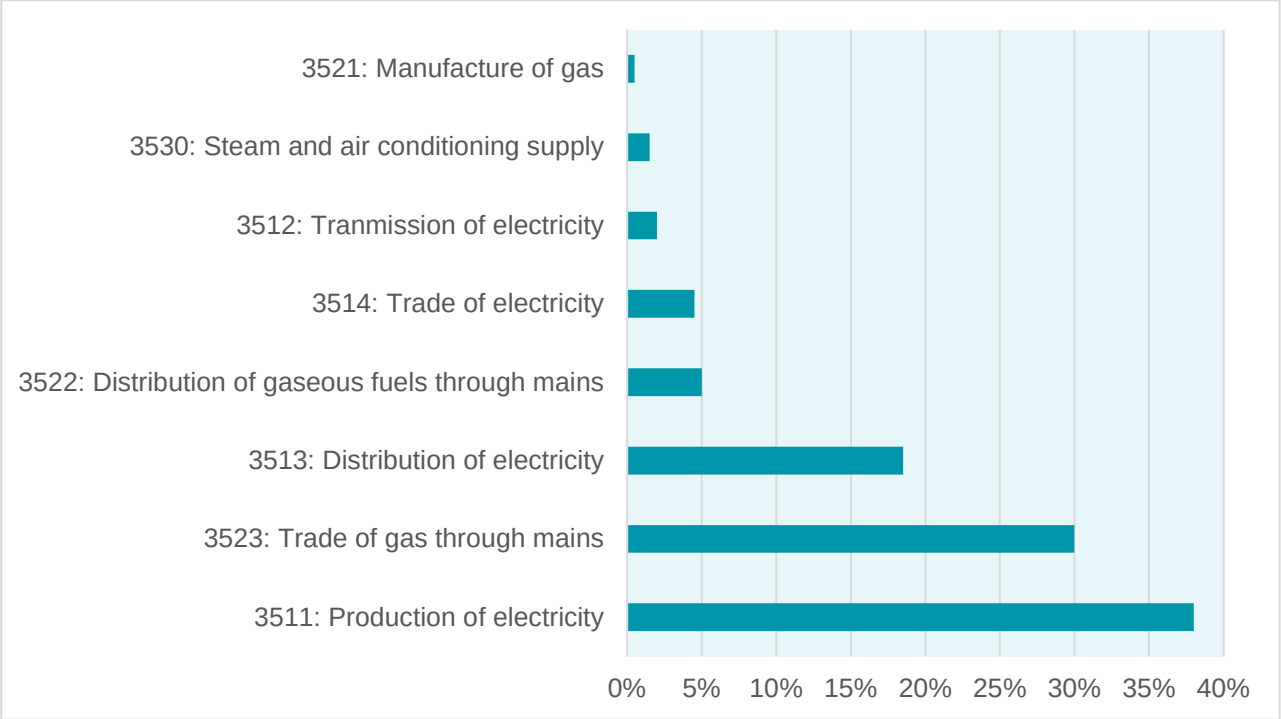


Figure 1. Employment in the energy sector in the City Region

Existing programmes, funds and strategies

Lowering carbon emissions, while taking advantage of innovations in renewable energy to create jobs and growth, is a core element of the City Region's SEP to transform the region's economy. The two focus areas of activity are supporting businesses and residents to become more resource efficient and reduce their energy bills, and developing a 21st century low-cost local energy infrastructure, building on the City Region's energy assets.

There is already a lot of activity in the City Region about resource efficiency. Projects and programmes currently underway include:

Leeds City Region Energy Accelerator

The Energy Accelerator (the Accelerator) is a key mechanism in delivering on the 'Clean Energy and Environmental Resilience' priority of the SEP, which aims to create a resilient zero carbon energy economy underpinned by high quality green infrastructure.

This programme is currently being established and will provide project development support services to remove barriers associated with project development funding and expertise preventing investment in low carbon capital projects in the City Region. The Accelerator will offer specialist technical, commercial and legal expertise to low carbon local energy projects, particularly to public sector sponsors. It will help projects get off the ground, providing technical support and advice to move them from concept to point of delivery. The Combined Authority is establishing the Accelerator as a commercial project development support unit, with a total value of €3.27 million funded by the European Investment Bank (EIB) ELENA programme and match funding from the Local Growth Fund.

Once up and running, the Accelerator will increase levels of technical support and investment for low-carbon projects in the City Region, and enable at least £60 million worth of capital investment into the City Region.

Leeds City Region Resource Efficiency Fund

The Combined Authority established a Resource Efficiency Fund (REF) to assist Small and Medium Enterprises (SMEs) in the City Region to identify, fund, and implement capital resource-efficiency improvements. The fund formally launched in February 2017 and will run to October 2019, estimated to be worth up to circa £2.8 million over this period. The services provided to SMEs take one of the three following forms, with additional wrap around support from a dedicated resource efficiency account manager:

- Type I Assessment: a simple one-day technical assessment of energy, waste and water saving opportunities and funding;
- Type II Assessment: a more in-depth two-day assessment, providing a rigorous assessment of opportunities and funding to include energy and water efficiency, waste reduction, and potential plant, product and process improvements; and
- Type III Assessment: a review of an existing technical assessment previously undertaken by the client SME to assess accuracy and viability.

Following the delivery of free resource efficiency assessments, businesses can receive up to 50 percent capital grant funding of up to £10,000 towards the cost of purchasing energy, water or waste saving capital improvements.

Better Homes Yorkshire

Help is available to residents to install energy efficiency and heating improvements in their homes through the Better Homes Yorkshire (BHY) programme. Supported by the Combined Authority, working in partnership with councils and private property owners, the programme has improved 3,107 privately owned or rented homes to date reducing energy bills, carbon emissions and fuel poverty.

Local supply chain partners within the City Region have delivered around 85 percent of the contract value to date. The partnership has worked together to secure and deliver a range of projects and programmes with funding brought together from multiple sources, including national government (Green Deal Communities, Central Heating Fund), Growth Deal, local authority capital plans, Energy Company Obligation (ECO), customer contributions and most recently National Grid.

Leeds City Region District Heat Programme

The LEP is working in partnership with local authorities and private sector partners across the City Region to support the development of more than 10 district heat network opportunities, which have the potential, once completed, to provide low cost heat to over 1,100 businesses while saving millions of tonnes of carbon.

Earlier this year Leeds City Council launched one of the UK's largest heat networks, the £35 million Leeds 'PIPES' Network to be completed in spring 2019. The scheme that is part-funded by the Leeds City Region Growth Deal (£4 million) and delivered in partnership with energy company Vital Energi will bring low carbon, lower cost heating and hot water to the city of Leeds, while also cutting 22,000 tonnes of carbon emissions every year.

The 'PIPES' programme uses super-insulated steel pipes to connect the Recycling and Energy Recovery Facility (RERF) in the Aire Valley to customers across the City of Leeds. Heat will be extracted from the centre as steam which will then be used to transfer heat to the heat network and into people's homes. The 16.5 km scheme is set to connect 1,983 council homes and numerous business around Leeds City Centre.

Northern Energy Strategy

The Northern Energy Taskforce, convened by the Institute for Public Policy Research (IPPR North), came together with the belief that the energy sector should continue to be a fundamental strength of the economy of the North. The Northern Energy Strategy, the final report of the Northern Energy Taskforce, is a roadmap that contains recommendations for national, regional, and local stakeholders on how to create an energy economy worth £15 billion and create 100,000 jobs by 2050. This includes a call for Local Energy Devolution Deals and the negotiation of a Northern Energy Compact.

The IPPR Northern Energy Strategy outlines ambitious recommendations such as:

- The negotiation of a Northern Energy Compact, a long-term arrangement that facilitates public and private investment in energy assets, including a binding northern carbon budget negotiated with the Committee on Climate Change (CCC), which legally commits the region to a share of the responsibility;
- The formation of a Northern Energy Accelerator as a regional delivery vehicle, which works with key stakeholders to identify and implement opportunities and acts as a driving force; and
- Striking Local Energy Devolution Deals with government, including devolved receipts from the Carbon Floor Price and Emissions Trading Scheme, in return for specific commitments to stimulate the acceleration of a decentralised approach to energy generation and efficiency.

West Yorkshire Transport Strategy

The Combined Authority produced this document through engagement with West Yorkshire's five local authorities and the City Region LEP, alongside a range of private sector stakeholders. The strategy looks out to 2040 and assesses both what success would look like, and how it would overcome regional barriers and weaknesses.

The strategy has six core themes: Road network; Places to live and work; One system public transport; Smart futures; Asset management and resilience; and Inclusive growth, environment, health and wellbeing.

Particular challenges faced by the strategy include the size and diversity of the West Yorkshire region, which causes difficulties in balancing transport priorities and funding, the failure of road and rail investments in keeping up with economic and population growth, and the significant number of automobiles on the road affecting air quality.

The strategy seeks to overcome these through influencing and maximizing investment decisions, driving the deployment of appropriate technologies that dovetail with the inclusive growth ambitions of the SEP.

North Yorkshire Local Transport Plan

North Yorkshire County Council created the NYLTP document through consultation with the public, stakeholders and partner organisations. One headline finding of the process was that the local population prioritise maintaining current transport services and infrastructure to a good standard over providing new services and infrastructure.

The thematic objectives of the plan are economic growth, road safety, access to services, environment and climate change and healthier travel. The main interplay with the energy falls under 'environment and climate change', looking at growing the use of lower carbon transport modes, such as buses, trains, walking, cycling and car-sharing.

Sheffield City Region Transport Strategy

The Sheffield City Region Combined Authority worked in partnership with the Sheffield City Region LEP and other authorities to develop this strategy, setting out transport priorities up to 2040. It has aimed to strike the correct balance between encouraging investment and productivity, whilst increasing economic inclusion, access to employment and creating safe, healthy streets.

The strategy has four overarching goals, within which sit detailed policies and targets, these are:

- Support inclusive growth
- Create healthy streets where people feel safe
- Improve the quality of the outdoors
- Promote, enable and adapt different technologies

West Yorkshire Low Emissions Strategy

This document represents a joint commitment made by the local authorities of West Yorkshire and the Combined Authority to improve air quality across the region. It has key crossovers with both the City Region LEP SEP and WYTS, which look to reduce carbon emissions, improve efficiency and deploy low carbon technologies that will consequently improve air quality. There is an important point to be recognized however, that a desire to grow the regional economy and boost productivity will likely have ramifications on air quality progress if not considered at these initial stages.

The focus areas demarcated for tackling transport emissions are passenger cars, buses, trains, freight, taxis and public sector fleet vehicles. This will be funded through maximising existing streams – such as the Growth Deal and West Yorkshire Transport Fund – identifying funding as part of development proposals, or indirectly through contributions from Section 106 Planning Obligations or Community Infrastructure Levy (CIL) arrangements, as well as from new grant funding.

Local Industrial Strategy

This strategy is the City Region's response to the Government's 2017 Industrial Strategy White Paper. It will build on the existing SEP, which enabled the LEP to secure a £1 billion Growth Deal in 2014.

The LIS faces several key region challenges. Similarly to much of northern England, the productivity gap is increasing, incomes are lower that the elsewhere in the country, living standards have stalled and stubborn deprivation exists. As a document, the strategy has an important role to play in addressing these challenges, drawing together elements of previous work, and its authors, to create a focal point and deliver joined-up solutions. The emergent ideas currently under research include transformative private sector leadership, a focus on technology, and maximising the HS2 and Northern Powerhouse Rail projects through the development of inclusive growth corridors.

Building on the City Region's strengths

The map in Figure 2 shows the City Region area, its key sectoral assets, its exceptional concentration of universities, and the principal transport routes.

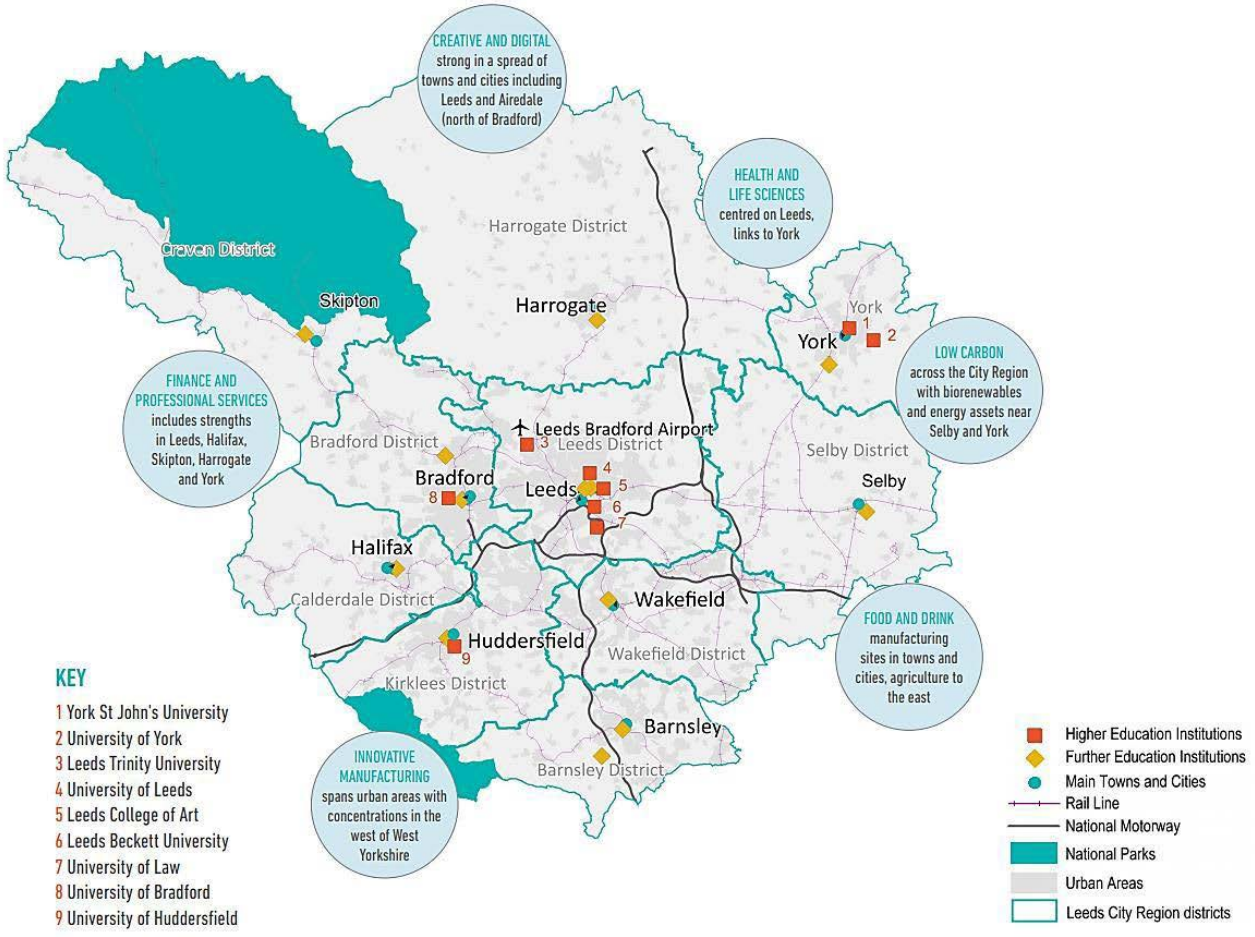


Figure 2. The City Region – more than a sum of its parts

Some key strengths of the City Region include:

- Already home to the busiest rail station outside of London, Leeds is set to cement its role as a central East-West and North-South transport hub through the arrival of HS2

- Bradford is the ‘Producer City’ at the heart of the North, with above average concentrations of production business and employees across manufacturing, energy and utilities
- Kirklees is home to world-leading engineering and textile businesses, and has important links to Manchester, Leeds, and Sheffield
- Wakefield is situated at the heart of the UK’s transport network, and has key strengths in ma manufacturing, logistics, and automotive
- Selby’s economy is characterised by manufacturing, distribution, construction, and energy production
- Craven's extensive upland areas add to its quality of life and attractiveness and make it an important area for green infrastructure and water management
- Working to achieve full superfast broadband coverage across the City Region through schemes such as the Superfast West Yorkshire
- Energy sector employment is highly concentrated in Leeds, Wakefield and Selby, with Leeds accounting for half of the total sector employment in the city region – particularly gas trading and electricity generation and distribution
- The energy sector’s labour productivity is among the highest of any industry in the region, more than £100 per hour worked
- The energy sector in the region is relatively highly skilled, with a strong representation in management, professional and associate professional/technical occupations
- The City Region hosts a significant level of Higher Education provision that is directly relevant to the skills needs of the energy sector
- Employers in the city region make a significant investment in apprenticeships that relate to the specific needs of the energy sector, including recently developed apprenticeships that are based on employer-defined standards

The City Region already has many of the skills and expertise needed to advance the projects and programmes presented in this strategy. Moreover, an important part of the City Region economy (e.g. manufacturing, construction, and distribution) has the potential to play an integral part in reducing the energy intensity of the City Region. Many opportunities also exist related to sustainable transport and smart grid systems integration.

In addition to the aforementioned strengths, the City Region is home to a strong low carbon sector and energy generation capacity (in particular Drax) that is critical to the UK and a focus for innovation.

These strengths are relevant to the energy strategy as they can be used as a foundation from which to build further clean growth in the City Region. For instance, high energy intensive industries operating in the key strength sectors such as manufacturing and construction should become the target of energy efficiency initiatives and projects. Additionally, existing plans to achieve full superfast broadband are linked to the smart energy revolution and can be an important stepping stone for smart street lighting.

Energy baseline

An energy and carbon baseline is a useful tool to demonstrate how a region is and has been performing, as well as offering a means to compare itself to national or other region's levels. Data has been obtained from publicly available sources, and is available for a ten year period spanning 2005 to 2015. Unless otherwise specified, all energy data (consumed or generated) is quoted in GWh, and all emission data is in $ktCO_2$. Where primary data for the City Region has not been available, values have been calculated using regional or national data and normalised to the City Region, or by considering the 10 local authorities that make up the City Region.

Energy consumption

Energy consumed by 'end users' is categorised into three main consuming sectors: transport, domestic, and industry and commercial. The type of energy consumed is broken down in to the different fuel types: electricity, natural gas, coal, manufactured fuels, petroleum products, and bioenergy and wastes. Both the end user consumption categories and fuel types can be further broken down to increasing levels of granularity.

In 2015, the City Region consumed 64,232 GWh of energy, enough to boil over half a trillion kettles; this value has been steadily decreasing since 2005, when the energy consumption was almost 22 percent greater, see Figure 4. This decrease in consumption has occurred during a period when the population in the region has increased by 7 percent, meaning that energy consumption per capita has fallen at a significant rate too. The decrease in energy consumption is likely driven through increases in energy efficient technologies and a move to less energy intensive industries.

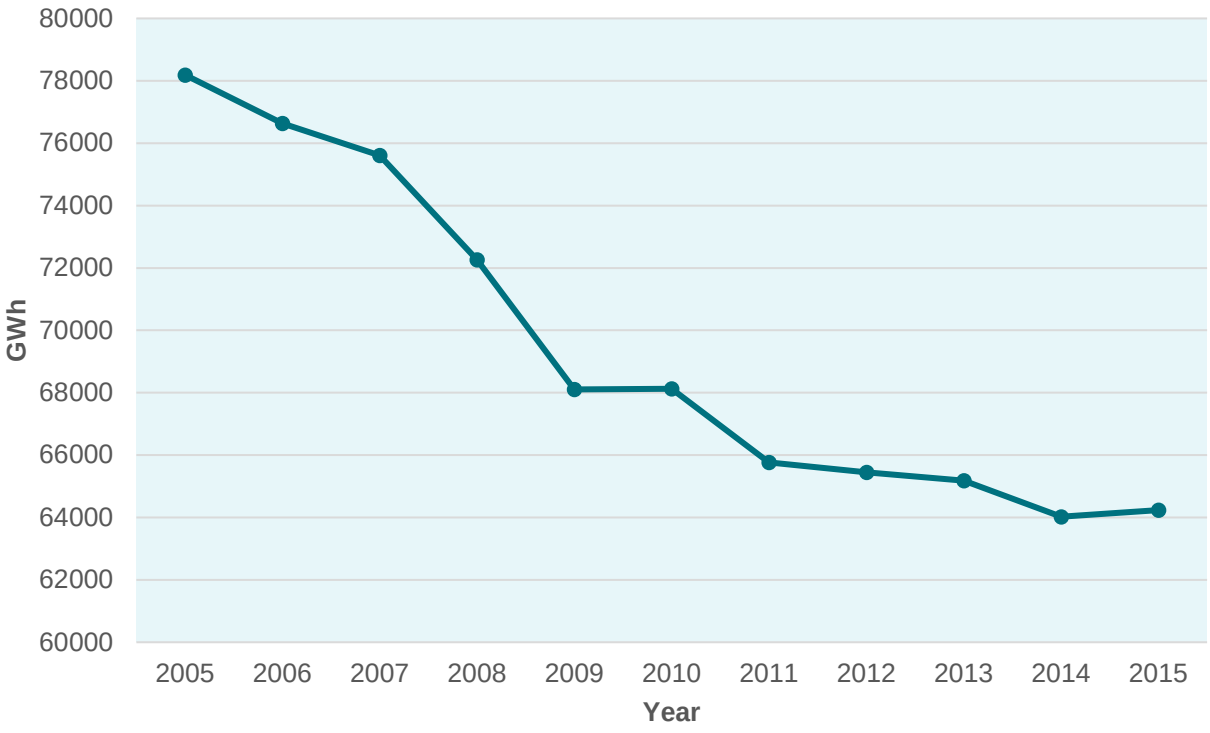


Figure 3. Energy consumed by all end-users and for all fuel types in the City Region with respect to time

By comparison, over the same period, the total UK energy consumption fell by a slower rate of 15 percent; but at a slightly higher rate of 24 percent in the Yorkshire and Humber

region. This is likely a result of the City Region moving to less energy intensive industries more recently than other parts of the UK. The energy consumed per unit of GVA in the City Region is more closely aligned to that of the UK than that of the Yorkshire and Humber region. This suggests that the City Region has an economy and energy scenario more similar to the rest of the UK as a whole as opposed to industrial nature of the Yorkshire and Humber region. Furthermore, the energy consumed per unit of GVA has decreased steadily over the last ten years suggesting either, or a combination of, an increase in energy efficiency or / and a shift in the type of industry in the City Region.

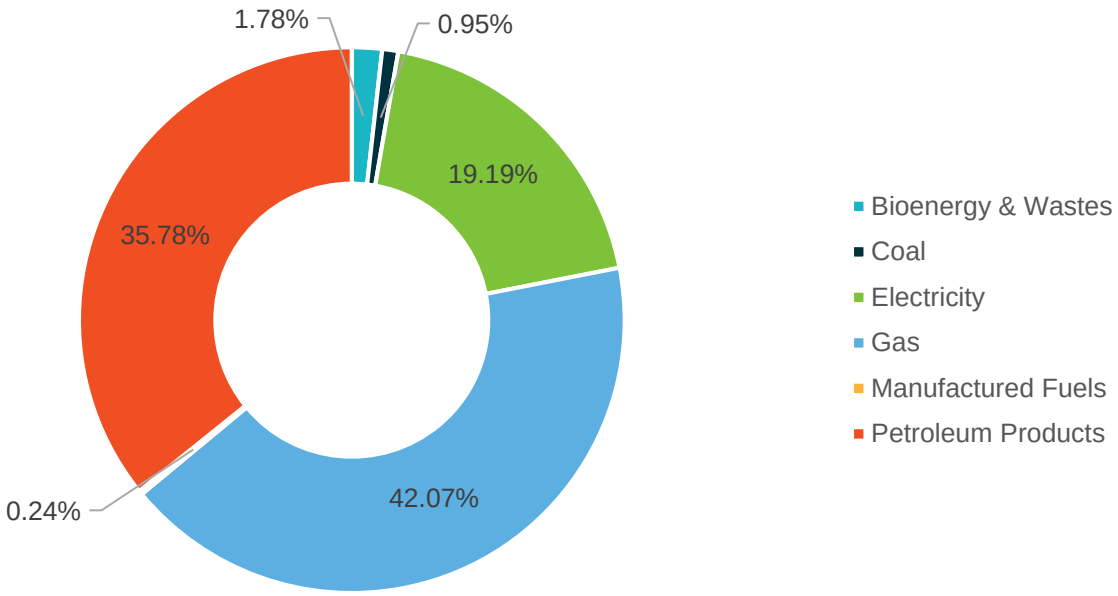


Figure 4. Breakdown of energy consumed in 2015 by fuel type

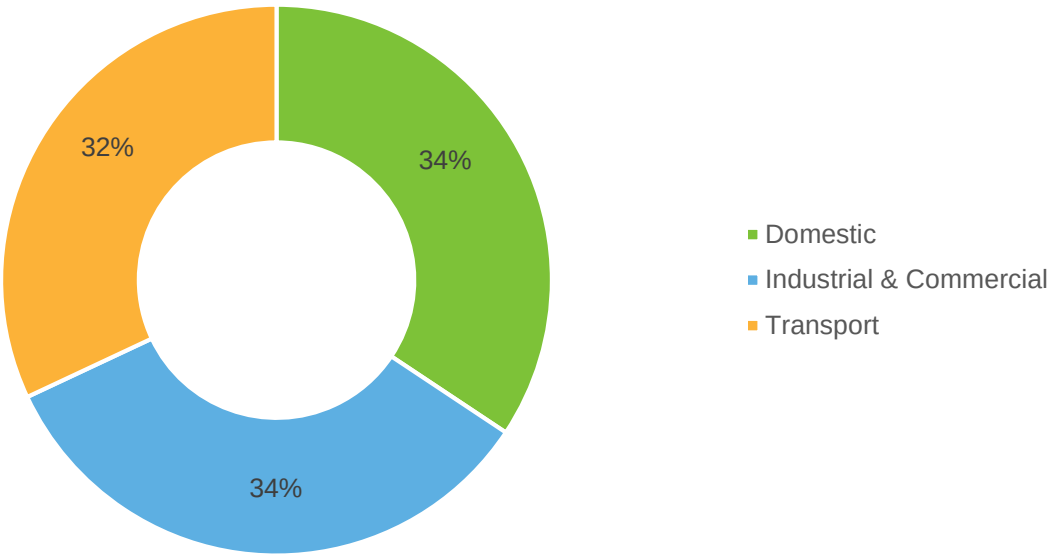


Figure 5. Breakdown of energy consumed in 2015 by user

Of the 64,232 GWh of energy consumed in the City Region, the overwhelming majority of it was from fossil fuel sources, only 5.5 percent of energy consumed was from a renewable (including bioenergy) source. This demonstrates the City Region's reliance on fossil fuels as an energy source, although this is not dissimilar to UK as a whole where 8.8 percent of energy consumption is from renewable sources. The breakdown of energy by fuel type in 2015 can be seen in Figure 6.

The end users who consume this energy are broken down in to the transport, domestic and industry and commercial sectors. The split between the different sectors is fairly even as can be seen in Figure 5. Despite this, the fuels consumed by each sector differ significantly; the transport sector consumes exclusively petroleum products; the domestic sector consumes primarily gas (76 percent) and electricity (21 percent); whereas the industry and commercial sector consumes gas (50 percent), electricity (38 percent) and petroleum products (10 percent).

Emissions

The emissions produced in the City Region are a direct result of the energy consumed; this means that emissions from electricity generated within the City Region are excluded from the analysis presented. The emissions considered are Scope 1 and Scope 2 only, this includes emissions as a direct result of fuel burnt and electricity consumed by end users. Scope 3 emissions, from aviation, waste disposal, and supply chain activities are excluded from the analysis presented. These scope 3 emissions have been excluded as the data required to perform a complete analysis is not available, and aren't directly attributable to the City Region.

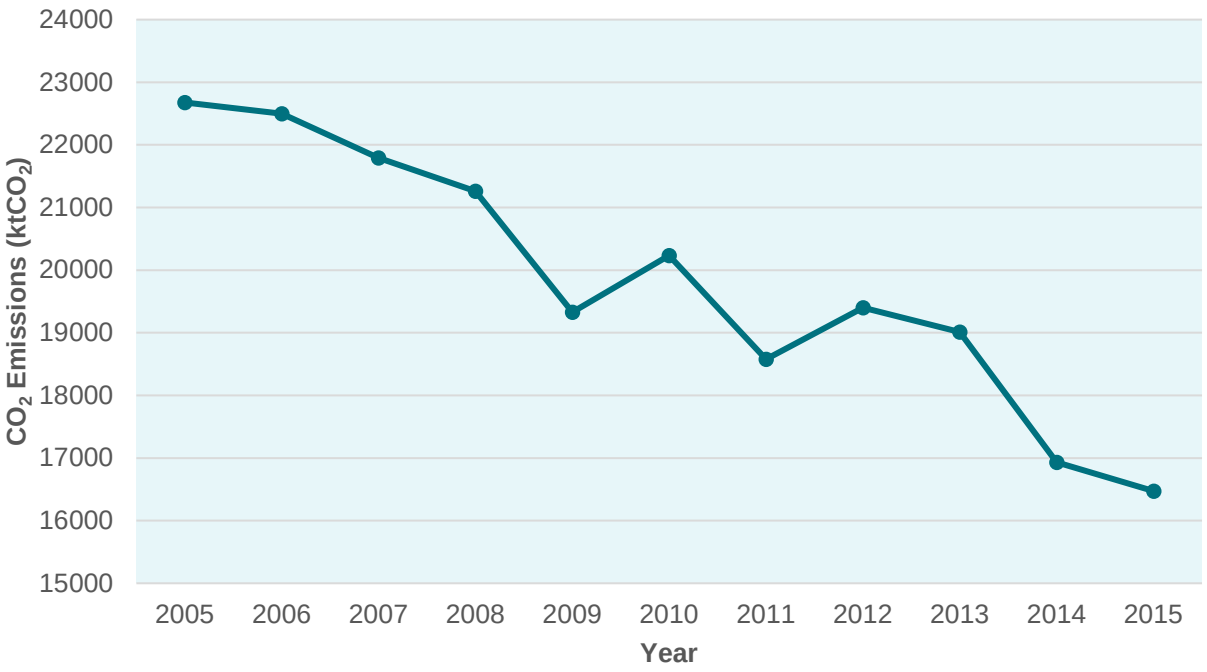


Figure 6. Emissions produced by all users and fuel types in the City Region with respect to time

The total emissions in the City Region in 2015 were 16,472 $ktCO_2$, equivalent in weight to more than 1.3 million double decker busses, this represents a 4 percent and 43 percent share of the UK and Yorkshire and Humber region respectively. Emissions declined between 2005 and 2015, with a reduction of 38 percent in this period, see Figure 6. The greatest decrease in emissions, not as a result of a decrease in energy consumption, is a

result of the decarbonisation of the UK electricity grid. The share of renewable electricity sources feeding the national grid has increased by 20 percent over the ten-year period, resulting in electricity increasingly becoming a less carbon intensive fuel.

Both the emissions per capita and emissions per unit of GVA have decreased, again signifying a trend of the general population and businesses being less carbon intensive while becoming more economically productive.

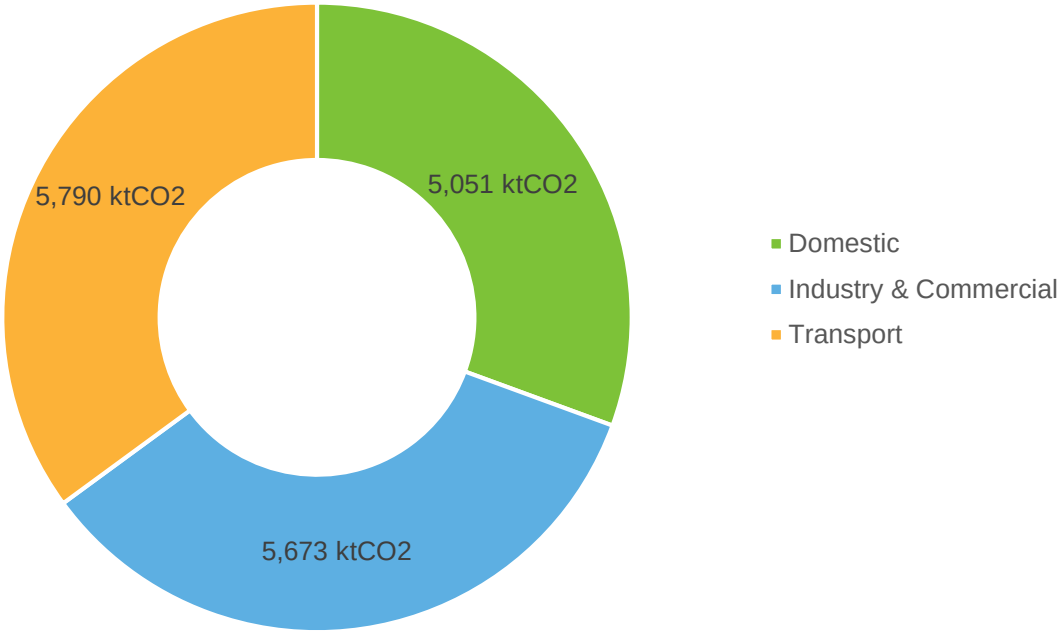


Figure 7. Emissions by sector (2015)

The majority of carbon emissions in 2015 were produced in the transport sector, however, in 2005 this was the lowest emitting sector. The domestic and industry and commercial sectors have benefitted from using less carbon intensive electricity as the grid has decarbonised. This suggests that until the transport sector is electrified or is able to benefit from the development of hydrogen technology, it will continually increase its share of carbon emissions.

Electricity generation

The City Region generates a nationally significant amount of electricity; 39.5 TWh of energy is generated within the City Region and only 12.3 TWh of electricity is consumed, meaning the region is able to export 27.2 TWh of electricity to the remainder of the country (see Figure 8). The City Region's position as a sizeable exporter of electricity will very likely continue into the future with plans in place for the natural gas CCGT plants to come on line as coal is phased out by 2025.

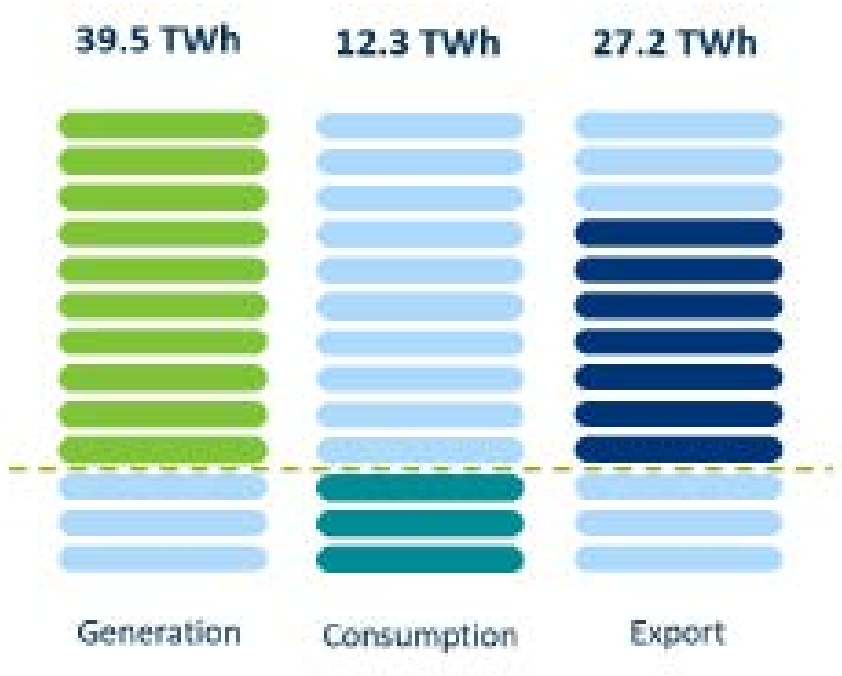


Figure 8. Regional generation, consumption and net export

Although the vast majority of electricity generated in the City Region is supplied to the national grid and not consumed locally, it is still important to take generating facilities in to consideration within the baseline.

The region is unique in its local electricity mix, thanks to Drax power station, which is the UK's largest coal fired and biomass fired power station. As of 2015, Drax alone supplied 68 percent of the regions 39.5 TWh of electricity, the rest of the electricity was supplied by Eggborough coal fired power station (until decommissioning in March 2018), as well as a mix of renewables, gas and gas oil (Figure 9). Despite, the comparatively small share of electricity generated by renewables, the rate at which renewable capacity is being installed is significant. Between 2014 and 2016 installed capacity of solar PV, onshore wind and energy from waste (EfW) has increased by 40 percent, 21 percent and 820% respectively.

Figure 9. Percentage breakdown of generation by fuel type

Socio-economics

As of 2017, the region is home to 3,063,100 people, the population has been increasing at a steady rate of almost 18,500 people per year since 2000. The current level of people in employment in the region stands at 73.6 percent, this is slightly less than the overall UK

level (74.9 percent), but higher than the Yorkshire and Humber region level (73.4 percent). Current levels of employment are higher than they were prior to the economic downturn in 2007/8.

GVA within the region has been increasing too, GVA for the year 2015 equalled £64.7 billion. However, GVA per capita has fallen with levels at the lowest they have been for the last fifteen years, this low productivity challenge is a trend being seen across 70 percent of all LEP regions.

The industries (as defined by the Office for National Statistics (ONS)) generating the greatest amount of GVA within the City Region are: public administration and defence, compulsory social security, education, human health and social work activities; and wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage, accommodation and food service activities. The two industries (as caregorised by the office for national statistics) alone provided 40 percent of the regions GVA. This is a significant change from 15 years prior when the largest industry was manufacturing.

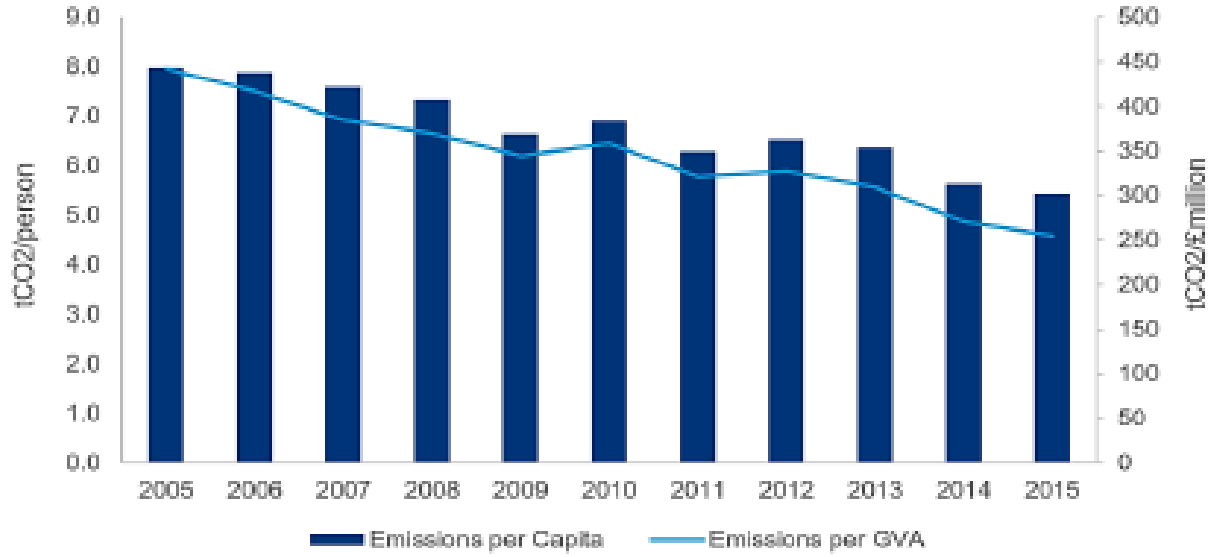


Figure 10. Regional emissions normalised by per capita and GVA produced

Forecasts

Forecasts of energy consumption and emissions produced within the region have been developed up to the year 2036, these forecasts intend to show a business as usual (BAU) scenario. This scenario will be used as a baseline onto which various transition pathways can be laid. The predictions have been generated by using both local/regional data (e.g. number and type of cars on the road, City Region housing ambitions), as well as national data (e.g. industry and commercial growth, grid carbon intensity).

Energy consumption is forecast to rise in the domestic and transport sectors, see Figure 11. The growth in domestic energy consumption is driven by an increasing population, and more homes being built with an assumed 2015 efficiency. Increasing use of electrical appliances within the home will likely cause an incremental increase in consumption too. Increases in energy consumption within the transport sector is a result of continual growth in terms of number of vehicles on the road, increased mileage, and a shift to more freight being carried by road. Industry and commercial energy consumption is forecast to decline further resulting from a move to less energy intensive industries and a drive to increase efficiency to reduce operating costs.

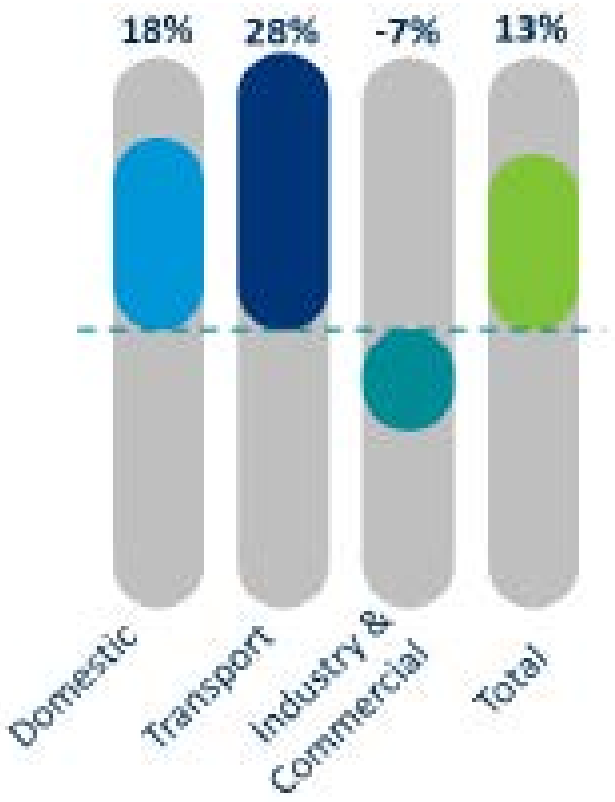


Figure 11. Business as usual energy forecasts as a percentage change from 2015 to 2036

Overall, emissions produced within the City Region are forecast to decrease by 13 percent between 2015 and 2036, see Figure 12. This is driven by a significant decrease in emissions from the industry and commercial sector, a result of not only decreasing energy consumption but also a move to less carbon intensive fuels, and further electrification of processes (which benefit from a less carbon intensive grid supply). The domestic sector also benefits from falling emissions, despite increasing energy consumption, this will likely be thanks to domestic heating and homes in general becoming more efficient, and once again, a less carbon intensive grid. Transport emissions will likely increase in line with energy consumption, this is a result of minimal or no change in the efficiency of internal combustion engine (ICE) vehicles, the move back to petrol cars from diesel, and a lack of growth in the electric vehicle market.

Although the BAU scenario leads to a reduction in emissions, it is not enough of a decrease to begin to reach the levels of reduction targeted by the UK government. This scenario is overly reliant on emission reductions being met by the decarbonisation of grid electricity. Greater efforts and localised action will need to be made to reduce energy consumption and emissions within the domestic and transport sectors in particular.

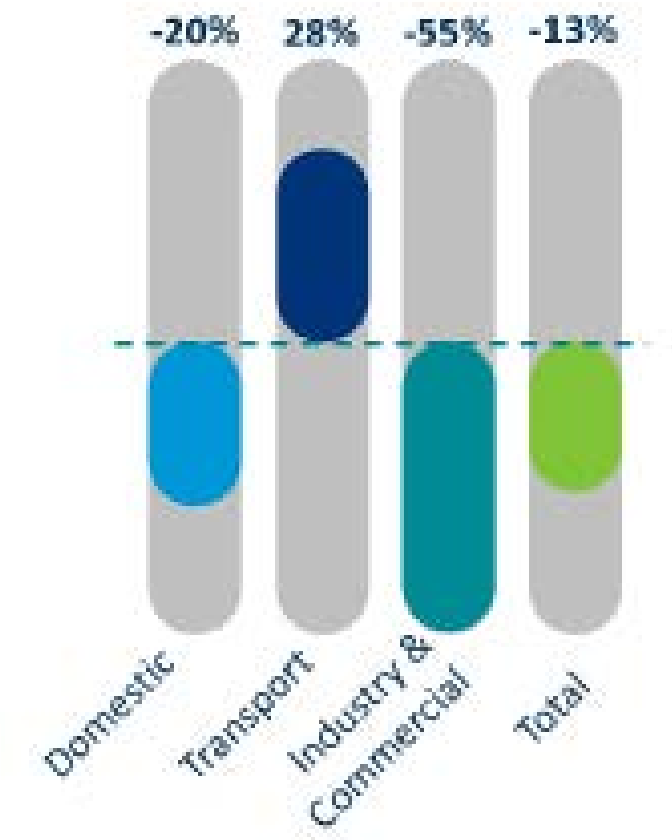


Figure 12. Business as usual emission forecasts as a percentage from 2015 to 2036 by sector

There is a pipeline of large scale projects that will help the region in achieving its own local electricity generation decarbonisation. This includes:

- 2018: Eggborough coal power plant to be decommissioned
- 2020: Drax to convert the fourth of its six reactors to burn biomass
- 2022: Eggborough to have 2.5 GW of CCGT up and running
- 2023: Drax will develop its remaining two coal reactors to a 3.6 GW CCGT plant, and install 200 MW of energy storage
- 2024: Knottingley and Ferrybridge will open CCGT plants with a combined 3.5 GW capacity

Science-based target and scenario modelling

Science-based target

Background

The Paris Agreement in 2015 saw 195 of the world's governments commit to prevent climate change by limiting global warming to well below 2°C, and to pursue efforts to limit the increase to 1.5°C. Targets to reduce GHG emissions are considered "science-based" if they are in line with the level of decarbonisation required to keep global temperature increase below 2°C, compared to pre-industrial temperatures, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The number of corporate organisations that have publically committed to a science based target has grown exponentially since the Paris Agreement, with 440 of the world's leading companies now taking action. Against the backdrop of Donald Trump's announcement to withdraw the United States from the Paris Agreement, there has also been a significant increase in the number of US states and cities committing to align their carbon reduction targets to the science.

The international Science Based Targets initiative (SBTi) has developed a number of methodologies for the calculation of science-based targets. The Sectoral Decarbonisation Approach (SDA) is a methodology published by the SBTi in May 2015, and is suitable for the calculation of a City Region science-based target.

The SDA is a methodology that allows organisations to calculate science-based carbon reduction targets while taking into account differences in economic growth and emission reduction potential across various economic sectors. The SDA follows the decarbonisation pathway of the International Energy Agency (IEA) 2DS and B2DS. The 2DS is in alignment with the IPCC's Representative Concentration Pathway (RCP) 2.6 scenario and describes a global emissions trajectory that recent climate science research indicates would give a 50 percent chance of limiting the average global temperature increase to 2°C. The scenario allocates a global carbon budget for every year up to 2050 to individual sectors and sub-sectors. The IEA's B2DS describes a global emissions trajectory that represents a 50 percent chance of limiting average future temperature increases to 1.75°C.

The allocation of a sectoral carbon budget takes into account inherent differences between sectors, including mitigation potential and cost, as well as how fast each sector is projected to grow relative to global economic and population growth. The carbon budget for an organisation in a given sector is a combination of two elements: 1) the emissions from direct combustion of fuels in the sector (scope 1 emissions), and 2) the sector's share of emissions from the power generation sector based on the amount of electricity consumed (scope 2 emissions).

The sectoral emissions must change by a certain percentage by 2050 to meet this target, these changes are outlined below in Figure 13.

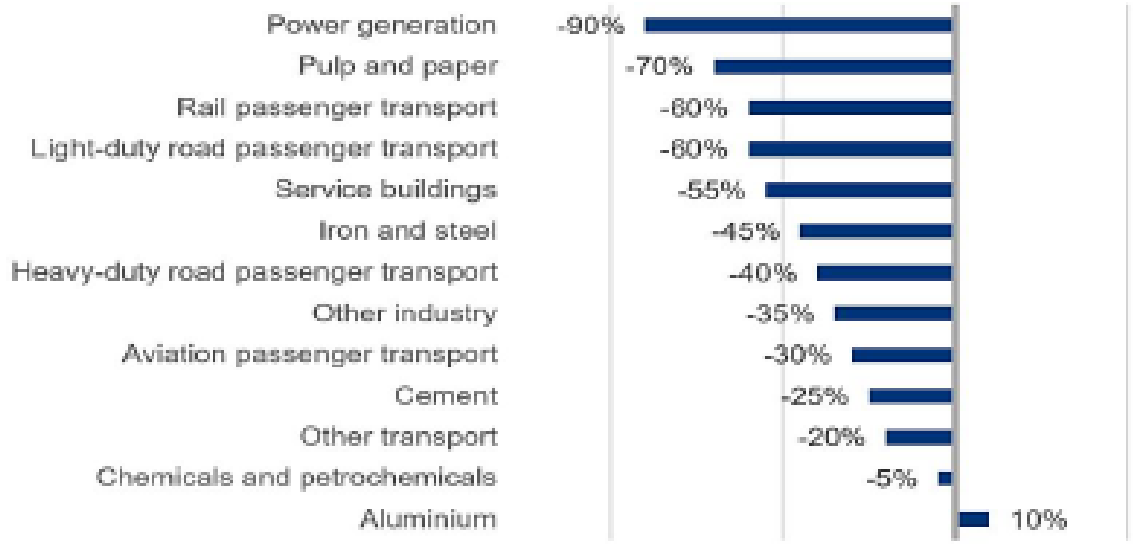


Figure 13. Emission reduction targets by industry to meet Paris Agreement

Setting a science-based target for the City Region

The SEP outlines an ambition for the City Region 'to become a resilient zero carbon energy economy underpinned by high quality green infrastructure by 2036.' Whilst this is a commendable level of ambition, the SEP did not define what is meant by "zero-carbon" or articulated what would be in and out of scope for such a target, as such there is a lack of clarity on how, or indeed whether, this ambition can be achieved. Despite this, the inclusion of this ambition in the SEP signals that there is a significant level of political and senior-level buy in, and a genuine aspiration for the City Region to lead in delivering against this agenda. In an effort to quantify and understand a possible route to delivering against this ambition, we have explored the potential for the City Region to set a science-based target for all energy consumed within the City Region, which outlines reduction pathways for the sectors which make up its energy economy.

We have developed a bespoke science-based target model for the City Region, which identifies a carbon reduction pathway for each sector represented in the energy baseline. Based on the Organisation for Economic Co-Operation and Development (OECD) pathway (which is a subset of the 2DS/B2DS pathways) for emissions reduction, this model generates a 53 percent emissions reduction target for 2036 against a 2015 baseline year, representing a total reduction of 7,784 $ktCO_2$. To assist in meeting this target it is advised that the greatest reduction comes from the transport sector (-52 percent), followed by domestic (-49 percent), industry (-43 percent) and commercial (-40 percent), see Figure 14. However, these figures are a guideline and the sectoral proportions may vary as long as the overall reduction of 53 percent is met. In order to achieve this ambition, it would be critical for action to be taken across all sectors within the City Region. It should be emphasised that these individual sectoral reduction targets should be treated as guides, with the ultimate aim to meet the regional science based target. The likelihood of each sector meeting these targets relies significantly on private-public sector collaboration, and setting out strategies that take note of and develop further the proposed delivery plan.

The projects identified in the action plan will feature a high level indication of the contribution that these could make towards meeting the set science-based target.

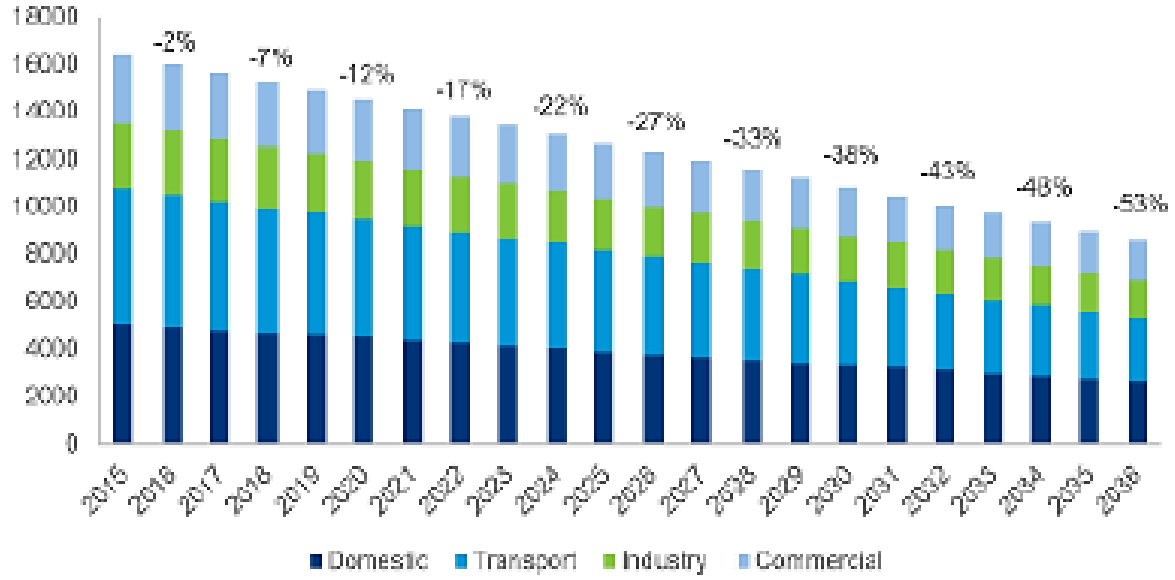


Figure 14. Guideline reductions by sector to meet science-based target

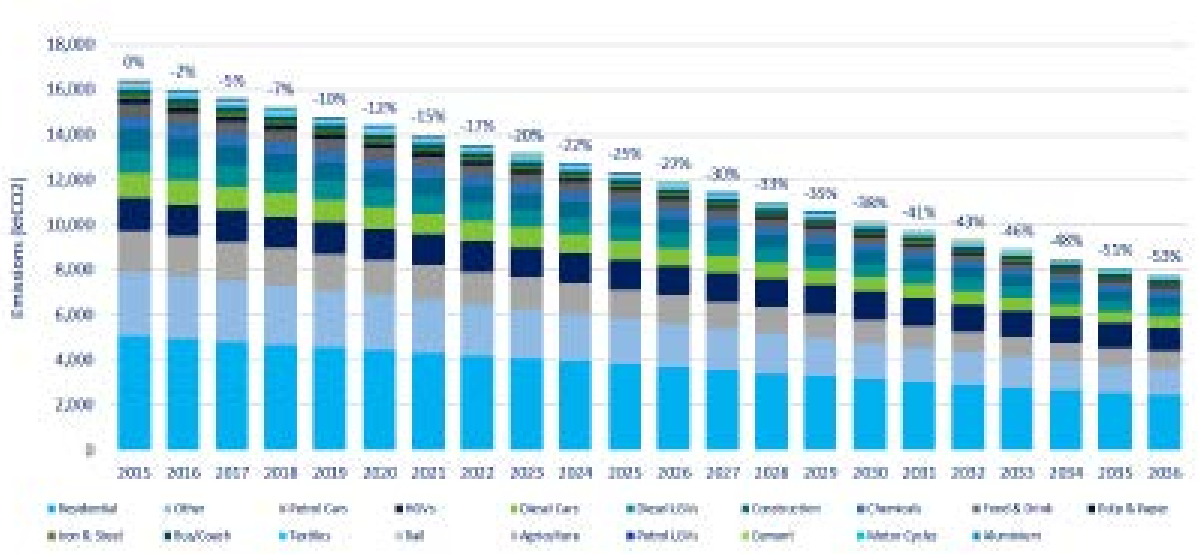


Figure 15. Guideline reductions by sub-sector to meet science-based target

As outlined in the BAU forecast of baseline emissions, the City Region is already predicted to reduce its emissions by 13 percent by 2036 compared to 2015 levels, meaning that an additional 40 percent of carbon savings would need to be identified in order to meet the science based target. However, the UK itself has set legally binding targets to reduce emissions by 57 percent for 2032 and 80 percent for 2050 compared to emission levels in 1990 through the UK Climate Change Act. Therefore, a potential City Region's science based target currently offers a stepping stone target to then progress to meet the UK's eventual 2050 target.

Delivering against commitments outlined in the Clean Growth Strategy, the UK government released its 'Emissions reduction pledge 2020' report. Within this it was outlined that the government has set a voluntary target for public sector bodies to meet a 30 percent reduction in emissions by 2020/21 compared to 2009/10 emissions in their own estate. BEIS have indicated that they will trial the voluntary target before determining whether to make any amendments to the scheme, possibly including the introduction of the target as a mandatory requirement. This signals that BEIS are encouraging further

ambition from the public sector with respect to emissions reduction, and setting a science-based target for the City Region would demonstrate a leading level of commitment.

Stakeholders within the City Region have shown a significant appetite for the introduction of tailored science based targets. The proposed science-based targets offer an industry breakdown, which helps to ensure everyone is able to contribute their fair share of emissions reduction. However, some stakeholders expressed concerns of how to ensure that everyone within the City Region is engaged in meeting a science-based target need to be addressed. Furthermore, stakeholders want to be sure that the right support network is in place to help businesses and residents in how they can meet their targets. If a target is introduced it must be clear how that target can be achieved. Scenario modelling and consideration of deployment of low carbon technologies can help to address these concerns and show potential pathways for businesses, industry, and residents to meet any science-based target.

Recommendations

We understand that the Combined Authority may well have some reservations regarding committing to a science-based target for the City Region, not least because the target will not be achievable without the commitment of a range of public, private and third sector stakeholders from across the City Region. However, setting a science-based target could also have a positive impact in creating collaboration, raising ambition and delivering a broad range of the Combined Authorities economic, social and environmental priorities.

Whilst the delivery plan outlined within this document does go some way towards achieving the science-based target (estimated to be 49 percent – see section on carbon savings in the delivery plan), there is a need for more detailed project scoping and development of the projects already identified to understand fully the carbon savings potential of the delivery plan. In determining whether to set a science-based target for the City Region, we recommended that the Combined Authority undertake the following activities:

1. Stakeholder mapping and engagement plan: map and prioritise the key stakeholders that would need to play a role in delivering against a shared science-based target for the City Region. Identify stakeholder-related risks and assess the willingness of prioritised stakeholders to engage with the Combined Authority and in the agenda more generally. Develop a plan for the engagement of these stakeholders.
2. Determine the carbon reduction potential of existing and planned activities: undertake a review of existing and planned carbon reduction activities in the City Region to determine the proportion of the target that is achievable through these activities. This could be added to the carbon savings estimated in the projects identified in the Delivery Plan, and the reductions already forecast in the BAU scenario, primarily a result of decarbonised electricity supply, to determine an overall “gap to target” and consequent assessment of deliverability. Beyond the Combined Authorities own planned activities (e.g. the Delivery Plan, Energy Accelerator, District Heat Programme, Better Homes Yorkshire), there would be value in understanding the extent to which broader existing commitments / planned activities across the private, public and third sectors would contribute towards delivery of the target.
3. Stakeholder consultation: engage with key internal and external stakeholders, including politicians, LEP Board members and local business leaders to determine their appetite for setting a science-based target and to inform thinking on an appropriate framework for its delivery (e.g. use of MOUs, reporting procedures.

Scenario modelling

Scenario overview

In order to meet the proposed science-based target, two distinct transition pathways have been developed, that consider the roll out of different technologies across the City Region between 2015 and 2036. These flexible pathways have been split into two themes, purposefully shaped to be in line with those outlined in the BEIS Clean Growth Strategy – high hydrogen and high electricity. These will be compared to a third BAU scenario. The BEIS Clean Growth Strategy has been used as the chosen framework as it is most in line with the data used throughout this report and modelling, thus promising strong continuity with data and targets in this report. The scenarios will consider deployment trajectories of certain technologies, a high level overview and a summary of the technologies involved in these scenarios is outlined below.

Baseline

Under this pathway, a BAU growth is assumed for the domestic, transport and industrial and commercial sectors. Any change in energy demand within these sectors is presumed to mirror those forecast by BEIS for the UK as a whole. Special consideration has been made to ensure the forecasts remain relevant to the City Region by taking in to account any goals/targets set by the LEP, and normalising data to reflect housing, vehicle and employment data for the region.

High Hydrogen

Under this pathway, hydrogen is used to heat buildings, fuel vehicles and power industry. Existing gas infrastructure is adapted to distribute hydrogen, particularly in urban and suburban areas and a network of hydrogen fuelling stations supports the use of hydrogen vehicles. There remains some electrification of heat in more rural areas. Hydrogen is primarily produced from natural gas, using CCUS to capture emissions. This is relevant to the City Region, given the pioneering plans to convert the gas grid to hydrogen through the H21 project in Leeds and the associated research into Carbon Capture Use and Storage (CCUS).

High Electricity

Under this pathway, electricity is the main source of energy in 2036, with a rapid rise in the use of EVs, the electrification of heat and use of cleaner fuels in industry. This creates a significant increase in the demand for electricity, supplied through renewables, biomass and gas CCGT electricity generation assets. CCUS is not used in the UK by 2036 within this pathway. This is relevant to the City Region, given the drive for the electrification of transport and the installation of new renewable electricity capacity.

Commonalities

Common to each of these pathways is improved energy efficiency, heat networks, the decarbonisation of electricity, public transport growth and low emission vehicles. It should be recognised that pathways are illustrative, and the ultimate way forward may be a combination of these approaches or another approach that builds on further innovation.

High hydrogen scenario	High electricity scenario

• Improved energy efficiency in buildings:
  o Improved domestic insulation
  o New domestic boilers
  o LEDs in businesses
  o More efficient motors, drives and HVAC in business
• Introduction of heat networks powered by:
  o Gas CHP
  o Water source heat pumps
  o Waste energy
• Increased public transport
• Roll out of H21 hydrogen gas network
• Widespread adoption of hydrogen fuel cell vehicles
	• Improved energy efficiency in buildings:
	  o Improved domestic insulation
	  o New domestic boilers
	  o LEDs in businesses
	  o More efficient motors, drives and HVAC in business
	• Introduction of heat networks powered by:
	  o Gas CHP
	  o Water source heat pumps
	  o Waste energy
	• Increased public transport
	• Electric heating from heat pumps in homes
	• Widespread adoption of electric vehicles
	• Increased generation of solar PV and onshore wind

The level and rate of deployment of these technologies has been altered such that the emissions reductions will meet the science-based target, from these results the model is able to predict the amount of additional GVA and jobs created. A full breakdown of all the technologies and their respective deployment are outlined in key figures from the economic impact analysis.

Methodology

The methodology developed for the scenario modelling is outlined below as a five step process:

1. **Business as usual**: BEIS projections for final energy consumption by user were used to create a year on year percentage change template. This could then be applied to current energy consumption within the City Region to project future consumption up to 2036. These projections were further corrected by aligning them with known parameters of the City Region (number and types of specific vehicles, planned housing growth, and number of domiciles with a gas connection). This BAU scenario was used as the basis from which energy savings could be calculated for the two other scenarios.
2. **Technology definition**: this required the detailed description and cataloguing of each individual technology, namely the energy saving potential of it being put in place compared to what is there currently. For example, the introduction of one EV to replace an existing ICE vehicle will result in an increase in electricity consumption and a decrease in petrol consumption. Thus, each technology will have an assigned energy change with respect to fuel type per unit deployed of that technology.

Similarly, each unit of technology deployed will have an assigned value of GVA generated and jobs created.

3. **Energy and Carbon Saving**: the energy saved is simply calculated as the number of units of technology deployed multiplied the energy change per unit. This summation can then be subtracted from the BAU case to determine the future energy consumption of a particular scenario. The carbon emissions for each scenario are calculated as the carbon factor for each particular fuel multiplied by the energy consumption for that same fuel, with considerations put in place for the fact that the carbon factor will not necessarily stay constant with time.
4. **Deployment**: The level of deployment of each technology was guided where possible by ambitions of the LEP and those outlined in the clean growth strategy, otherwise they were selected such that the City Region will meet the proposed science-based target.
5. **Socio-economics**: Once the level of deployment is determined, the GVA and jobs created per unit of technology can be used to calculate the total level of GVA added and number of jobs created for the region.

Sectoral breakdown

Domestic

Within the domestic sector the majority of energy consumed is from the burning of natural gas, this is for both heating and hot water services. In a typical home within the UK more than three times as much energy is consumed from gas than electricity. The UK housing stock as a whole is typically quite old, and this is reflected in the energy efficiency measures within dwellings:

- The average UK boiler efficiency is 79.3 percent, a new boiler can offer efficiencies greater than 95 percent.
- Only 65.6 percent of homes with lofts have a 125mm depth or more of insulation.
- 68.5 percent of suitable properties have cavity wall insulation installed.

These statistics help to explain why there are no dwellings within the City Region with an Energy Performance Certificate (EPC) rating of A, while roughly half of dwellings with an EPC rating fall in to a D category or lower.

The scenario modelling aims to address this by assuming there will be a substantial growth in domestic energy efficiency measures. Across both scenarios, any dwelling with an EPC rating of D or lower will benefit from loft insulation, cavity wall insulation, solid wall insulation (where possible) and a new efficient boiler. This limit has been selected as currently roughly half of the housing stock has an EPC rating of D or lower, and so it would be beneficial to target efforts into getting the lowest half to a category C or above. Current plans aim for a minimum EPC requirement of E for a property to be rented privately, however, this is not seen as particularly ambitious.

Gradually between 2015 and 2036, new forms of heating and hot water generation will appear within the domestic sector. This will include district heating powered by a combination of gas CHP, waste heat and water or ground source heat pumps. Within the high electricity scenario, heat pumps will become common place as opposed to gas boilers, and hydrogen burning boilers will be installed in the high hydrogen scenario.

Decarbonisation of the grid in all scenarios will result in less urgency to decrease electricity consumption as a means of cutting carbon emissions.

Industry and commercial

In industry, many of the most energy intensive activities involve both low temperature and high temperature processes as well as drying. These activities are often hard to alter in their set up without significant investment. Therefore, the focus of the scenario modelling has been on motors, compressed air and lighting which together account for nearly 20 percent of all industrial energy consumption in the UK. The model assumes across both scenarios a significant investment in newer, more efficient motors as well as replacing all lighting with LEDs.

This results in a substantial decrease in electricity consumption, however, the consumption of fossil fuels remains stubbornly high and as such emissions within the industrial sector will be unlikely to see any significant decrease. Nevertheless, the science-based target can be met in numerous ways, and there are sectoral guides to help meet the overall science-based target.

The commercial sector has a more straightforward energy mix, with almost all of its gas consumption being used for space heating and hot water and electricity being used for lighting, appliances, and HVAC. Given the energy and monetary savings available to businesses from upgrading to more energy efficient technologies, the scenario model assumes a total uptake of LED lighting and installation of more efficient HVAC units. It is assumed that some of the heating and hot water from gas boilers will be replaced by the district heating systems being rolled out in the City Region, with much of the rest being replaced by heat pumps or hydrogen gas boilers.

Emission reductions within the commercial sector will likely be substantial due to both energy efficiency improvements and a reduction in the reliance on gas for providing heating and hot water.

Transport

Both energy consumption and emissions are forecast to grow across the UK within the transport sector, this is driven by an increase in the number of both passenger and commercial vehicles on the road. The department for transport expects the total number of vehicle miles to increase anywhere from 19 percent to 55 percent by 2040 from 2015 values. With a move away from diesel vehicles back to petrol (as is already being seen in current UK car sales), and marginal increases in vehicle efficiency, both energy consumption and emissions are forecast to rise.

The scenario model aims to tackle this issue with an increase in public transport as well as a substantial rollout of both electric and hydrogen fuel cell vehicles. It is assumed across both scenarios that bus numbers will increase, a result of increased park and ride schemes and new city centre low emission zones, helping to take some passenger vehicles of the roads. EVs numbers will increase across both scenarios and for all vehicle types, the rate of increase will fall in the hydrogen scenario as the H21 project becomes live. This then provides the infrastructure needed for the roll out of hydrogen vehicles within the City Region.

Technology types included in the transport analysis are shown below:

Petrol	Diesel	Electric	Hydrogen
Cars	Cars	Cars	Cars
	Bus and coach	Bus and coach	Bus and coach
	LGVs	LGVs	LGVs
	HGVs	HGVs	HGVs

Table 1. Technology types included in transport analysis

With a significant roll out and almost 40 percent market penetration for zero emission vehicles, it is expected that emissions from the transport sector will more than halve.

Generation

For taking in to account the changes planned to electricity generating plants, the regional electricity grid intensity factor has been used. This factor is used to calculate the level of emissions from electrical energy consumed in the City Region.

In both scenarios the same pipeline of large scale power projects have been considered, these include the conversion of Drax to biomass and gas CCGT, as well as new gas CCGT plants at Eggborough, Knottingley and Ferrybridge. There is a continual growth in small and medium scale renewable projects, including the installation of solar PV, onshore wind and anaerobic digesters. Furthermore, there will be a comparatively small but substantial growth in the electricity generated from waste. The high electricity scenario is expected to see a greater roll out of solar PV through small-scale domestic and commercial installations; as well as a slightly greater increase in onshore wind projects. The resultant grid intensity will decrease by approximately 70 percent between 2015 and 2036, this is in line with projections from BEIS of national grid intensity projections.

The technologies included in the economic analysis are shown below:

Technology type	Fuel type
Coal	Coal
Biomass	Biomass
CCGT	Gas
Solar PV	Electricity
Landfill gas	Electricity
Onshore wind	Electricity
Anaerobic digestion	Electricity
Storage	Electricity

Table 2. Technologies included in the economic analysis

Economy and jobs

As well as a possibility of reducing both energy consumption and emissions, the deployment of new technologies will support jobs and generate GVA in the City Region. The amount of each of these can be calculated by looking at the level of deployment (number of units) and unit cost of each technology. This capital investment is used as a base for calculating potential total GVA and employment figures, using Office of National Statistics (ONS) Annual Business Survey figures for relevant Standard Industrial Classification (SIC) codes. The proportion of the total potential GVA and jobs created that would be retained in the City Region will depend on the strategic decision to support the manufacturing base delivering these values.

Learning rates have also be taken in to account on certain technologies, giving each technology a percentage decrease in unit cost per year. This is particularly important for some technologies (e.g. Hydrogen fuel cell vehicles) where there is a significant cost barrier to wide scale market penetration.

It was outside the scope of this modelling to include the additional economic impact of the capital investment that would be recouped through the operation, maintenance and replacement stages of project lifetimes. It is likely that these impacts are significantly higher than the original capital investment. Additionally, GVA and employment figures from capital investment in other regions that may flow through to the manufacturing base in the City Region have not been taken into account.

Given these exclusions, the total potential GVA and employment figures from capital investment in the City Region are still conservative estimates of the net impact on the total economy. The findings have been sense-checked against economic impact calculations of the H21 Leeds City Gate project for hydrogen conversion of the existing gas grid and are broadly consistent when compared on a like for like basis (i.e. excluding investment in hydrogen vehicles).

SIC codes, employment and GVA values

The ONS Annual Business Survey for 2016 (released May 2018) was used as the source for data on SIC codes, jobs supported and GVA values. 2016 values for approximate gross value added at basic prices (aGVA), total turnover, and total employment average during the year were used to calculate a proportionate value for jobs supported and GVA impact. ONS Indexes to the UK SIC of Economic Activities 2007 used to confirm placement of 4-digit SIC codes. These are shown in the table below:

C25.21	Manufacturing of central heating radiators and boilers	
C26.11	Manufacture of electronic components	
C27.2	Manufacture of batteries and accumulators	
C27.4	Manufacture of electric lighting equipment	
C27.11	Manufacturer of electric motors, generators and transformers	
C28	Manufacture of machinery and equipment n.e.c.	Note – used for district heating as district plants contain components across a variety of SIC codes

C28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	
C28.13	Manufacture of other pumps and compressors	Note – used as a proxy due to the uncertainty on the choice of technology used for CCS
C28.25	Manufacture of non-domestic cooling and ventilation equipment	
C29.1	Manufacture of motor vehicles	Note – latest employment number only available for 2011
D35.22	Distribution of gaseous fuels through mains	Note – data on turnover and aGVA only available for 2008. Employment figures for 2008 used for consistency
F43.29	Other construction installation	

Table 3. SIC codes and UK Standard Industrial Classification of Economic Activities

Electricity generation was matched to SIC code D while heat, energy efficiency and transport were matched to SIC codes C and F.

Results

Preliminary results from the scenario modelling analysis show that both a high electricity and high hydrogen scenario can reduce energy consumption, increase energy efficiency and decarbonise processes enough to be able to meet the aforementioned science based target. The figure below illustrates annual carbon emissions from deployment scenarios modelled across the Baseline, High Electricity, High Hydrogen and Science-Based Target scenarios. All data provided by BEIS has 2015 as the most recent year at the time of creating the model, hence that has been used as the start year for the sake of accuracy.

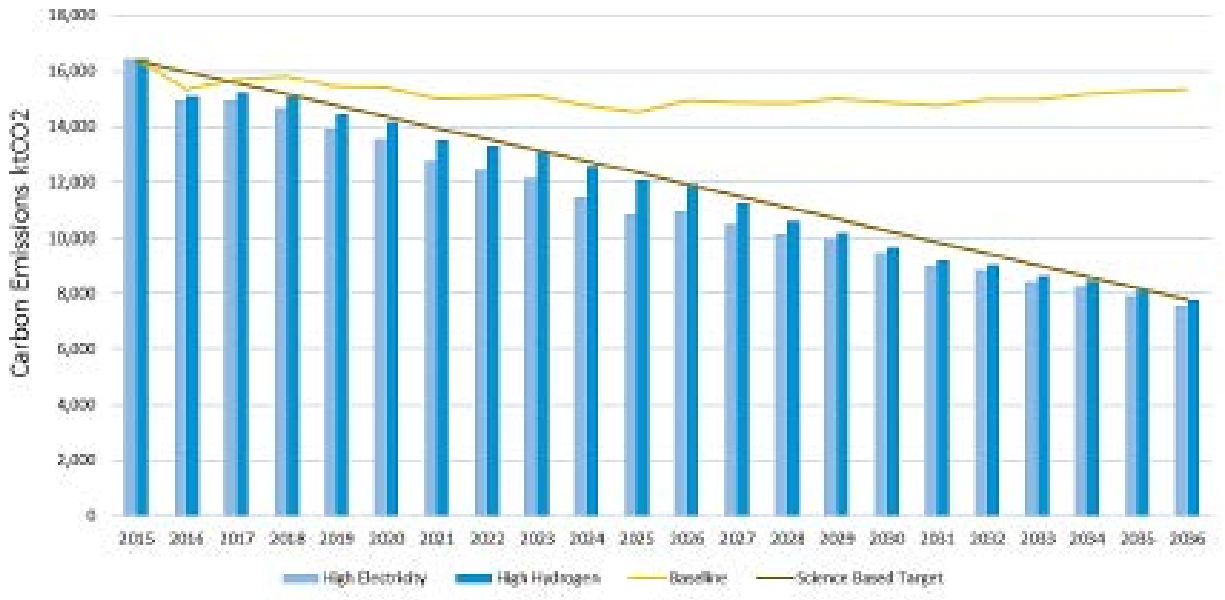


Figure 16. Emissions projections results from scenario modelling

Carbon emissions remain significantly higher in the Baseline scenario relative to the High Hydrogen, High Electricity and Science-Based Target scenarios. This is partially driven by

a lack of energy efficiency measures deployed in the Baseline, which keeps energy consumption high, and partially by a lack of conversion to lower carbon energy generation and transport options.

The Clean Growth Strategy forecasts a strong potential growth in the UK's low carbon economy, with an opportunity for growth that is over three times greater than expected UK GDP growth. This could result in the UK exporting anywhere between £60 billion and £170 billion worth of low carbon goods and services. This offers a unique opportunity for the City Region to invest in a growing sector and bolster its local economy.

The expected capital investment in the City Region on meeting the science-based target through either a High Electricity or High Hydrogen scenario offers the potential to boost GVA and support employment. Figure 17 below illustrates the maximum potential GVA from the expected capital spend in the assumed deployment scenarios.

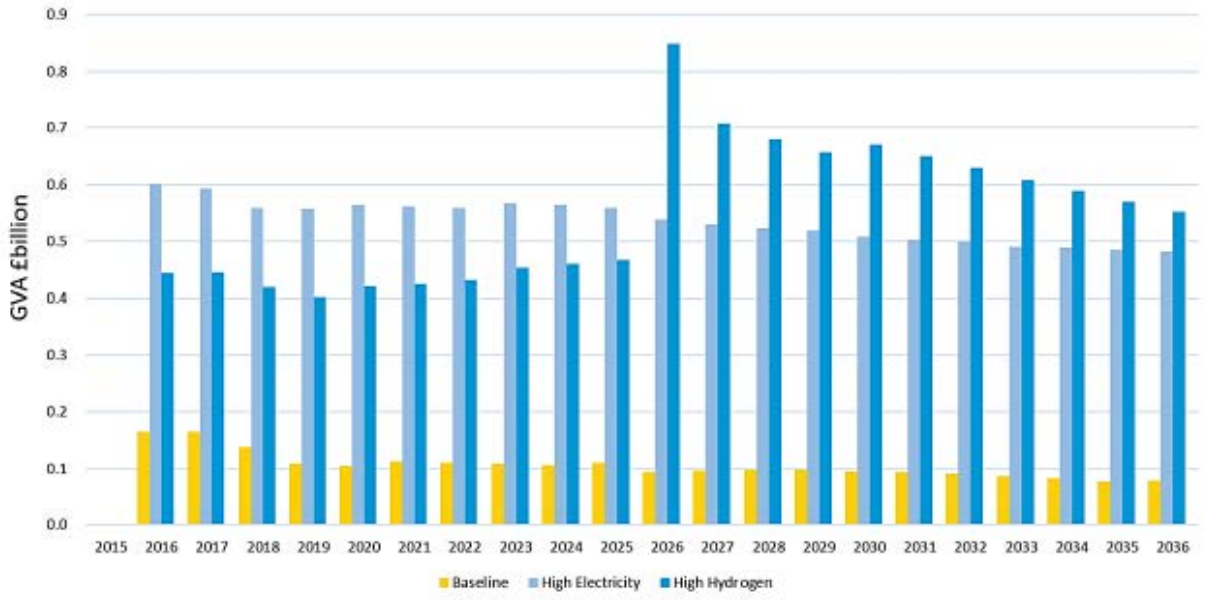


Figure 17. GVA results from scenario modelling

Note that this is not an indication of the maximum GVA which is retained in the City Region, but instead the maximum GVA expected from the capital spend on converting to new technologies. Significant investment is required to make this transition to 2036, as clearly illustrated in Table 4 above; the associated GVA for the Baseline scenario is significantly lower than for the High Electricity and High Hydrogen scenarios in all years.

Expected capital spend		
Baseline	**Hydrogen**	**Electricity**
£11 billion	£50 billion	£46 billion

Table 4. Expected capital spend to meet deployment scenario

In 2026, the High Hydrogen scenario sees a significant increase due to the investment in the hydrogen network, which supports the deployment of hydrogen-based technologies from 2027 onwards. This is in contrast with the High Electricity scenario, which sees a more modest GVA boost from year to year. These GVA estimates do not include the

impact of additional spend on operation and maintenance or fuel costs and they do not account for capital spend which is diverted to other regions or countries.

Maximum cumulative GVA (millions) by 2036 (real values)		
Baseline	**Hydrogen**	**Electricity**
£2,636.6	£11,574.7	£11,299.4

Table 5. Maximum cumulative GVA by 2036

Maximum cumulative GVA by 2036 is shown in Table 5. In order to tap into this potential GVA, the City Region will need to support local manufacturing capabilities in the electricity or hydrogen alternative scenarios. The largest GVA boost associated with capital spend is for domestic transport, with the breakdown shown in Table 6 below.

Maximum cumulative GVA (millions) by 2036 (real values)			
	Baseline	**Hydrogen**	**Electricity**
Diesel vehicles	£1,096.88	£ -	£ -
Petrol vehicles	£1,099.15	£588.99	£492.83
Electric vehicles	£ -	£2,327.97	£5,031.00
Hydrogen vehicles	£ -	£3,169.28	£ -

Table 6. Maximum cumulative GVA by 2036, domestic transport

Employment supported from capital spend in the energy transition is significantly higher in the High Hydrogen scenario than in the High Electricity scenario from 2026 onwards. This illustrates the capital spend on the hydrogen network expected in 2026 and the associated technology take-up in the years following. An illustration of jobs supported across the Baseline, High Electricity and High Hydrogen scenarios is shown in Figure 18 below.

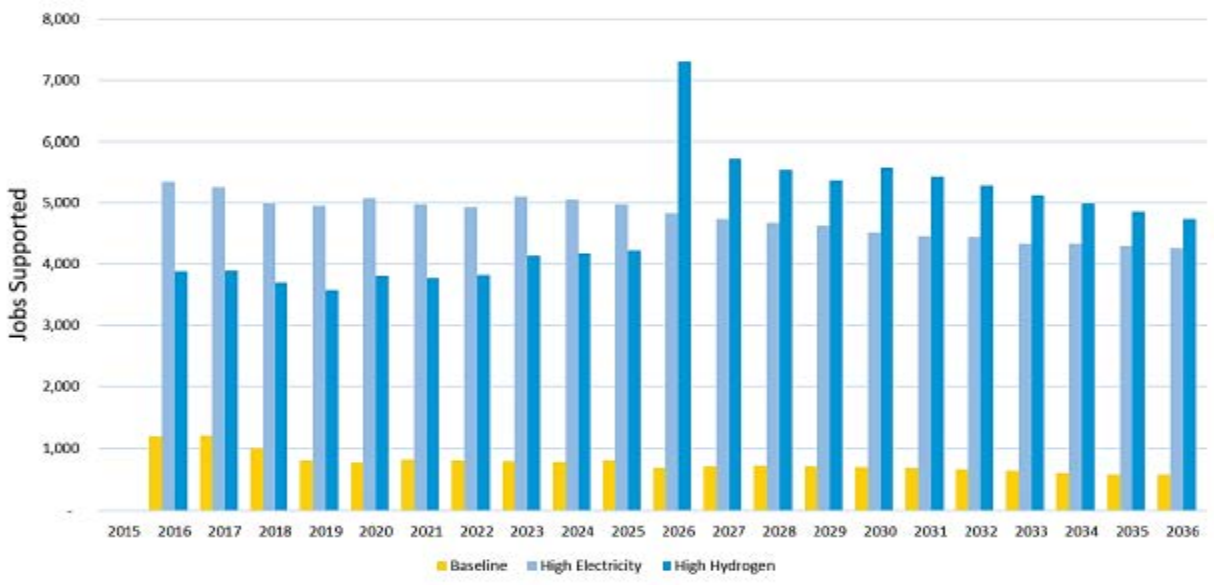


Figure 18. Jobs supported results from scenario modelling

The potential cumulative employment up to 2036 associated with the capital investment in the energy transition is shown in Table 7 below.

Maximum cumulative employment up to 2036		
Baseline	**Hydrogen**	**Electricity**
16,771	99,564	100,825

Table 7. Maximum cumulative employment up to 2036

In particular, the maximum employment potential for the High Hydrogen scenario is more likely to be retained in the City Region if the H21 project goes as planned. The modelled H21 capital expenditure for the City Region is equal to £1,027 million, which is roughly consistent with the estimate for H21 expenditure in the draft economic impact estimates for H21. Similarly, the direct jobs supported in the model from the H21 spend equals 1,700 (temporary) full-time equivalent (FTE) jobs annually from 2026 onwards, which is also consistent with the jobs estimated in the H21 estimates ranging from 1,751 to 1,923 (temporary FTE jobs).

Significant reductions in emissions are forecast across the domestic, transport and commercial sectors, with less impact made within the industrial sector. Furthermore, there is opportunity to create a thriving economy thanks to potential strong low carbon automotive and built environment industries. However, building up this manufacturing base to retain as much of the potential GVA and employment opportunities as possible is a requirement to unlocking value for the City Region.

Strategic priority areas and delivery plan

Vision and priority areas

Overall ambition

The LEP has defined its vision for the City Region in its SEP. The vision is underpinned by four inter-connected strategic investment priorities: (i) growing business, (ii) skilled people and better jobs, (iii) clean energy and environmental resilience, and (iv) infrastructure for growth. These were developed in consultation with stakeholders during a series of workshop sessions.

The main aim of priority (iii) clean energy and environmental resilience is for the City Region 'to become a resilient zero carbon energy economy underpinned by high quality green infrastructure by 2036.'

Guided by the SEP, by an in-depth stakeholder engagement exercise of interviews and workshops, and by the energy baseline modelling exercise, five strategic priority areas have been identified, setting out the role of energy in supporting economic growth across the City Region:

A. Resource efficient business and industry
B. New energy generation
C. Energy efficiency and empowering consumers
D. Smart grid systems integration
E. Efficient and integrated transport

It should be noted that the order in which these priority areas are listed does not represent any reflection of our view of the importance of each of the priority areas, which are all crucial elements in delivering a low carbon and efficient energy economy. Each of the priority areas is expected to contribute to the key challenges identified by the LEP Board for delivery of the local inclusive industrial strategy.

An overarching principle is to ensure that people feature in all of the above priorities; the energy strategy needs to work for its people, communities and businesses. Transparency is another key thread, with stakeholders expressing concerns over the ongoing complexity and confusion behind the landscape of advice and authority. Lastly, responding to the 'energy trilemma' of security of supply, affordability, and decarbonisation should underpin all priorities.

Strategic priority

Resource efficient business and industry

Resource efficiency has an important role to play in reducing energy consumption and boosting regional productivity. How products are both made and used contributes a huge source of emissions across the UK, particularly in a strong manufacturing region such as Leeds. Resource efficiency in businesses and industry has not, however, received as much concentrated attention as have other areas of action on carbon emissions reduction, despite the fact that it is estimated that between now and 2032 resource efficiency could save more than seven times as much in carbon emissions as the smart meter roll out and nearly three times as much as the Renewable Heat Incentive (RHI).

Industrial sectors with particularly significant opportunities for resource efficiency are construction, vehicles, and food and drink. The first could deliver the largest savings

through reuse and use of low carbon materials; the second from encouraging the retention of cars; in the food and drink sector the key opportunity is through avoiding food waste.

The Combined Authority has already seen considerable impact through their successful REF programme. However, as this programme is exclusively targeted at SMEs, there is additional scope in the region to engage industry stakeholders more widely and identify the barriers and challenges preventing their full adoption of resource efficient practices. Furthermore, setting up sector specific 'resource efficiency partnerships' or working groups could help to progress the identification and communication of opportunities, maximising their economic and carbon saving potential.

A1. Deliver advice and financial support to SMEs through the REF and build on the legacy of the programme through access to new finance to enable further implementation

Resource efficiency is about reducing resource use and also using resources, including energy, water and materials, in a better way, including through reducing or eliminating waste.

A typical SME has the potential to reduce energy, water, and material use by at least 20 percent through the implementation of simple measures. Through these measures, SMEs in the UK could save a total of £1.37 billion in any single year. As well as savings from bills, focusing on resource efficiency can open up new business opportunities to SMEs: research has shown that 92 percent of UK business leaders think that green growth presents an opportunity for their own business, and that over 65 percent of consumers think it is important to buy from environmentally responsible companies.

There is a need to support and stimulate best practice resource efficiency improvements among businesses. In order for this to be successful, one needs to learn to speak to different audiences using an appropriate narrative. It is key to overcome the often complex and confusing landscape of advice. There are opportunities to build on existing wider initiatives such as the Energy Savings Opportunity Scheme (ESOS), and take advantage of new programmes under the Clean Growth Strategy, e.g. heat recovery and innovation programmes.

The REF was set up to assist SMEs to identify, fund, and implement capital resource efficiency improvements. Common issues for SMEs are a lack of available human resources and skills and inability to access finance to deliver materially impactful and successful projects. A key aspect of this is having the technical capability and time to develop and present credible quantified business cases to senior decision makers in the business. Through the fund, eligible SMEs are awarded a free resource efficiency assessment worth up to £1,100, hands-on business support, and the possibility of 50 percent capital grant funding of up to £10,000 to help them top invest to save resources and reduce their costs.

Whilst this fund is still running, there is potential to build on its legacy and reach out to stakeholders to secure access to new finance to enable further implementation. There are 121,600 businesses in the city region, representing a huge potential market for the expansion of the REF and to boost regional productivity.

A2. Implement energy efficiency improvements across the large industrial sectors, demonstrate new and innovative technologies and share learning, such as from the Government's Industrial Energy Efficiency Accelerator (IEEA)

The recent release of the UK Industrial Strategy, the Clean Growth Strategy and the Industrial Decarbonisation and Energy Efficiency Action Plans to 2050 has set the stage nationally for action at the LEP level to implement energy efficiency improvements across

the large industrial sectors in the City Region. UK central government is showing great interest in regional industrial and decarbonisation opportunities.

The Industrial Decarbonisation and Energy Efficiency Roadmaps and Action Plans present opportunities that can be exploited by industrial businesses in the City Region, such as the £7 billion manufacturing sector, which in Leeds alone supports around 28,600 jobs, making it the second largest UK centre for manufacturing outside of London.

In addition, businesses in the City Region can learn from the BEIS-funded £9.2 million Industrial Energy Efficiency Accelerator (IEEA), which is running over a four-year period (2017-21). The IEEA aims to lower the cost of near-market energy efficient technologies for a range of industrial sectors, through their installation and monitoring in demonstration projects. Where appropriate, demonstration sites and technology innovators can also receive project de-risking and incubation support through the IEEA, to help them deploy projects, build a sales pipeline, and raise finance.

A3. Support innovation and growth in energy intensive industries, including technology innovation through carbon capture, utilisation and storage (CCUS) and energy efficiency technologies

Energy intensive industry sectors in the UK are loosely defined as those with high heat and/or electricity demand. Through its eligibility criteria for the Energy Intensive Industry Exemption, BEIS defines energy intensive companies more specifically as those with an electricity intensity of at least 7 percent. The City Region is home to energy intensive businesses, particularly in the glass, food and drink, and chemicals sectors. No estimates have been found on how many energy intensive industries are based in the City Region. It would be useful to undertake a cluster study of high energy intensive industries in the City Region, uncovering their extent and geographic concentrations.

Energy is a high and controllable cost for energy intensive industries; such businesses around the City Region could benefit from putting in place programmes to reduce operating costs through, for instance, operational energy efficiency. One option is to engage in Demand Side Response (DSR). DSR works on the basis that significant peaks in national electricity use result in higher costs for non-domestic consumers during those peak times. Incentivising high energy consumers to reduce their energy use temporarily during unusually high peaks allows those consumers to reduce their costs accordingly. Conversely, those consumers are also able to benefit from lower prices when electricity demand across the national grid is low, or when available supply to the grid is high (for example, at times when weather conditions enable high levels of renewable electricity generation). The DSR approach helps to soften both peaks and troughs of electricity demand, helping in matching supply and demand across the system. This helps at the system level to reduce the costs and carbon emissions otherwise associated with reacting to these peaks and troughs to ensure grid stability.

Innovative new technologies, such as in the area of heat recovery, also represent an opportunity for the City Region. The UK Government's Industrial Heat Recovery Support (IHRS) programme was launched by BEIS in autumn 2017 with an open consultation process to design the programme in accordance with industry's needs. The IHRS programme aims to facilitate recovery and reuse of industrial waste heat by overcoming barriers and initiating a series of demonstrator projects.

Several of the BEIS Industrial Decarbonisation and Energy Efficiency Action Plans (see A4 below) identify as a key action the opportunities for carbon capture and utilisation (CCUS) to be deployed at industrial clusters in the UK. The Carbon Capture and Utilisation Demonstration Programme has been launched by BEIS with a Scoping Study, with results

due to be delivered to government in summer 2018. The Scoping Study will identify participants for the Demonstration Programme and work with them to produce site-specific cost estimates of potential projects for co-funding.

These programmes all present opportunities for the City Region's energy intensive industries to grow their businesses whilst decarbonising. A number of key players have already started this transition, such as Drax, where they will convert the fourth of their six reactors to burn biomass by 2020, install energy storage and develop the remaining two coal reactors to a 3.6 GW CCGT plant in 2023.

A4. Facilitate action across the energy intensive sectors within the City Region; coordinate a collaborative sector involvement in the BEIS sectoral Industrial Decarbonisation and Energy Efficiency Action Plans

Industrial symbiosis is an opportunity for action across the energy intensive sectors within the City Region, and national and international research and support programmes exist to determine and support synergies. A significant amount of industrial symbiosis has already occurred in the UK, facilitated by programmes such as the National Industrial Symbiosis Programme (NISP) through the Waste and Resources Action Programme (WRAP), and through EU Horizon 2020 funding.

To build from this and enable an ambitious vision of collaborative decarbonisation and energy efficiency in energy intensive industries it would be helpful to establish a strategic platform for industrial leadership. To make best use of such platform one would need first to undertake a cluster study on the high energy intensive industries in the City Region (as already noted above, under A3). Such a platform, potentially in collaboration with BEIS and the NEYH Hub, would strengthen the City Region's strategic sectors and could unlock new opportunities to improve the energy efficiency of industrial operations.

The Combined Authority has the potential to work with BEIS to be a leader in the implementation of 2050 Industrial Decarbonisation and Energy Efficiency Action Plans across a number of sectors. The City Region could also begin discussions with other LEP regions to form 'mega-clusters', potentially collaborating with other energy hubs across the north of England.

New energy generation

The SEP recognises the scale of opportunity that the transformational move to innovative, clean energy technology across all aspects of the economy presents for economic growth in the City Region. There have already been improvements in energy efficiency and carbon reduction across the City Region, and local authorities in the City Region are taking a leading role in pushing this further, pledging to be '100 percent carbon neutral' by 2050.

In order to capitalise on the new energy generation opportunity, the Combined Authority will need to consider carefully the barriers and challenges, as expressed by stakeholders, such as a potential lack of skills to meet set targets, insufficient access to funding and finance, and network and regulatory barriers.

Stakeholders have stated that they would welcome a clear strategy in place to mitigate existing challenges, and in addition they want to see a strategy and actions that are underpinned by a whole energy systems approach. Furthermore, generation needs to be considered in conjunction with distribution and use, while ensuring the protection and preservation of the local landscape and consideration of clean air zones.

B1. Providing a test bed for game changing, innovation technologies e.g. H21 Project

The City Region is currently leading the way on innovative technologies around the use of hydrogen. Existing programmes and governance arrangements such as the Combined Authority Energy Accelerator and the cross-LEP NEYH Energy Hub have the potential to be key vehicles for further developing this game changing technology.

The H21 Leeds City Gate project has developed a plan to convert the existing gas network in Leeds to 100 percent hydrogen, which emits zero carbon emissions at the point of use. The conversion of the gas network to 100 percent hydrogen can be considered in three components: the hydrogen production and transmission system, the gas network conversion, and the conversion of appliances. The H21 project could give the region a first-mover advantage in a fuel and its accompanying technologies to create substantial potential for economic growth and job creation. The majority of the UK's hydrogen is currently produced within the nearby region of Tees Valley, meaning there is already a natural hub of expertise.

It is proposed that the H21 project could be implemented in Leeds from 2021 to 2029.The total cost of hydrogen conversion for the city of Leeds is estimated at £2,054 million, with an additional £139 million ongoing OPEX costs per year. This investment would enable the provision of hydrogen to meet an average annual demand of 6 TWh/year. Following a successful pilot in Leeds, grid conversion could then be extended to other urban centres across the City Region and beyond.

The main elements of the project would include:

- Four steam methane reforming plants built in Teesside, fitted with 90 percent carbon capture, that would convert natural gas into hydrogen.
- The construction of a pipeline to transport the captured carbon from Teesside for storage in spent oil and gas wells in the North Sea.
- Salt storage caverns for hydrogen built in Teesside, some of which may be repurposed from existing caverns in the area. These would be used to deal with inter-seasonal and other storage requirements.
- A hydrogen transmission system (pipeline) that will transport the hydrogen from Teesside to Leeds.
- Minor upgrades to the gas network infrastructure within Leeds, which generally already has the capacity to convert to 100 percent hydrogen.
- Conversion of gas appliances for consumers.

Northern Gas Networks (NGN), the gas distributor for the north of England, including northern Cumbria and much of Yorkshire, is leading industry projects examining hydrogen for use in the gas network. Following a successful NIC bid (£10 million funding secured), NGN are now demonstrating the safety case of 100 percent hydrogen in a gas network ('upstream' of the meter), in specialist test environments in Buxton and Cumbria. NGN is working closely with Leeds City Council and the Combined Authority to identify demolished / derelict sites where mains networks still exist in order to provide a safe, 'real-life' test environment with no customer impact. It should be noted that it is probable that only a small proportion of the jobs created through H21 will be within NGN; it is the supply chain across the City Region (construction, supply and maintenance) that stands to benefit from the project and potential roll out.

In addition, BEIS are funding Hy4Heat, a £25 million project testing the possibility of domestic gas pipes for hydrogen and developing a range of innovative appliances such as

boilers and cookers. The aim of the programme is to accelerate commercialisation of hydrogen-fuelled technologies. A full report was due in summer 2018. Many questions are being addressed through H21 and Hy4Heat and it is anticipated that this can lead to a subsequent trial in an occupied community to inform policy decisions in the early 2020s.

B2. Drive investment in distributed generation and low carbon energy projects e.g. solar, biomass, heat pumps, mine water recovery

According to stakeholders, cleaner and more affordable energy should underpin the priorities for new energy generation. In light of this, opportunities within the City Region arise from distributed energy generation and renewable heat technologies.

Within this we can consider a range of appropriate renewable heating technologies, including heat pumps, biomass, solar thermal, and waste heat recovery. Technologies can be deployed at individual building level or across entire communities. Renewable heat technologies have significant potential to reduce carbon emissions. For example, heat pumps can provide significant CO2 savings in comparison to standard electrical heating systems, since they require only around one third of the electricity.

The UK Government announced in its Clean Growth Strategy support to drive investment in this area, for example by spending £4.5 billion to drive the deployment of low carbon heat technologies in homes and businesses between 2016 and 2021 through the RHI.

B3. Drive investment in heat networks

Closely related to the priority above is the development of heat networks across the City Region and the potential economic and social benefits that these schemes could deliver. According to estimates, heat networks currently contribute £0.02 billion GVA in the north of England. There is potential for heat networks to play a significant role in the future provision of heat supply to buildings across the City Region, particularly where these are located within the more densely populated cities and towns, and as part of newly constructed developments. Given the existing industrial activity in the region, there is also significant potential to capture waste heat from industry and feed this in to local heat networks or distribute to nearby towns and cities. The use of heat from mine water also presents a potentially significant opportunity within the City Region.

Across the City Region, the Heat Network Opportunity Report identified 89 potential projects, of which 24 generated an internal rate of return (IRR) of greater than 4 percent (as a rule of thumb this is the minimum for public sector investment). Several local authorities are currently leading on the development of schemes across the City Region. The most progressed example is Leeds City Council, who are developing a £35 million scheme, the Leeds ‘PIPES’ Network, that will capture waste heat from the Council’s Recycling and Energy Recovery Facility and distribute it to council-owned, commercial, and residential buildings within Leeds city.

The focus of this priority should now be on progressing those schemes identified in the existing City Region District Heating Programme towards implementation (i.e. developing the full business case, securing investment, progressing procurement, construction and operational installation) while continuing to identify new stand-alone opportunities and potential extensions to existing/proposed networks. National funding such as the BEIS Heat Network Delivery Unit (HNDU) and Heat Network Investment Project (HNIP) offer opportunities to support and accelerate progress. More information on these schemes is provided in the Delivery section of this document.

B4. Use the Energy Accelerator as a vehicle for project development

Stakeholders' ambitions are for the City Region to become an accelerator and hub for clean energy innovation. The City Region Energy Accelerator programme is currently being set up and will provide grant funding and specialist expertise to help public and private sector organisations in the City Region in developing low carbon local energy projects.

The Energy Accelerator programme (described in detail in the earlier Context section of this document) will offer opportunities, in particular for SMEs (and others), to win significant contracts, and can attract investment to the area and build skills. Whilst the Energy Accelerator is not an action area in its own right for the purpose of this strategy, it will act as a key delivery mechanism to support projects identified in the Delivery Plan section below.

B5. Energy innovation and supply chain development e.g. CCUS and hydrogen, energy storage, links with technology providers and research institutions

The potential for energy innovation across the supply chain spans different technologies such as CCUS, energy storage and hydrogen (for an overview of the latter refer to priority B1).

CCUS refers to methods and technologies that remove carbon dioxide from the flue gas and from the atmosphere, followed by the recycling of carbon dioxide for utilisation and safe and permanent storage options.

The IEA estimates there will be a global CCUS market worth over £100 billion; with a modest share of this market, this could increase UK GVA to between £5 billion and £9 billion per year by 2030. In the BEIS Clean Growth Strategy, the government has outlined ambitions to demonstrate leadership in CCUS through collaboration and the investment of £100 million in leading edge CCUS and industrial innovation to drive down costs and a further £162 million for R&D investment.

CCUS has a range of potential applications in the City Region. Firstly, if the H21 project goes ahead, CCUS will be required to capture the carbon dioxide emitted during the hydrogen generation process. Current proposals outline that carbon dioxide would be sequestered through a CCUS system in the North Sea. CCUS could also be deployed to decarbonise clusters of carbon-intensive industries located within the City Region. As mentioned in previous sections it is recommended to undertake a study on the high energy intensive industries cluster in the City Region and the potential for décarbonisation.

Energy storage relates to the capture of energy produced at one time for use during a later period. It enables a range of potential benefits, including absorbing "wrong time" energy, then releasing it to meet demand, helping support capacity constraints and balance the influx of intermittent low carbon technologies onto the grid, and avoiding expense associated with reinforcing assets and adding new capacity. The electricity storage network set out a target of 2,000MW of new electricity storage by 2020, projected to support the creation of 10,000 jobs across the UK, rising from 500 in 2015.

The City Region should seek to access these jobs which will range from research and development, design, testing and commissioning roles as technologies are rolled out. Having the largest workforce in norther England, and being the largest producer of graduates in STEM in the North, the City Region is already well placed to tap into these job opportunities.

Densely populated areas such as Leeds and York can provide valuable testing grounds for energy innovation, creating significant potential for R&D opportunities to be exploited

within the City Region. Feasibility studies are required to understand the optimal pockets for testing energy innovation across these areas.

Energy efficiency and empowering consumers

Energy efficiency is a key area for carbon reductions in the UK, and could save as much power as would be generated by six new nuclear reactors according to figures from the UK Energy Research Centre (UKERC). Efficiency measures are particularly important regarding heat as there is not yet an efficient and cost-effective method for decarbonizing heat on a large-scale. Energy efficiency can save hundreds of pounds on fuel bills for inhabitants, an empowering option given the rise in energy tariff prices. In particular, it brings the most significant benefit to the lowest efficiency houses, often owned by those who are lower-income or fuel poor. Furthermore, these efficiency measures also have a positive impact on health, particularly important for fuel-poor households and the elderly.

The region has developed a good supply chain in energy efficient materials and measures, as well as in the skills required for installation and maintenance, however it is important the momentum behind this progress is maintained.

C1. Deliver energy efficiency improvements to homes across the City Region to reduce fuel poverty and improve health

Around 85 percent of UK's existing housing stock will still be in use by 2050 according to estimates. As such, these buildings must use energy in the most efficient way. Significant portions of the City Region's housing stock is from the Victorian and pre-1930 era, with poor insulating qualities largely due to solid walls unsuitable for cavity insulation.

In a bid to address this, the City Region has successfully run several domestic energy efficiency programmes. The Kirklees Warm Zone scheme has been heralded as an exemplar to the rest of the UK. It insulated 51,000 homes, delivering 105 GWh of energy savings and directly creating 126 jobs.

There are approximately 14,000 fuel poor households in the City Region, higher than the UK average, according to estimates from BHY. To address this issue, the Combined Authority approved a new £2.9 million Warm Homes programme partly funded by National Grid to help lower fuel bills for more than 700 households in the City Region. This builds on the BHY scheme as well as on the Combined Authority's existing Tackling Fuel Poverty Programme, which has been running since early 2017, and provides up to 100 percent-funded grants.

There are recognised connections between fuel poverty and health problems; it therefore key that City Region continues to expand its current portfolio of work in this area.

C2. Develop partnership and funding models with utilities, local authorities, housing associations, community energy groups and the health sector to impement energy efficiency programmes, building on the success of programmes such as BHY

With energy efficiency and retrofit programmes having been heavily reliant on central government and intermittent schemes led by large energy companies, the City Region has an opportunity to continue to set more clarity and stability by driving action locally.

Experience shows that the success of energy infrastructure projects, as well as the actual implementation of energy efficiency measures, depends upon understanding stakeholder views and securing commitment from a range of stakeholders to switch from the status quo to something new. The Combined Authority can play an influential role in advancing the retrofit of existing properties through collaboration with other key stakeholders such as private and social landlords, developers, energy suppliers, local communities, local

planning authorities, housing associations, mortgage lenders and credit unions amongst others.

BHY was launched in 2015. It has delivered measures to 3,107 properties, utilising a blend of finance sources. New schemes such as the BeWarm Wakefield, which has just been launched, are building on the success of the BHY programme.

C3. Promote better housing standards in new development, in line with Government commitments

If we want to achieve 80 percent reductions in emissions by 2050, we need to embed sustainability into new developments. Mitigating actions could be fitting clean energy measures and enhancing energy efficiency where possible, or investing in wider low carbon infrastructure.

A key goal within the SEP is to double house-building in the City Region. Key benefits associated with housing growth in the SEP are: create jobs, stimulate private sector investment and ensure residents have access to good quality, affordable, homes in the right places to meet employment growth. By setting clear sustainability credentials, the City Region can create new business opportunities for local homebuilders and owners as well as improve the attractiveness of new developments in accordance with success criteria for sustainable new build: environmental performance, deliverability, affordability, reliability, and comfort.

New standards such as Passivhaus are needed in that they aim to achieve thermal and occupant comfort with passive measures, including good levels of insulation, passive solar gain, and internal heat sources, high levels of airtightness, and good indoor air quality. The rise of off-site modular construction methods also represents an opportunity for sustainable new build.

Smart grid systems integration

Smart technologies are increasingly important in alleviating grid strain and meeting the demands of new patterns and types of energy consumption. They can do this through increasing flexibility in a number of ways, shifting demand off-peak, matching demand with generation and digitising energy – such as with smart meters, allowing for better access to usage data and therefore to make quick alterations.

Given the growth in decentralized energy generation and use, through domestic solar PV arrays, batteries and EVs, this is a crucial time for the UK's energy system. Forward-facing, proactive investment in creating a smart grid for the City Region will deliver skills, jobs and investment, whilst reducing potential constraints and high costs from grid reinforcement further down the line.

D1. Unlock the transition to a smarter, more integrated energy economy, which balances supply and demand, capitalising on the City Region's existing sector strengths in the digital and data analytics market

There are around 8,500 digital technology companies in the City Region, employing some 70,000 people. These offer an expert workforce with highly relevant skills to both energy systems and smart grid developments. In addition, these could be leveraged for new technologies such as digital transformer monitoring units and substation controllers, smart meter data processors, and artificial intelligence (AI) enabled demand response.

Government is spurring digital infrastructure through its new Digital Infrastructure Fund that sits alongside the government £31 billion National Productivity Infrastructure Fund that was first presented in the Government Industrial Strategy White Paper. This public

spending is earmarked for raising UK economic growth over the six years from 2017-18 to 2022-23.

Densely populated areas such as Leeds and York can provide valuable testing grounds for new technologies around smart grids and networks, including the potential for digital technology to provide the data and software to underpin these technologies. This creates significant potential for R&D opportunities to be exploited within the region.

D2. Support the deployment of smart grid technologies across the domestic, commercial and industrial sectors, including smart meters, demand-side response, energy storage and data analytics

Building on the existing strengths and successes, there are opportunities for the City Region to develop into new priority sectors and technologies that will be needed as the UK moves to a decarbonised future.

Northern Powergrid is responding to the call for a smart, flexible energy system through its 'Smart Grid Enablers' upgrade programme. The company is dedicating £83 million for switching to smarter grid technologies, running to 2023. The resulting calculated savings between 2023 and 2031 are estimated at £400 million-£500 million. These smarter grid measures such as DSR and energy storage are expected to overcome any potential issues concerning new decentralised renewable generation and EV charging.

There are several DSR mechanisms in use throughout the UK, including balancing services such as Frequency Response (FR), Demand Turn Up (DTU), and Short Term Operating Reserve (STOR), capacity mechanisms, and peak avoidance. BEIS's Clean Growth Strategy estimated the technology could liberate up to 4.9 GW of UK electrical capacity by 2032. Energy storage on the other hand is not currently widely deployed across the UK; however, its deployment is key to creating a flexible low carbon grid.

Opportunities specific to the City Region have been identified in terms of smart meters and energy storage. Beyond this, more innovative projects using old mine shafts to store heat or hydrogen have been identified in the Sheffield City Region. This is highly relevant to Leeds City Region, which also has a history of mining and a well-established network of old mine shafts across the City Region.

D3. Facilitate innovation through technology incubation, collaboration with local start-ups, technology deveopers, and research institutions to access Government research and development funding and commercialise technologies

It is key to foster regional technology innovation and incubation to create economic growth and business capabilities. Bringing in local technical and research expertise, such as universities and research institutions is a way of doing so.

The Accelerator is being specifically set up to address this area. It looks to bring together stakeholders including technology developers, industry and energy experts to progress innovative solutions. This dovetails with the UK's IEEA, which is already underway, and there will likely be learnings and experience that can be shared between the two.

Efficient and integrated transport

The low carbon transport sector has made considerable progress across the UK over the last decade, particularly in the electrification of railways, buses and cars. This progress has also grown integration, the ability of the various public transportation vectors to be more valuable as one contingent whole, demonstrated by West Yorkshire's successful MCard scheme. Both these areas, can be effectively integrated into future transportation projects, however this requires the use of a holistic 'whole-system' planning approach.

The size and diversity of West Yorkshire's economy and geography presents several challenges in balancing transport priorities and funding. Furthermore, investment in road and rail has not kept pace with economic and population growth, resulting in congestion and delays, a lack of public transport capacity and a lack of resilience. However, major national and pan-northern rail investment, and the £1 billion WYTF are set to overcome these challenges, whilst developing the local transport economy.

E1. Promote a better, more integrated transport system, which is clean and efficient, addresses air quality issues, and promotes alternative transportation through cycling, walking and public transport

An underinvestment in strategic transport infrastructure has historically restricted connectivity. Better integration between the different existing forms of transport within the City Region should maximise their effectiveness. There is also a need for continued modal shift, reducing the number of car journeys by transferring drivers onto efficient bus routes, bikes and new programmes such as Bus Rapid Transit (BRT) routes.

Modal shift from car transportation to 'active travel', such as walking and cycling, is a key to cleaner air, population health and a low carbon transport network. Leeds has already successfully deployed modal shift schemes aiming to inspire behaviour change in commuters. The Combined Authority and local authority partners have won a successful bid for £60 million of Department for Transport (DfT) Cycle City Ambition funding to develop the CityConnect scheme to improve infrastructure, promote, and enable travel that is more active. In particular, Leeds is home to Cycle Superhighway 1 'CityConnect', a cycling route that connects Bradford to Leeds city centre. This has raised a total of £30 million, through £22.1 million government funding and local match funding, for the development of CityConnect 2.The Combined Authority and North Yorkshire County Council are also developing Local Cycling and Walking Implementation Plans (LCWIPs)

The public and private sector play a key role in promoting sustainable transport. Across the City Region, there has been a series of aims and actions directed at improving and integrating the existing rail and bus networks. Part of this has been driven by the Connecting Leeds strategy, which plans to create a new high frequency bus network, develop three new railway stations, and expand park and ride by 2,000 spaces, whilst linking these schemes with HS2.

The existing MCard smart ticketing system for West Yorkshire's bus and train networks is highly successful, with more than a million transactions per week making it the largest system outside London. Following on from the success of integrating the West Yorkshire car club, the system is pushing to add new payment products and travel vectors.

The Combined Authority 2040 transport strategy aims to improve the efficiency of the transport network management through using the data streams provided by the MCard system. There is also future scope to use this travel data as well as telematics and the tracking of bus routes to make interventions in inefficient driver behaviours.

E2. Support the deployment of cleaner transport technologies, including electric vehicles and ultra-low emission vehicles, hydrogen fuel cell EVs and a network of charging infrastructure

Opportunities for cleaner transport span private and public transport, as well as delivery vehicles that are ubiquitous in cities worldwide, particularly with the advent of online delivery services. This is a crucial area of transport that needs to decarbonise, alongside the more traditional delivery vans for shops and works vehicles that are almost exclusively diesel engines and often guilty of extended periods of 'idling'.

Between 2011 and 2016, the number of EVs on the road globally increased thirty-fold, in part due to the cost of battery packs having fallen by 80 percent since 2010. The Combined Authority has already seen success in securing £1.9 million of government funding to convert 500 diesel taxis to Ultra Low Emissions Vehicles (ULEVs). In line with this, the recent City Region Technology Options Appraisal undertaken by the Carbon Trust scored 'Electric and Plug-In Hybrid Vehicles' as second of eighteen technologies.

As outlined in the Clean Growth Strategy, the UK government is supporting this development with £1 billion to fund ULEV uptake and £80 million charging infrastructure deployment. However, in addition to central government, LEPs and local authorities hold key planning powers to drive large-scale EV uptake through their ability to deploy a network of local charging infrastructure.

The development of hydrogen fuel cell vehicles is key to the H21 project. This could see hydrogen vehicles connecting to the new hydrogen grid, providing key impetus for the extension of the network, and creating an integrated grid and transport network. Combined with the Clean Air Zone (CAZ) and proposals for a compressed natural gas (CNG) depot, there is building momentum behind this particular technology area.

Delivery plan

Projects

To collate the following list of projects we have considered the key strengths of the City Region, reviewed the evidence outlined in WP1 to WP3, and undertaken an in-depth stakeholder engagement exercise.

We have also produced an excel model that enables the Combined Authority to score projects on a number of criteria to assess their local strategic fit and deliverability. The local fit was assessed against the priorities of the SEP and the emerging LIS. Projects can also be scored against their national strategic fit, however as local fit is to give a more priority, it has been excluded from the following project overviews.

For each identified project, we have provided a description, a rationale for intervention, a list of key outcomes sought, a high-level estimate of potential carbon savings, a list of funding sources, key stakeholders and their roles, delivery mechanisms and next steps. Whilst some projects are 'feasible' projects and can already be described in more detail, other are only 'concept' projects and therefore would need more studies to be thoroughly scoped-out.

Stakeholder roles

A critical issue that could impede the success of this energy strategy and delivery plan is a lack of clarity regarding the roles, responsibilities, and expectations of the various stakeholders and individuals who will need to come together to translate paper into action. We have tried to list the key stakeholders that should be engaged for the successful investigation and delivery of the proposed project.

Within the stakeholder workshop, we facilitated an initial roles and responsibilities exercise that was designed to assist stakeholders to understand more fully their own roles and responsibilities in relationship to the energy strategy, and to provide them with an opportunity to share their expectations about the roles and responsibilities of others.

The Combined Authority will have to do some further thinking around the potential stakeholders involved in each of these projects. To do so it can be useful to broadly group stakeholders into four overarching categories, representing organisations or individuals

that tend to have common interests yet will experience their own journey in their interaction with the project:

- The investors are the stakeholders who will be providing the finance and investment for the project. Your investors are likely to have a pre-determined set of evaluation criteria and priorities that govern their investment decisions; they will also be comparing your investment opportunity against others. It is important for you to understand what your investors are looking for, so that you can tailor a proposition that appeals to their interests. They may be internal decision makers or external investors. As a sub-category of your investors, you can have promoters, who take responsibility for promoting the project and driving delivery.
- The consents are the stakeholders involved in providing the necessary permits and licenses to allow your project to proceed. This group have a mandate to undertake a particular function, such as procuring for a piece of work or construction, which includes specific requirements and timescales. You will need to engage with this group to understand what consents you require and the procedure for obtaining them.
- The customers are the organisations that you want to provide a service to, through the provision of heat, cooling and/ or electricity. You need to understand their drivers and develop an offer, which appeals to their interests and secures them as a customer.
- The final group, we categorise as the other group, which includes stakeholders such as the procured delivery partner or the public. You should adopt a tailored strategy to manage these disparate groups.

It is key to understand stakeholders' drivers and barriers and to identify shared interests and dual benefits. This is particularly key in the implementation phase of this Energy Strategy, as stakeholders will be asked to advance projects and programmes identified in this strategy with those pre-existing commitments of their corporate plans. Ideally, one would find synergies between existing and upcoming plans, and link up different private and public sector bodies sustainability action plans.

Carbon savings

The annual carbon savings that could be realised for the City Region have been calculated for each project within the delivery plan, however, this has only been completed for projects where there is another data available to be able to construct a high level estimate. The savings are quoted in kilo tonnes of CO_2 per annum and are based on a series of assumptions, which are outlined below (specific project related assumptions are mentioned within the individual project descriptions). The resulting savings are thus high level estimates and not exact figures, they therefore aim to give the reader an appropriate idea of the magnitude of carbon savings available.

Main assumptions used for carbon savings calculations:

- 2017 BEIS carbon factors have been used for all fuel types.
- Capacity factors for generating sources are aligned to BEIS average values.
- Approximately 15 percent of domestic and commercial buildings are under the public sector domain (based on UK average figures from ONS).
- The LEP to construct 8,835 new homes per year.

- Average annual energy consumption figures per vehicle are: Petrol/Diesel – 12,000 kWh; Electric – 2,000 kWh; Hydrogen Fuel Cell – 4,000 kWh.

Many of the projects are mutually exclusive, therefore a sum of the carbon savings of all of the proposed projects is not possible. Hypothetically, if all projects were to be put in place there could be cumulative savings of 3,803 $ktCO_2$ per annum, which over the lifetime of the projects (up to 2036) would result in a 23 percent decrease in emissions against current values. This, therefore, is not a great enough reduction in emissions to meet the region's science based target (49 percent of the way to meeting the target), with a further 3,981 $ktCO_2$ reduction required. That said the highlighted projects here reflect primarily work conducted by the LEP and public sector, and therefore there will be significant savings available elsewhere and through the private sector.

Good governance

An enabling factor to deliver against the objectives in this energy strategy is to have suitable governance structures and processes. The key characteristics in the governance of an energy strategy that the Combined Authority should keep in mind are:

- To provide vision and leadership
- To monitor progress and give visibility to success
- To be accountable for progress against objectives
- To ensure adequate resourcing is available
- To provide an effective link to national bodies

Project boards/ steering groups are an essential part of good governance, and it is advisable to establish key steering groups should they not already be in place. If networks already exist then one can benefit from economies of scale by tapping into these networks and forums.

Monitoring

Monitoring occurs during the strategy timeframe and is key in that it helps to understand if the strategy is on track, understand where impacts will or will not be realised, identify what changes are needed to ensure success and learn from the future.

Evaluation on the other hand happens after the strategy timeframe. It is important to evaluate the strategy to determine whether the objective has been met, the impacts realised, and learning for the future identified.

Should the City Region seek to commit to setting a science-based target, the Combined Authority should consider how such a target would be monitored. For example, this could include an annual assessment of the carbon emissions across the City Region, using updated data on emissions from key organisations including BEIS, ONS, Northern Powergrid, NGN, and the City Region local authorities. This data could be compared against the 2015 baseline year data as outlined earlier.

The use of relative metrics, such as the Carbon Emissions Per Capita, Carbon Intensity (e.g. carbon intensity per kilowatt-hour) or the ratio of GDP to carbon emissions, will allow the Combined Authority to account for changes in population or economic output and provide a benchmark to allow a like-for-like comparison with other regions or against the UK's national progress.

Each of the identified projects has a list of potential next steps as well as key outcomes sought, i.e. what are the success factors for the projects. It is recommended that the

Combined Authority and other key stakeholders that will bring these projects forward monitor their success based on outcomes sought and on a set of Key Performance Indicators (KPIs).

It is recommended that the Combined Authority and key partners discuss the implications of various approaches to monitoring progress towards achieving their low carbon ambitions to reach a fit-for-purpose solution that does not place additional burden on Combined Authority and is easy to understand and implement.

To facilitate this we have provided a set of principles that should govern the monitoring of individual projects.

What are you monitoring?

For each of the projects and initiatives in this strategy it will be important to monitor the activities that have been undertaken to advance those proposed projects, the policies that have been put in place and their effectiveness, the outputs and the costs. The Combined Authority and other delivery stakeholders should also assess whether corrective actions are needed at the point of monitoring.

How are you monitoring it?

One needs to have sufficient clarity around who is being monitored, and how. Delivery staff, end consumers, and all other affected stakeholders can be the object of the monitoring activity. LCR LEP and delivery partners can decide to monitor the strategy and projects' progress in monthly reviews or at specific pre-defined milestones.

How do you react to monitoring findings?

If the monitoring indicates that the strategy is not on track it is important to address the following questions at a minimum:

- How far off is it?
- Is it only in certain areas or all areas?
- What action is needed to correct it?
- Who can implement it? quickly can it be corrected?
- How can unintended impacts be mitigated or reduced going forward?

If it is assessed that the strategy cannot meet its objectives you will need to understand if:

- The objective is still relevant and appropriate
- It is just a timing or instead a systemic matter
- What changes are needed

Priority 1: Resource efficient businesses and industry

The proposed projects under this priority have been divided up into projects addressing financial, technical, skills and expertise needs, and those focused more specifically on advancing certain innovative technologies.

Resource Efficiency Fund Phase 2	
Rationale for intervention	Build on the Combined Authority existing successful ~£2.8 million REF programme for SMEs, further improving the productivity of the region's SMEs by reducing their waste, conserving valuable resources, and cutting any potential related costs.
Project description	Extend the scope reaching a larger number of SMEs, and a wider scope for the types of assessment. Assessment could also pilot system-wide innovation and circular economy. Funded support activities could include industrial symbiosis assessments to identify and implement mutually beneficial business opportunities to generate new supplies of raw material and new methods of waste disposal, or appraisal of opportunities to close the loop on end user waste.
Key outcomes sought	Ensure that resource efficiency becomes standard practice within the local SME sector, circularity principles start to be embedded in the City Region's SME economy and the City Region gains a productivity boost through this leadership. More specific success factors are: reduced raw material costs, reduced disposal costs, new revenues from waste materials and by-products, diverting waste from landfill, reduced carbon emissions, strengthened environmental resilience of local businesses, increase productivity, competitiveness, and new business opportunities.
Potential carbon savings	Given the average annual carbon savings per project and the number of projects proposed within the (current) REF scheme, it is assumed that this project may offer approximate annual carbon savings of 1 $ktCO_2$. One existing example is a company that replaced a fixed speed air compressor has halved its energy costs, saving a massive £10,000 a year. The company has also reduced its emissions by 61 tCO_2 per year.
Funding sources	Including but not limited to ERDF, Leeds City Region Growth Deal, Horizon 2020, Innovate UK, or the future UK Shared Prosperity Fund. There is a new £50 million White Paper Innovation Loans pilot for SMEs run by Innovate UK to target the most promising projects on the cusp of commercialisation.
Key stakeholders	Combined Authority: lead organisation, scoping the programme and applying for funding SMEs: beneficiaries of the funding, helping scope the new programme Consultancies: deliver the programme and provide training and advice to SMEs.
Delivery mechanisms	• Evaluation exercise of existing REF and lessons learned

	• Stakeholder engagement workshops with SMEs, both those beneficiaries of current REF and non-beneficiaries • Creation of an outline business justification for extension of the fund • Funding bid to ERDF and other donors to raise funds
Next steps	Engage with stakeholders involved in the delivery of the existing REF and those beneficiaries of the fund to test appetite for and feasibility of an extension.

Green City Region web portal and one-stop shop	
Rationale for intervention	Reduce the access barrier to information faced by those SMEs and businesses not already actively operating in the energy sector. There is the potential to better market the available energy efficient technologies and opportunities across the City Region to support the transition towards a low carbon economy.
Project description	The idea would be to build on the existing Leeds Business Growth Hub but to expand the energy and environmental services offered by the hub. Businesses within the City Region need a one-stop shop where they can receive advice on energy efficiency.
Key outcomes sought	Ensure that businesses across the City Region have equal access to local and national support initiatives, and that it is possible for businesses to access integrated interest free loans and training courses on engaging with government funding for instance. Foster greater collaboration/ partnerships between local businesses regarding their energy efficiency initiatives. Increase awareness of energy savings potential amongst businesses.
Potential carbon savings	It has been approximated that greater collaboration between business and industries could yield 15 $ktCO_2$ per annum.
Funding sources	Internal combined authority budget as the funding needs for this action are expected to be minimal and can be linked to existing Business Growth Hub funding.
Key stakeholders	Local businesses as the beneficiaries of the advice The Combined Authority through the Business Growth Hub as signposting source.
Delivery mechanisms	• Do a gap analysis of current advice and resources provided under the Leeds Business Growth Hub and of what information is sought by local businesses • Expand the advice and services provided under the Leeds Business Growth Hub to include advice on how to best

	approach the transition towards low carbon energy opportunities, including environmental, energy and water topics • Create an online web portal that clearly signposts existing technical, financial and social support and that covers energy and environmental topics of interest to businesses, the public sector and individuals
Next steps	Engage in conversations between the Leeds Business Growth Hub, the Combined Authority and the Chamber of Commerce to scope out the offering in more detail.

Green curricula in apprenticeships	
Rationale for intervention	The City Region productivity gap with the UK average is persistent although there is a strong trend toward more people becoming better qualified in the City Region. At present education and training achievements, do not appear to align with labour market demand in the same way. Three key aspects are needed to support good growth in the City Region: great education connected to businesses, employability e.g. accessing jobs and realising potential, and building a workforce that has skills and attractive talent. Yet employers in the City Region already make a significant investment in apprenticeships that relate to the specific needs of the energy sector, including recently developed apprenticeships that are based on employer-defined standards.
Project description	Incorporate good business practice around energy and water management into curricula of apprenticeships, especially in apprenticeships in engineering and manufacturing technologies which are a priority subject for the City Region.
Key outcomes sought	Ensures that upskilling happens on the workplace to complement the planned support for businesses. Prepare the skills and talent of the future to be able to succeed in a green economy. Ensure businesses in the City Region are equipped with talent that can lead the energy revolution and actively contribute to energy efficiency savings.
Potential carbon savings	Given the number of expected new yearly apprenticeships, the average carbon emissions per capita and the potential realisable carbon savings from green curricula, the approximated carbon savings per annum for this project have been estimated to be 25 $ktCO_2$.
Funding sources	Apprenticeship funding in England, see government policy papers.
Key stakeholders	Universities, the Combined Authority, local authorities within the City Region, businesses.

Delivery mechanisms	• Engage with universities and current employers offering apprenticeships to test the appetite for such an initiative
Next steps	Set up a programme by which energy, waste and water training become part of apprenticeship curricula within the City Region.

Advancing industrial energy efficiency	
Rationale for intervention	Even marginal efficiency gains for energy intensive consumers will have magnified impacts for cost saving, freeing up capital for inward investment or expansion. These gains have the potential to enable innovation, as large energy users might invest in a new technology or process if it shows promise for significant savings. Investments can influence potential jobs and improve the environmental resilience of the organisation.
Project description	Target the high emission industrial sector (e.g. iron, steel, aluminium etc.) of the City Region with an energy efficiency innovation programme. This could include capacity building and incubation support to develop a pipeline of investable industrial energy efficiency projects.
Key outcomes sought	The aim is for large energy users (see modelling results in previous section) to implement measures that have a sizeable impact on the City Region's overall energy consumption. Through this programme, one could support partnerships between developers of energy efficient technologies and industrial companies willing to test technologies on-site. Integrate and connect industrial sites to deliver energy and cost savings through clustering. Benefits of industrial clusters include improved firm and region visibility, diffusion of knowledge and good practice, sharing of common resources, facilitated networking, focus for industry expertise, and source for long-term strategic leadership.
Potential carbon savings	The clean growth strategy outlines an aim for an increase of 20 percent in energy efficiency across the industrial sector, thus it has been approximated that this project could offer annual savings of 590 $ktCO_2$.
Funding sources	Potential government funding programmes such as the current BEIS IEEA. The government has specific guidance on funding low carbon industry. Within the Energy Innovation Programme, BEIS expects to invest around £100 million in low carbon industrial innovation.
Key stakeholders	Combined Authority, local energy intensive industries, energy efficiency service providers/ developers of energy efficient technologies, financiers.

Delivery mechanisms	• Combined Authority to support and push within the NEYH energy hub for project feasibility studies for innovative technologies which reduce costs • Sharing technology specific learning across the relevant sectors, bearing in mind the potential constraints of competition law • Look at lessons learned from existing programme such as the BEIS IEEA to assess potential replicability
Next steps	Engage with stakeholders in the key emitting industries (see modelling results for a detailed list) or with industry representatives to understand their needs and barriers for support towards higher industrial energy efficiency and innovation.

Industrial waste heat recovery and heat recovery from refrigeration	
Rationale for intervention	The City Region is home to a large number of manufacturing organisations and thermal facilities such as energy from waste plants. The efficiency of a thermal power plant is typically only 30 percent, with over 50 percent of the potential energy often lost as wasted heat. At present there is no comprehensive infrastructure in place to capture the heat emitted from the generation of electricity via combustion and re-use it for productive ends, either on site or sold to third parties. As a sub-sector of heat recovery one could focus on recycling waste heat from refrigeration, particularly within the retail sector where refrigeration can account for over 50 percent of energy use costs.
Project description	Quick-start the deployment of waste heat recovery infrastructure across the City Region, targeting energy from waste plants and energy intensive industries including the glass, chemicals and food and drink sectors where there is a large opportunity for waste heat recovery. Equip key stores (following best practice from Aldi for instance) with heat recovery systems from refrigeration units, used to direct heat from exhaust air back into the ventilation system.
Key outcomes sought	Re-use the recovered waste heat on site to improve process efficiency, or alternatively integrate it as a generation source for a local heat network for instance, to bring socio-economic benefits to the local area. Foster additional R&D to improve performance of the heat recovery technology. Spur growth in those jobs that require skills to install and maintain such technologies. Improve retailer's productivity as efficiency and savings grow.
Potential carbon savings	It is assumed that the largest heat generating industries, and refrigeration from the commercial sector will be able use their waste heat as useful heating within the domestic sector. This would replace

	the use of gas boilers. This project could save approximately 290 $ktCO_2$ annually.
Funding sources	BEIS Heat Recovery Support Programme: funding support to enable the identification and implementation of waste heat recovery projects in industry: £6 million will be available in Phase 1 to provide support for feasibility studies, and phase 2 will provide £12 million financial support, delivered through competitive grant funding. The capital grants available can work alongside the funding provided under HNIP.
Key stakeholders	BEIS: potential funder of activities and technologies deployment as part of the IHRS. Local industries as the beneficiaries of the scheme. Representative bodies of key industries e.g. British Glass: speak as a single voice for the industry and potentially help individual industries to apply for funding.
Delivery mechanisms	• The Industrial Decarbonisation and Energy Efficiency Roadmaps and Action Plans present opportunities that can be exploited by the City Region industrial businesses, such as the £7 billion manufacturing sector, which in Leeds alone supports around 28,600 jobs, making it the second largest outside of London. • Look into the BEIS IHRS Programme as well as the Accelerator as potential delivery mechanisms.
Next steps	• Undertake a mapping of the local industrial organisations in the City Region that have a high potential for re-use of waste heat / are located close to existing or planned heat networks. Narrow the analysis down to those that would qualify for the BEIS IHRS programme (see requirements below). • As per the above undertake a mapping of the local large-scale refrigeration users Engage with key players, potentially through representative bodies, to raise awareness of the potential for waste heat recovery and available support options • Draft guidance on the application process and programme plans is available here: https://www.gov.uk/government/publications/industrial-heat-recovery-support-programme-guidance-and-application-forms • Applications for IHRS grant funding can be submitted for competitive assessment at any point during the programme rolling Application Window (timing to be confirmed)

Carbon Capture, Utilisation and Storage	
Rationale for intervention	The existence within the City Region of a number of brownfield locations with existing infrastructure means that it is a likely location for CCS in the UK. Drax has announced that it is to pilot the first bioenergy carbon capture storage (BECCS) project of its kind in Europe, which, if successful, could make the renewable electricity produced at its North Yorkshire power station carbon negative. This is a good first effort to build upon.
Project description	Deploy new CCS installation across the City Region, supporting and building on the pilot project at Drax to complement its current policy of biomass co-generation.
Key outcomes sought	Investment in CCUS has the potential to bring jobs to the City Region and increase the area's economic output through foreign investments. The key outcome sought is to increase the volume of CCS to reduce carbon emissions of the City Region.
Potential carbon savings	A report by the Energy Technology Institute (ETI) in 2016 has suggested that by the 2050s BECCS could deliver roughly 55 million tonnes of net negative emissions a year in the UK – approximately half the nation's emissions target. Through the pilot at Drax the company is aiming to capture up to a tonne of carbon dioxide per day if the second phase of the trial goes ahead. As large fossil-fuel fired power stations are considered as energy generation and not consumers, CCS for these facilities has not been considered in any of the carbon saving calculations. Therefore CCS has been considered only for the largest fossil fuel consuming industries, with 90 percent of all emissions captured and stored, and the energy required to do this take in to account, the potential annual carbon savings have been approximated as 335 $ktCO_2$.
Funding sources	In October 2017, the government announced its new approach to CCUS in the Clean Growth Strategy, re-affirming its commitment to deployment in the UK (subject to cost reduction). Following the advice of the CCUS Cost Challenge Taskforce, the government will set out a deployment pathway for CCUS by the end of 2018. As part of the government's Clean Growth Strategy BEIS has allocated up to £20 million to design and construct carbon capture and utilisation (CCU) demonstration projects.
Key stakeholders	The Combined Authority, local academic institutions and universities, first movers such as Drax, technology company of the likes of C-Capture which has partnered with Drax.
Delivery mechanisms	• Feasibility works should be undertaken for likely storage locations to mitigate the risk profile for potential developers and investors

	• Monitor the progress of the Drax BECCS pilot project, in particular outcomes of initial feasibility tests to prove the system's viability • Focus on the development of CCS clusters through strong collaboration with nearby regions and ongoing initiatives in Teesside, Merseyside and Grangemouth. The newly established NEYH Energy Hub will be a no-brainer delivery mechanism.
Next steps	• The Combined Authority should be a leading force in developing a CCS cluster in the region via the NEYH Energy Hub. The City Region should seek to maximise the benefits of collaborating with existing national initiatives such as the BEIS Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050. • Look at the Technology Innovation Needs Assessments (TINAs) work undertaken as part of the Low Carbon Innovation Coordination Group, in particular the CCS TINA.

Priority 2. New energy generation

The following projects relate to heat network development across the City Region as well as to a set of other technologies identified in particular through the previous energy mapping studies undertaken in the City Region.

The following section gives an overview of key guiding principles behind district heating schemes. Heat network development in the UK usually follows a well-defined project pathway to delivery from mapping and masterplanning, techno-economic feasibility and detailed project development, through to commercialisation, construction, and operation. Illustrative timeframes for project development:

- 2-6 months for energy mapping and masterplanning
- 6-12 months for feasibility and detailed project development
- 12-18 months for commercialisation
- 1-2 years for construction
- 40+ years for operation

The current UK government has a keen ambition to accelerate the growth of heat networks in the UK, seen as a key part of the solution to decarbonising UK heat supply, which is currently primarily fuelled by natural gas. Heat networks currently provide around 2 percent of total UK heat demand, but research undertaken by the Committee on Climate Change estimates that 14-20 percent of UK heat demand could be cost effectively met by heat networks by 2030 and 43 percent by 2050.

To facilitate this growth, BEIS established the HNDU as a vehicle through which grant funding is provided to local authorities. BEIS is also about to launch its HNIP, a £320 million capital fund which is expected to support up to 200 projects by 2021, leveraging up to £2 billion private sector investment. Heat networks have the potential to enable local economic growth and job creation, and can be an effective means through which to introduce innovative delivery models for energy supply including municipal-led investments that provide a long-term source of revenue to the public sector.

The City Region is already home to several heat networks such as Derwenthorpe, University of York, Saxton Gardens in Leeds and Harrogate Town Centre and Harrogate

Town Centre that are all relatively small-scale applications consuming a mixture of gas CHP and biomass.

Through the City Region District Heat Programme, several schemes have been investigated including in areas such as Barnsley, Wakefield, Bradford, Castleford, Knottingley, Halifax, Leeds, York, and Huddersfield. Across the City Region, local plan documents encourage the increasing rollout of networks, with identified connections spanning leisure centres, new residential developments, schools and town/city centre buildings.

Eight projects in particular have strong potential to be taken forward:

Leeds PIPES	
Rationale for intervention	Deliver cheaper heat (resulting in lower energy bills) and new jobs to support the design, construction, and maintenance of the scheme.
Project description	The Leeds City Centre is one of the UK's largest heat networks and was officially launched in March 2018. The network will utilise waste heat from the Leeds RERF, and deliver it to 1,983 council homes and numerous businesses around Leeds City Centre, with a total network length of 6.5 km. Heat is scheduled to be available for spring 2019, with all homes connected by autumn 2020. This is a major scheme, and among the most progressed examples of new district heating projects across the City Region. The Council is interested in extending the network to provide additional branches to the city centre and the rapidly developing Southbank area. The phase 2 extension will not require a new energy centre as the phase 1 spine network has been designed with growth in mind. Carbon Trust have conducted a high level opportunity assessment on the Leeds Southbank extension, which generates an IRR of 6.2%, and could connect to the network between 2020 and 2025.
Key outcomes sought	Success looks like an expanding network that integrates renewable heat sources and is considered reliable, with tariff prices below average market rates.
Potential carbon savings	Phase 1 of the network is anticipated to result in 22,000 tCO2 per year (880,000 tCO2 over a 40 year lifetime). The extension to Southbank would result in a further 113,720 tCO_2 over 40 years.
Funding sources	The planned network has an estimated capital cost of £35 million, the extension to Southbank is estimated to cost an additional £15 million. HNDU funding could be sought to undertake additional feasibility analysis and the project could potentially secure HNIP capital funding.
Key stakeholders	The scheme is led by Leeds City Council, who have contracted Vital Energi as their DBOM (Design, Build, and Operate & Maintain) partner. There are 11 sites proposed for connection in the South Bank area, all of which are mixed-use developments, the largest being the Former Tetley Brewing Site and City One.

Delivery mechanisms	• Conduct detailed techno-economic feasibility study to further examine the opportunity to extend the network to the South Bank area • Engagement with South Bank developers to build support and ensure sites are futureproofed for connection • Engagement with Local Planning Authority to explore whether planning conditions can be used to safeguard connections • Deliver extension through existing business model that has been established to construct the main heat network
Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

Barnsley Town Centre District Heat Network	
Rationale for intervention	The project will deliver carbon savings and cost reduction to public sector organisations, local job creation and revenue generation for the Council. The project also has potential to alleviate fuel poverty through cost reduction to a number of social housing buildings owned by Berneslai Homes. There is a longer term opportunity for the demonstration of innovative technology through the inclusion of mine water heat.
Project description	Barnsley Council is currently developing the Barnsley Civic Quarter heat network, for which techno-economic feasibility has already been concluded, and funding secured to undertake Detailed Project Development (DPD). The project is a £5.2 million capital investment and the intention is for the project to use a 1.2MW gas CHP engine, with the potential to switch towards low carbon mine water waste heat in future.
Key outcomes sought	Success looks like a reliable network with a clear plan for developing and switching to renewable heat, serving a diverse range of buildings.
Potential carbon savings	The project is estimated to save 26,946 tCO_2 over 40 years.
Funding sources	DPD will be funded through a mix of HNDU and Energy Accelerator support in order to bring the project to financial close. Capital funding could come through a mix of prudential borrowing and a capital grant or a soft loan through HNIP. Innovation funding may be available through sources such as the Smart Systems Catapult and Innovate UK to develop the mine water heat opportunity.
Key stakeholders	Barnsley Council will likely play an investment role, possibly partnering with other public sector bodies such as Barnsley College. Key stakeholders include the customers, with the project possibly connecting to a range of public and private sector buildings across the

	Civic Quarter of Barnsley Town Centre, including council-owned buildings such as Westgate Plaza and the town hall along with Barnsley College, the Magistrates Court, and the Premier Inn. There is a longer-term opportunity for the project to extend to the remainder of the town centre, potentially connecting to the council-owned Glass Works redevelopment.
Delivery mechanisms	• Undertake DPD to develop a HMT compliant business case and seek Council approval • Engagement with customers to sign Heads of Terms agreements • Determine preferred contract and procurement strategy, will likely require a level of Council investment and ownership
Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

Bradford Civic Quarter District Heat Network	
Rationale for intervention	This project will deliver carbon reduction, revenue generation and reduced costs to the public sector and local job creation.
Project description	Bradford Council is developing the Bradford Civic Quarter heat network, which is currently entering into the Detailed Project Development phase. The proposed network extends for 2.66 km and is worth £13.1 million in capital value. The preferred generation technology is a mix of 1.6MW gas CHP and 999kW biomass boiler. The scheme would connect to a range of public sector buildings in the Civic Quarter and would likely represent an investment led by the council.
Key outcomes sought	Success looks like an expanding network that integrates renewable heat sources and is considered reliable, with tariff prices below average market rates.
Potential carbon savings	The project is estimated to save 2,059 tCO_2 per year, or 82,360 tCO_2 over 40 years.
Funding sources	The project could access HNDU and the Accelerator funding to support further project development along with capital funding through HNIP through a grant or soft loan. The project is likely to require some form of capital investment from Bradford Council.
Key stakeholders	Key stakeholders include Bradford Council, who will likely play an investment role in the project along with providing a large public sector demand through the connection of eight council-owned buildings. Other proposed public sector customer connections include the Ministry of Justice Magistrates and Combined Courts, the Police (Nelson St Police Station) and West Yorkshire Pension Fund. A range

	private sector buildings are proposed for connection e.g. the Odeon, Jurys Inn and Bradford Ice Arena.
Delivery mechanisms	• Undertake DPD to develop a HMT compliant business case and seek Council approval • Engagement with customers to sign Heads of Terms agreements • Determine preferred contract and procurement strategy, will likely require a level of Council investment and ownership
Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

Halifax Town Centre District Heat Network	
Rationale for intervention	This project has the potential to generate revenue, deliver carbon reduction and cost reduction to local public and private sector stakeholders.
Project description	The Halifax Heat Network project is currently in DPD stage, it is looking at gas powered CHP, with the potential to switch towards a renewable heat source in the future once the network is established. The proposed location of the new Energy Centre is North Bridge Leisure Centre, with works completed as part of the new swimming pool development. The scheme has an anticipated starting date for construction of 2020/2021.
Key outcomes sought	Success looks like a cost effective, reliable, network with integrated low carbon heat sources, with tariff prices below average market rates, and scope for expansion.
Potential carbon savings	The project is estimated to save approximately 1,250 tCO_2 per year.
Funding sources	The estimated capital value is £9.55 million. There is a need to seek to optimise the preferred scheme identified in the original feasibility study as this drew the conclusion that the scheme was not commercial viable. This could include more investigation into the energy centre cost, testing variations of customer connections and increasing the heat demand connected to the network. Further project development funding is available through HNDU and the Accelerator with longer term potential to access capital funding through HNIP.
Key stakeholders	Given the economic returns, it is highly likely that the project would require capital investment from the public sector via Calderdale Metropolitan Borough Council buildings. Other key stakeholders included public and private sector customers, such as the library and town hall, Eureka and Industrial Museum and Westgate Arcade.

Delivery mechanisms	• Further optimisation of the preferred scheme to identify a viable solution • Progress the project to DPD stage, creating an Outline Business Case • Determine preferred contract and procurement strategy, will likely require a level of Council investment and ownership
Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

Huddersfield Town Centre District Heat Network	
Rationale for intervention	The project has the potential to deliver against Kirklees Council commitments to reduce carbon emissions, provide cost savings and deliver local economic benefits.
Project description	Huddersfield Council is developing the Huddersfield Town Centre heat network project, with a capital value of £26.7 million, and would connect the existing SITA Energy from Waste facility to Huddersfield Town Centre via 5.28 km of pipework.
Key outcomes sought	Success looks like a successful partnership with the EfW plant operator and a reliable heat source that strengthens the case for similar projects.
Potential carbon savings	The preferred scheme option is estimated to save 11,276 tCO_2 per year over 40 years, equivalent to 451,040 tCO_2 over the lifetime.
Funding sources	The project could access HNDU and the Accelerator funding to support further project development along with capital funding through HNIP through a grant or soft loan. The project is likely to require some form of capital investment from Kirklees Council through prudential borrowing.
Key stakeholders	Key stakeholders include Kirklees Council and SITA, who will likely both need to play a role in delivery of the scheme. Proposed connections include existing and planned council and public sector owned buildings and some private sector connections.
Delivery mechanisms	• Undertake DPD to develop a HMT compliant business case and seek Council approval • Engagement with customers to sign Heads of Terms agreements • Determine preferred contract and procurement strategy, will likely require a level of Council investment and ownership

Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

District Heat Network Pipeline Development	
Rationale for intervention	To continue to build a pipeline of viable district heat network project opportunities that can deliver environment, economic and social benefit to local people.
Project description	Delivery rapid heat mapping opportunity assessments to identify potentially viable projects for further development, this could include a focus on new development areas including special planning areas (SPAs) and town centres such as Selby, Skipton and Harrogate. In addition, the project could further develop schemes that have had earlier stage Energy Masterplanning and feasibility completed, including in York and Castleford.
Key outcomes sought	A new pipeline of viable district heat projects that have stakeholder support and will deliver local benefit.
Potential carbon savings	Carbon savings would depend on the nature of the projects being brought forward in the pipeline.
Funding sources	Funding sources could include HNDU, the Accelerator and local authority match funding, along with HNIP capital funding through grant or soft loan.
Key stakeholders	Key stakeholders would include the Combined Authority, local authorities and developers.
Delivery mechanisms	• Circulate a call to key stakeholders to identify potential project opportunities • Deliver early stage opportunity assessments as part of the pipeline development activities through the Energy Accelerator • Where viable projects are identified, they could be developed to financial close through the Accelerator, potentially alongside match funding from HNDU
Next steps	• Engage with stakeholders to determine detailed plan for delivery through the Accelerator

District Heat Network Financing Project	
Rationale for intervention	The Combined Authority has access to its own prudential borrowing, and may be willing to invest in district heat network projects,

	particularly where they are located in SPAs and deliver against the Combined Authority's own investment criteria.
Project description	There is a need to understand further potential financing and delivery models that could be employed in this circumstance and to identify suitable projects that the Combined Authority could invest in. This may include projects that have stalled because of a lack of resource or capacity in the local authority.
Key outcomes sought	The Combined Authority investing in and developing district heat projects across the LCR, particularly where these have stalled.
Potential carbon savings	Carbon savings would depend on the nature of the schemes being financed through the project.
Funding sources	Beyond the Combined Authority's own funding, funding sources could include HNDU, the Accelerator, along with HNIP capital funding through grant or soft loan and third party investor financing.
Key stakeholders	Combined Authority, local authorities, BEIS, investors
Delivery mechanisms	• Compare various models for delivery and select a preferred model • Identify preferred projects for delivery • Seek approval for investment
Next steps	• Undertake a project to compare various investor models and engage with the relevant decision makers and investors to determine a preferred approach.

H21 implementation, skills and supply chain	
Rationale for intervention	Whilst the UK has been successful in decarbonising electricity in order to contribute towards meeting its legally binding carbon reduction targets, we have made much less progress in decarbonising heat. One of the potential routes to decarbonising heat is through the conversion of gas grids to hydrogen. NGN are proposing to pioneer this approach in Leeds in a programme that would enter implementation in 2029. Whilst there remains a large amount of uncertainty with respect to the deliverability of this project, it offers a huge economic opportunity for the City Region to become a leader in this innovative technology area which has the potential to be replicated across the UK and beyond.
Project description	NGN are proposing to implement the pioneering H21 Leeds City Gate project, which would involve the conversion of the existing gas network in Leeds to 100 percent hydrogen, which emits zero carbon emissions at the point of use. It has been proposed that both the Medium

	Pressure and Low Pressure gas distribution networks within the area of conversion have sufficient capacity to convert 100 percent hydrogen. The conversion of the gas network to 100 percent hydrogen can be considered in three components; the hydrogen production and transmission system, the gas network conversion and the conversion of appliances: • For Leeds, NGN is proposing that demand for hydrogen is initially met through the installation of four Steam Methane Reformers (SMRs) located at Teesside, fitted with 90 percent carbon dioxide capture. The carbon dioxide would then be compressed and sequestered under the North Sea. • A transmission pipeline would be installed to transport hydrogen from the production site to the gas network in Leeds, with salt cavern storage along the transmission route, located north of Hull to manage demand. The existing gas network in Leeds would be segmented and converted from natural gas to hydrogen incrementally through the summer months over a proposed three-year period, in an attempt to minimise disruption. • The final component would require the installation of hydrogen appliances and equipment for the domestic, commercial and industrial sectors. There are already a small number of models on the market, but deployment levels are extremely low given the lack of demand. There would need to be a firm commitment to hydrogen conversion in order to stimulate the market to develop and manufacture this equipment at the scale that would be required. In addition, the availability of hydrogen in a network could pave the way for the widespread use of hydrogen vehicles, via fuel cells and fuel decentralised combined heat and power schemes. In order to maximise the retention of economic value from the development of this project, the Combined Authority could play a role in building local skills and capability. This could include the provision of local training and apprenticeships, promotion of the sector and engagement/matchmaking with the supply chain.
Key outcomes sought	Local economic value retained as a result of the implementation of this pioneering project.
Potential carbon savings	Excluding the transport sector (hydrogen for transport is considered under a separate project), the H21 project could cut emissions from the domestic and commercial sectors, resulting in an approximate carbon saving of 116 ktCO_2 per annum.
Funding sources	NGN are proposing to use a regulatory finance model in order to help to keep costs down, this is an established method of finance which allows for the amortisation and socialisation of costs, i.e. for the part of the cost of an asset that is written off as amortisation or depreciation. NGN already invests significant amounts in upgrading and replacing

	the existing gas network, with a £1.2bn REPEX programme over 8 years committed in their current Business Plan, this is a replacement expenditure required by gas distribution companies to comply with the Health and Safety Executives (HSE's) Mains Replacement Programme. It is proposed that the H21 project would keep impact on bills to a minimum, with a cost increase of no more than 30 percent, but potentially much lower than this. Stakeholders have expressed the view that this investment should not be compared to a "do nothing" BAU case, given the need to transform the way in which we heat our buildings in order to meet carbon reduction targets that we are committed to through the Climate Change Act. Rather, compared to alterative heat decarbonisation pathways through electrified heat, biogas conversion and heat networks.
Key stakeholders	NGN are the project promoter and implementer. There is a key role for government agencies including BEIS, HSE, Ofgem and others. The Combined Authority could play a role in facilitating supply chain engagement and the development of a regional skills programme in collaboration with universities and educational institutions. Other relevant stakeholders include the private sector supply chain, ranging from consultants to manufacturers.
Delivery mechanisms	In order to roll out hydrogen conversion at the scale proposed, significant work needs to be undertaken. There is a mixture of opinion regarding how feasible hydrogen conversion would be, with some challenging that grid conversion is an example of techno-optimism and might not offer the most cost effective solution for heat decarbonisation. Whilst the challenges are not insurmountable, there is a clear need for a policy position from government in order to provide more certainty and enable technology deployment. Nevertheless, if these risks and issues can be addressed, hydrogen has the potential to provide a significant proportion of the region's future heating demand, initially within the city of Leeds, followed by extension to other urban centres across the City Region and YNYER regions, particularly in Bradford within the City Region.
Next steps	• Engage with NGN to map out the potential supply chain for hydrogen and identify locally based organisations that could play a role • Engagement with the supply chain • Engage with universities and educational institutions to explore the potential for relevant training and apprenticeships to be developed

Public estate renewables programme	
Rationale for intervention	There is significant potential for renewable projects to deliver carbon reduction and local economic benefit through the growth of the existing local supply chain and skills development (e.g. through the integration of requirements to take on apprentices through contracting). The integration of renewable energy into the public estate demonstrates the sector leading by example and offers an opportunity to strengthen business cases through the aggregation of projects into larger portfolios across estates that have longer term certainty.
Project description	This project would see the public sector portfolio of buildings being utilised for the installation of renewable energy generation, through technologies such as solar PV, solar thermal, biomass and heat pumps. There is significant potential for the roll out of these technologies across the City Region. For example, building mounted solar is already an effective low carbon option for local authorities, with large sites such as schools becoming particularly popular. One report in 2015, identified that there are 4,232 current solar PV installations in Barnsley, with more than 300 council housing properties fitted with solar PV, generating 1.4 GWh electricity. The Combined Authority could work with the wider public estate to facilitate collaboration and provide technical assistance to undertake feasibility studies and develop business cases for investment.
Key outcomes sought	Success looks like a public sector building stock that is maximising its utility by covering its own electricity and heat needs and exporting to the grid.
Potential carbon savings	It has been assumed that if 10 percent of public sector assets were to generate their own electricity from renewable sources then there is a potential for 60 $ktCO_2$ to be saved annually.
Funding sources	The Combined Authority could explore funding options including through ERDF and UK Government to fund the establishment of a regional public sector renewables programme. Pipeline development could be delivered the Accelerator with an additional opportunity to undertake discrete studies through the Energy Hub. Projects can additionally access funding to facilitate implementation through the RE:FIT framework using an Energy Performance Contract (EPC) model or through Power Purchase Agreements (PPA) and the Feed-in-Tariffs (FiT) Scheme (although the government is currently consulting on the closure of this scheme in March 2019). The Enterprise Investment Scheme (EIS) offers up to £5 million in investment, provided by private investors who receive a tax break in return, supporting projects that earn lower than full commercial rates of

	return. This scheme has been around since 2004 but was recently highlighted as source of funding specifically for energy generation schemes.
Key stakeholders	The Combined Authority could play a role in facilitating collaboration between the wider public sector across the City Region to identify and implement projects. Other key stakeholders include universities, hospitals, local authorities, schools and the wider public estate who could play a role in developing and investing in projects.
Delivery mechanisms	Given the upfront capital costs involved in installing renewable energy technologies, an effective method could be to use a payback contract-based financial model, through an Energy Performance Contract. This could see a private investor or energy company paying the initial installation costs, before being reimbursed by the income generated from sale of electricity (e.g. to the grid or local private wire customers). The investor ultimately receives a profitable return on their investment, whilst the public sector body is able to deploy more renewable energy assets than otherwise possible.
Next steps	• Conduct a broad, detailed resource potential and feasibility study for public sector assets of City Region, identifying key projects to take forward to business case development. This could include whole estate opportunity assessments to prioritise sites for initial feasibility, energy data analysis, benchmarking, site audit and desk based modelling and options appraisals. This could be delivered through the Accelerator and Energy Hub.

Community Energy Schemes	
Rationale for intervention	Community energy schemes offer a constructive solution to tackling problems associated with energy security and consumer cost. There is a large opportunity to deploy community energy projects in both urban and rural settings across the City Region.
Project description	Community energy covers a wide variety of different schemes, such as: • Renewable energy installations, owned by the community, and often installed, maintained, operated, and decommissioned with help from the local workforce. These schemes can profit from subsidies such as FiTs and the RHI. • Collectively switching energy provider, in order to get the best deal for the community. • Community engagement to try to reduce energy usage, through improved efficiency measures. This can be applied domestically, commercially or within public sector bodies.

	• Engagement with the local authority to consider local heat networks, these projects can be supported through the rural community energy fund Projects will likely continue to happen at a slow rate without the intervention of the Combined Authority. However, there is a range of actions that could be taken to provide support and facilitate the growth of the community energy sector. These include: • Encourage local action and promote community energy • Develop Low Carbon Neighbourhood Plans (LCNP) • Sharing resources • Facilitating collaboration amongst the sector The Combined Authority could also consider the possibility of establishing a Community Energy Fund for the City Region, providing grant support to support the development stages of community energy projects. This could include conducting feasibility studies and developing investment-ready business cases. For example, the Greater London Authority (GLA) has established its own London Community Energy Fund, which aims to increase the number and positive impact of community energy projects across London.
Key outcomes sought	The implementation of a growing number of community energy projects in the City Region.
Potential carbon savings	Assuming the communities will not fund projects that would not be eligible for FiT limits the maximum generating capacity, as outlined by Ofgem. If two larger scale projects per year are funded then there is an approximate potential annual saving of 4 $ktCO_2$ available.
Funding sources	There are a wide range of existing funding sources available to community energy groups seeking to develop low carbon and renewable projects. This includes Innovate UK's open grant competition and the Rural Community Energy Fund, which provides feasibility grants and development loans to community renewable energy schemes in rural locations. In addition, there are a range of banks that will provide finance to community energy project, including Pure Leapfrog, Tridos Bank, Charity Bank and Coop; along with community group funds that will provide grants, including Big Lottery Fund, Greggs Foundation and Joseph Rowntree Foundation. In future, there are opportunities available to businesses looking to develop smart, localized energy systems and prove their use at scale through the Industrial Strategy Challenge Fund (ISCF) led by Innovate UK.
Key stakeholders	The Combined Authority, local authorities, Community Energy Groups, Community Energy England, Northern Powergrid (resources and advice on connection to the grid)

Delivery mechanisms	Help community energy groups access development support to develop investment ready business cases that catalyse the implementation of community energy projects, the Combined Authority could either play a facilitator role or more directly in the management of a community energy fund.
Next steps	To engage with the relevant stakeholders in order to determine their appetite and capacity to be involved in such a programme.

Carbon budgets and carbon management plans	
Rationale for intervention	In line with commitments outlined in the Clean Growth Strategy, the UK government released its 'Emissions reduction pledge 2020' report. Within this it was outlined that the government has set a voluntary target for public sector bodies to meet a 30 percent reduction in emissions in their own estate by 2020/21 (against a 2009/10 baselines). BEIS are encouraging ambition from the public sector with respect to emissions reduction, and developing carbon budgets and carbon management plans across the City Region would demonstrate a leading level of commitment.
Project description	Implement carbon budgets and carbon management plans across the City Region, setting targets and performance indicators, regularly reviewing progress, engaging staff and removing barriers, do public reporting and working in partnership to wider influence.
Key outcomes sought	A clear commitment from all councils across the City Region to reduce emissions from their own activities and showcasing a high level to commitment to the rest of the UK.
Potential carbon savings	If the 30 percent target reduction pledge is met across 80 percent of all public sector owned assets then a significant amount of carbon could be saved annually. Assuming the target is not met till 2036, then the average annual approximate carbon savings from this would equal 180 $ktCO_2$.
Funding sources	Own local council budgets and BEIS.
Key stakeholders	BEIS, Combined Authority, local councils
Delivery mechanisms	• BEIS 'Emissions Reduction Pledge 2020': BEIS will be consulting with the public sector throughout 2018 to inform the development of a Future Action Plan for the Public Sector, due to be published in 2019 and to determine the future of the Emissions Reduction Pledge beyond 2020.

	• The Combined Authority could facilitate conversations with individual local councils to set carbon budgets and management plans
Next steps	BEIS have indicated that they will trial the voluntary target before determining whether to make any amendments to the scheme, possibly including the introduction of the target as a mandatory requirement. City Region and local councils to take part in the BEIS consultation process to feedback local requirements that arise from the engagement surrounding the development and implementation of this Energy Strategy.

Green bonds for financing renewables energy projects	
Rationale for intervention	The UK Green Finance Taskforce issued a series of recommendations to the government in its March 2018 Accelerating Green Finance report, including driving the demand and supply for green lending products and issuing a sovereign green bond. Councils should use bonds to fund green energy infrastructure projects as they enable to build projects that otherwise may not get off the ground due to investment gaps. Green bonds incorporate both social and environmental impacts in their value stream, the proceeds can be used flexibly across a variety of renewable energy and energy efficiency projects, and typically represent a lower cost of finance than other alternatives, such as bank financing or private equity, and pay a higher interest rate.
Project description	Develop a green bond business model to support the ongoing transition to renewable energy. Enable the Combined Authority to raise finance across a portfolio of projects.
Key outcomes sought	Enable smaller projects such as community energy projects to access low cost capital through the aggregation of projects. Key success factors would be to scale up activity and stimulate productivity by progressing projects that create jobs, and by delivering new generation capacity.
Potential carbon savings	It is anticipated that green bonds could have the potential to fund several projects per year towards the upper end of FiT capacity renewable energy installations (5MWe solar PV). This would result in approximate carbon savings of 12 $ktCO_2$ per annum.
Funding sources	Bonds are a form of long-term debt in the form of a legal contract that can be traded between parties and can be issued by both private sector and public sector parties. Potential buyers include councils across the City Region, investors, residents across the City Region, White Rose Energy as public entities such as ESCOs can also issue green bonds, and Yorkshire Water

	considering there is room to (re)finance assets and projects through green bonds
Key stakeholders	Municipalities, states and other public sector entities such as utilities and transport companies can provide strategic issuance to support the growth of the green bond market. Pioneers: such as Swindon Borough Council who in 2016 became the first council in the UK to issue a solar bond to fund a 4.8MW community solar farm Investment groups: in Swindon the bond issue was being organised by Abundance The Combined Authority, councils across the City Region and local citizens.
Delivery mechanisms	• Green bonds are the most useful when there is an assured and sufficient pipeline of projects identified or where the initial projects have already been undertaken. The Combined Authority could work with other stakeholders mentioned above to identify a list of projects across a portfolio of local heat, electricity, and transport projects. Green bonds could be used to finance the projects identified through the Accelerator for instance • Engage with pioneers such as Swindon for knowledge transfer and lessons learned (French and Swedish municipalities are also worth engaging with - Gothenburg issued the first Green City bond in October 2013) • Investigate the potential to leverage business rates taxes as this approach was used to support bonds for Crossrail • Engage with retail investors
Next steps	If it is decided to bring this proposition forward, the key driving stakeholders will need to set up a measuring, reporting and verification (MRV) plan to ensure the use of proceed of bonds are spent on green projects.

Priority 3. Energy efficiency and empowering consumers

Improve Local Plan housing policies	
Rationale for intervention	One of the most effective ways to drive up energy efficiency standards in new buildings is to make use of the local planning system. In recent years, the UK has seen an increasing pressure to speed up house building against the backdrop of a policy shift as initiatives such as Zero Carbon Homes were scrapped and a belief that building homes more efficiently adds additional cost that threatens housing viability. Additionally, the Deregulation Act 2015 removed powers granted in the Planning and Energy Act 2008 for Local Planning Authorities (LPAs) to require energy efficiency standards that exceed Building Regulations. Whilst the Deregulation Act has still to this day not been enacted, this led to many LPAs feeling limited in their ability to use local planning

	policies to drive improvements in the energy efficiency of new housing stock. The UK Clean Growth Strategy signalled a recent ramping up of ambition on this agenda, outlining a clean growth mission to halve the energy usage of new buildings by 2030. In their consultation response to the revised National Planning Policy Framework (NPPF) the government included the following statement to attempt to give LPAs the confidence to set more ambitious policies in their Local Plans: "The Framework does not prevent local authorities from using their existing powers under the Planning and Energy Act 2008…local authorities are not restricted in their ability to require energy efficiency standards above Building Regulations."
Project description	It is recommended that LPAs across the City Region review this information and seek to introduce policies that give support for housing energy efficiency standards that go beyond Building Regulations. A good practice example for incorporating energy into Local Plans and ensuring developers take required steps to consider sustainability measures in new developments is a Sustainability Checklist, in use for instance by the London Borough of Richmond upon Thames. This mandatory SPD ensures all aspects of energy use in new build are considered, and mitigation measures put in place. Another step LPAs can take to strengthen Local Plans is the inclusion of energy hierarchies for developers. These hierarchies define a list of due diligence steps developers have to follow prior to installing heating and cooling technologies in homes.
Key outcomes sought	Success looks like a local planning system that helps to drive improvements in housing energy efficiency, deliver cost savings to residents and encourages the development of a highly skilled construction workforce. Engaging and informing developers at an early stage and mandating the checklist as part of the planning application has significant benefits: building works will increasingly contribute towards local sustainability, helping create towns, which will adapt to climate change as well as mitigate its effects; and measures will be implemented towards improving cost efficiency of the buildings, minimising their environmental impact, and improving quality of life for residents.
Potential carbon savings	If new local planning policies required that all new builds were to meet and EPC A standard, then this could result in potential annual savings of 19 ktCO2 in comparison to if new builds had an energy consumption equivalent to the average LCR domicile.
Funding sources	Local authorities own budgets
Key stakeholders	Local authorities planning and housing departments, and the Combined Authority playing a role in facilitating this discussion at a City Region level.

Delivery mechanisms	• Combined Authority to facilitate a conversation amongst planning representatives at City Region level to discuss the implications of this and develop policies for inclusion in Local Plans
Next steps	Ensure local plans and SPD are modified to include sustainability checklists, energy hierarchies and requirements above Building Regulations.

Promote sustainable design and construction	
Rationale for intervention	England has been suffering from a shortage of new homes and a high demand for housing nationally. To address the 'broken housing market', the government released its Housing White Paper. The plan estimates that England will need between 225,000 and 275,000 new homes per year, compared to the 160,000 currently built annually. This means we still need to build a further 8 million homes to meet demand, which presents an opportunity for action. We need to consider new developments within the context of the UK Climate Change Act and associated carbon budgets. If we want to achieve 80 percent reductions in emissions by 2050, we need to embed sustainability into new developments.
Project description	The rise of off-site modular construction methods and Passivhaus construction represents an opportunity for sustainable new build across the City Region that should be considered further.
Key outcomes sought	Modular housing is said to provide benefits such as speed and quality of build and a reduction in construction waste.Improving household energy efficiency may add some additional upfront cost, but when assessing the lifecycle costs of a building, typically offers a much more cost-effective solution. In addition, upfront costs will reduce as the deployment of more efficient building materials and technology solutions becomes widespread. A Passivhaus aims to achieve thermal and occupant comfort with passive measures, including good levels of insulation, passive solar gain, and internal heat sources, high levels of airtightness, and good indoor air quality.
Potential carbon savings	Assuming all new houses are to be built to a Passivhaus standard, and with new houses being built at a rate outlined by the LEP then annual savings of 4 ktCO2 are available. This also assumes that the alternative to the Passivhaus standard would be building homes that consume the same amount of energy as an average dwelling in the City Region.
Funding sources	In the 2017 Autumn Budget, the Government announced that it will unlock at least £44 billion of capital funding, loans and guarantees to support the housing market across new skills, resources, land and developments.

Key stakeholders	Local authorities planning and housing departments, house builders and developers, building societies and housing associations, technology providers.
Delivery mechanisms	• Combined Authority to work with individual local councils to investigate the potential to apply for the Government new housing funds
Next steps	Engage in conversations with builders of modular and Passivhaus homes and investigate the roll-out potential across the City Region.

Scaling up Better Homes Yorkshire	
Rationale for intervention	Following the success of the BHY programme, there is a potential opportunity to scale-up the delivery by continuing to focus on affordable measures delivered to large numbers of houses through a collective approach.
Project description	This could include the widespread rollout of retrofit fabric insulation and heating measures combined with new generation for households where it is suitable. A public awareness raising campaign could be rolled out as part of the programme.
Key outcomes sought	Success looks like delivering break-through levels of deployment of cost-effective household energy efficiency measures and a strong local and skilled workforce. The programme would improve living standards and combat deprivation. In addition, the programme delivers strongly against creating skilled jobs by broadening and scaling up the portfolio of efficiency projects across the region.
Potential carbon savings	Assuming the BHY programme continues at its current rate of delivering energy efficient measures (with an energy efficiency increase of 20 percent as reported) then the programme will continue to save approximately 2 $ktCO_2$ per annum.
Funding sources	Funding from the original BHY was brought together from multiple sources, including national government (Green Deal Communities, Central Heating Fund), Growth Deal, local authority capital plans, ECO, customer contributions and National Grid.
Key stakeholders	Combined authority, councils, private property owners, residents, supply chain
Delivery mechanisms	• Continue to secure additional funding streams to scale up the scheme, such as ECO, national government and Local Authority Capital Plans
Next steps	As this project is only a concept, further work is required to understand the target audience for the scheme, such as but limited to areas of deprivation and fuel poverty.

Whole system domestic energy efficiency retrofit demonstrator	
Rationale for intervention	Bring considerable cost-effectiveness through the geographic concentration of the measures, and the ability to mass procure equipment and labour. Several local authorities have successfully run similarly 'grouped' domestic energy efficiency projects, often rolling measures out street by street. Nottingham City Homes, the Arm's Length Management Organisation managing and maintaining Nottingham City Council's council housing stock, has become the first in the UK to adopt an approach to retrofitting housing solutions, known as "Energiesprong". The Energiesprong approach involves wrapping an existing property with pre-fabricated wall and roof panels.
Project description	This project looks to take a whole village or neighbourhood and deploy 'whole-system' energy efficiency measures to achieve a high level of efficiency.
Key outcomes sought	Success looks like positive buy-in from local residents, with energy bills markedly reduced and a demonstrator model that is replicable. The main aims are to establish a supply chain, to achieve 95 percent emissions reductions in homes and SAP A+. Domestic energy efficiency measures provide a key uplift to living standards, through thermal comfort and lower energy bills, in particular for fuel poor households. Installation would also provide a demand for skilled workforce.
Potential carbon savings	If a 95 percent energy consumption reduction is achieved for a limited number of council owned properties then a potential annual carbon saving of 11 $ktCO_2$ could be possible.
Funding sources	Potential funding sources including the Transition Zero Horizon 2020 project or other innovation funding.
Key stakeholders	Combined authority, local councils, housing associations, supply chain
Delivery mechanisms	• Engage with organisations that could play a role in delivering such a programme and explore funding opportunities • There could also be potential to interact with the P.e.t.e (Power. Energy. Technology. Efficiency.) project. This £2.5 million BEIS and Innovate UK project is looking to provide balancing to the grid and improve domestic efficiency through integrated home batteries, intelligent hot water tanks and cloud DSR services. This has been focused around Cornwall and London thus far, offering scope for expansion to the North.
Next steps	In light of the investigation into the Grenfell fire, and confirmation of the exacerbating factor of 'cladding', it is essential that robust safety

	processes' are in place to ensure suitable materials are being used for external cladding measures.

Public sector retrofitting	
Rationale for intervention	In the context of sustainable planning and transforming the City Region, public-building retrofit plays a key role. The mass rollout of LED across public sector premises has already been done to great effect by many local authorities across the UK, such as Kent, Surrey, Flintshire and Dundee.
Project description	Public sector retrofitting to improve energy efficiency performance across local authority portfolios. Sites could be council buildings, schools, hospitals, social housing etc. Focus on energy efficiency measures for retrofit and on energy management systems (EnMS). A sub-project suggested was the mass rollout of LED lighting alongside smart control, such as motion and daylight sensors across local authorities' entire building stocks where this has not already taken place.
Key outcomes sought	The policies for retrofit change of use and consequential improvements are designed to improve the energy efficiency of buildings, reducing operational energy costs and CO_2 emissions. Reduce the cost of energy for the public sector to increase its disposable budget. Help achieve targets in local authorities' sustainable energy action plans.
Potential carbon savings	LEDs lose a fraction of the energy that conventional fluorescent lights do through heat loss, and in total use approximately 5 percent of the energy a conventional light would consume. Retrofitting of just 10 percent of council owned buildings could yield an estimated 30 $ktCO_2$ per year, assuming similar energy savings are available to those seen in better home Yorkshire and the resource efficiency fund programme.
Funding sources	ESCOs, local authority budget, Public-Private Partnerships (PPP), EU structural funds and funding programmes, mortgage lenders, credit unions. LED lighting projects typically have pay back periods of less than three years, and more often than not of less than one year, meaning that a strong business case can be made for investment without the need for financing. A new government pilot project, Modern Energy Partners, will explore novel ways to drive more ambitious efforts to drive down consumption and emissions across the public-sector estate.
Key stakeholders	Combined Authority as driver for the initiative, local authorities within the City Region as coordinator of the initiative, funders such as local ESCOs, community energy groups, social landlords and housing associations, and central government

Delivery mechanisms	• Use energy audits and energy data to analyse consumption in different public estates • Select the buildings for the implementation of the energy efficiency measures, prioritising those with high energy consumption and replicability potentials • Procure the works to external advisers
Next steps	Use existing energy management steering committees or project board within local authorities to implement the retrofitting programme and engage in a PPPs, widely used to yield energy savings in the public sector.

Priority 4: Smart grid systems integration

Full fibre infrastructure	
Rationale for intervention	The UK government has made a commitment for the country to be 'full fibre' (100 percent coverage) by 2033. This Leeds-Huddersfield link can form the basis of new fibre infrastructure across the City Region that will boost productivity and connectivity, enable the deployment of carbon saving technologies, and provide a foundation for the deployment of future '5G technology'. This includes cloud computing, 'machine-to-machine' communications and other smart transport solutions. The City Region is an area of digital strength in the UK, with a skilled IT and telecommunications workforce. These skills can be leveraged and developed further to attract future investments and growing the specialised workforce.
Project description	The Combined Authority are developing a Local Full Fibre Bid to implement a fully connected, council-owned fibre link between the West Yorkshire's local authority data centres, with one in Huddersfield and one in Leeds connected to IX Leeds and Manchester via the Transpeninne Fibre upgrade project. The fibre cable would follow the route of Key Route Network roads and will interconnect the existing council's existing duct assets (underground cable holder) that is 'open-source', therefore reducing the number of trenches dug to install the various cables of modern infrastructure. The City Region could both support this project through to completion, as well as extend it across the region linking more urban centres and providing the infrastructure foundation for pan-regional next generation smart technology deployment. This could include the integration of blockchain technology, for which full fibre is a key enabler, and which is already being deployed by Transport for London (TfL).
Key outcomes sought	City Region becoming the location for a number of innovative 'next generation' digital connectivity projects, delivering cutting-edge pilots.

Potential carbon savings	The potential carbon savings for this project are not yet known due to the limited availability of data for such technology.
Funding sources	Kirklees Council is seeking funding from the Department for Digital, Culture, Media & Sport (DCMS), given the 2033 target the UK government should be the main target for funding. In additional, the National Digital Infrastructure Fund, is an element of the UK government's £400m Digital Infrastructure Investment Fund, which focuses on accelerating full-fibre network development. In addition, the National Productivity Investment Fund was increased in the Clean Growth Strategy to over £5 billion in 2020/21, it focuses on upgrading infrastructure of all kinds. Money is directed towards housing, transport, fibre networks and R&D. This offers an opportunity to apply for funding to improve infrastructure whilst simultaneously receiving grants to boost renewables that can provide the energy for the new housing or transport infrastructure.
Key stakeholders	Kirklees Council is currently formulating the project, however the Combined Authority could be effective in extending it, bringing in more actors. DCMS is the target financier, however private connections to the fibre cable could also provide capital. Road infrastructure companies need to be consulted for the work itself.
Delivery mechanisms	The Combined Authority can occupy a role as project sponsor for the initial Hudderfield-Leeds phase, before deploying a 'Whole System' approach to planning the extensions. This will account for all the considerations, criteria and impacts of extending full fibre, allowing the network to be progressed forward with the most efficiency and benefit, overcoming potential challenges at the design stage. There could also be potential to interact with the P.e.t.e project, which is developing cloud DSR services, but has been focused around Cornwall and London thus far.
Next steps	• Confirm backing of the Kirklees Council project, and assist in the financing drive to win DCMS support • Identify key urban centres, data centres and busy transport routes connecting them, and plot potential extensions to this project

Street lighting programmes	
Rationale for intervention	The City Region has over 265,000 streetlights. Most councils have already looked into LED replacement and several have schemes underway: • Calderdale council is replacing 11,000 lighting columns and 19,000 lanterns

	• Kirklees is installing 30,000 LEDs and has set the target of being 100 percent LED by 2021. Plans for the replacement of around 86,000 streetlights across • Leeds are due to be submitted to the city council's decision-making executive following a public consultation. There is considerable scope for the expansion of these schemes; however, councils are financially constrained and need assistance.
Project description	Accelerated LED replacement, smart lighting controls and networked solutions, being rolled out across local council zones. There are also strong opportunities to incorporate smart infrastructure options such as 5G/fibre connectivity, air quality sensors, and traffic monitoring equipment.
Key outcomes sought	Improving the efficiency of street lighting across the City Region, delivering significant cost-savings. Developing a skilled workforce. Success looks like the comprehensive roll out of LED street lighting across the City Region, combined with smart technology and controls, with a scheme in each borough. Street lighting programmes have been highly successful elsewhere in the UK (Dundee, Kent, Surrey and Flintshire), bringing large energy savings, reliability that helps safety and a potential economic opportunity for local businesses.
Potential carbon savings	If all 265,000 street lights in the Leeds city region were to be switched to LEDs (reducing the wattage to 20 percent of its current value), and have the capability to reduce the hours of operation by 40 percent (this could be achieved also by having longer periods when lights can be dimmed), then approximately 100 $ktCO_2$ could be saved annually.
Funding sources	Projects could benefit from project development support through the Energy Accelerator and financing support through RE:FIT. Some business cases may also be investable without the need for funding support due to favorable paybacks (on average 5-10 years). Potential funding sources include Salix Finance, the UK Green Investment Bank – Green Loan for Local Authorities / LED Financing Product, Department of Transport Challenge Fund, John Laing Infrastructure Fund, and the National Digital Infrastructure Fund, an element of the UK government's £400m Digital Infrastructure Investment Fund (relevant to smart lighting).
Key stakeholders	The Combined Authority, local councils, Highways England residents, technical contractor for installation.
Delivery mechanisms	• A number of street lighting projects have been identified in the Energy Accelerator pipeline, but there remains a need to undertake additional project identification, feasibility and procurement

	• The Combined Authority would be a natural lead to coordinate this activity, working alongside each of the City Region Local Authorities • Project appraisals to consider dimming and trimming strategies, assessment of CMS (Central Management System), part night lighting, and maintenance programme improvement • The full range of energy saving capital upgrades will be considered, including column upgrade and SON and SOX lighting replacement with energy efficient LED lighting
Next steps	Next steps could be to identify which council schemes can be extended through capital assistance, and which others require detailed project identification and planning in order to deliver LED replacement

Solar carports	
Rationale for intervention	There are 4,500 privately owned parking facilities in the UK and hundreds of large-scale shopping centres, therefore solar carports are a large untapped resource. The Bentley Solar carport in Crewe is a model that the City Region can adapt to their specific needs. FlexiSolar is delivering this 2.7MW solar canopy project, with financing coming through a PPA with Bentley Motors's nearby factory. The success of this programme in the City Region could further drive the business case forwards for rolling out electric vehicles, including buses.
Project description	Installing solar PV canopies above car parking spaces, providing space efficient renewable generation. The electricity generated can be used for lights, EV chargers, powering nearby buildings, exporting to the grid via FiT (subject to removal) or storage in batteries. This storage can be used to charge/discharge for maximum export financial benefit, or to give the carport more flexibility, reducing grid reliance.
Key outcomes sought	Several solar car port projects across the City Region, successfully integrating generation, storage and transport infrastructure.
Potential carbon savings	Solar carports could result in approximate carbon savings of 2 ktCO2 per annum, if similarly sized solar canopies to the one described in Crewe are installed at a rate of two car ports per year.
Funding sources	Private consumers nearby through private wire export or Power Purchase Agreements (PPAs), local authorities, energy service company, transport provider (e.g. Arriva), Charging Infrastructure Investment Fund
Key stakeholders	The Combined Authority, local authorities, landowners, District Network Operators (DNOs) etc.

Delivery mechanisms	• Engage with Nottingham City Council has already delivered two solar carports, collaborating with two private companies – Flexisolar and EvoEnergy • Take extra steps to minimise disruption and avoid any danger to the public due to the sites being frequently used carparks outside public buildings • Complete the installation in staggered phases to keep as many car parking spaces open as possible
Next steps	Identify car parks across the City Region that might be suitable, conduct feasibility studies that will give a prioritised list for which business cases should be developed.

Whole energy system approach pilot	
Rationale for intervention	A 'whole system' approach takes into account all inputs and outputs of the energy sector. Energy planning in new developments is a particularly suited project for this approach. It is considered the most cost-effective means of integrating low-carbon technologies, and can future-proof the development. It can also involve demand matching new developments with on-site generation, improving the attractiveness to investors and minimising any potential strain on the local grid.
Project description	This project would identify new early-stage developments in the City Region that are well-suited for this approach and could gain some benefits from its application. It would then select one particular case as a pilot, and use it to demonstrate the commercial benefits of 'whole system' planning to developments, stimulating its further use.
Key outcomes sought	Completed construction and operation of a new development that has used a 'Whole Energy System' approach to deploy low carbon technologies in a carbon reducing and commercially successful manner.
Potential carbon savings	Given the conceptual nature of this project, and the lack of current data available, it is not possible to offer a potential carbon saving for this project.
Funding sources	The Whole Systems Networking Fund (WSNF) is a £31 million fund that provides support for projects developing connections across interdisciplinary research, industry and policy makers, and making an impact on whole systems energy research. A new government pilot project, Modern Energy Partners, will explore novel ways to drive more ambitious efforts to drive down consumption and emissions across the public-sector estate.

Key stakeholders	Local authorities, planning officials, private housing associations/developers, 'Whole Energy System' academics
Delivery mechanisms	The pilot could be delivered through a consortium of the local authority, researchers, developers and technical experts. The planning department of the council or the Combined Authority would have a strong voice in being able to place certain considerations on a planning permission request. There could also be potential to interact with the P.e.t.e project. This £2.5 million BEIS and Innovate UK project is looking to provide balancing to the grid and improve domestic efficiency through integrated home batteries, intelligent hot water tanks and cloud DSR services. This has been focused around Cornwall and London thus far, offering scope for expansion to the north.
Next steps	• Identify the City Region's planning/pre-planning stage developments • Create a shortlist of those most suitable and then select one development that agrees to be a pilot to test the commercial effectiveness of this approach • In applying for the Whole Systems Networking Fund (WSNF) bring in varied stakeholders to contribute to the detailed project plan and business model

Energy storage for council-housing mounted solar PV	
Rationale for intervention	Leeds City Council has installed over 1,000 solar PV units on council-owned housing in the City Region. Battery storage allows for the capture of intermittent electricity, delivering a reliable supply at times of low generation (e.g. at night), or enabling that electricity to be sold at particular times of high-demand. This will increase the resilience of local residents electricity supply, and through off-peak and peak charging and discharging, will generate capital to lower residents own electricity bills.
Project description	The local authority will identify housing blocks and estates with high-density solar PV, and conduct feasibility studies to confirm the measurable benefits of the batteries to the residents and the local grid. Following this, battery storage will be installed at selected high-density locations to provide flexibility and maximise the solar PV utility.
Key outcomes sought	Localised grid pressure eased, reliable, cheaper energy for residents, income generated from discharging pays back battery costs and become source of council income, project extended, with storage considered alongside all future whole-site generation installations.

Potential carbon savings	Assuming electrical storage capabilities were installed for all sites where solar PV units have been installed, then a further 1 $ktCO_2$ could be saved annually. This assumes that 50 percent of the energy generated from solar PV is stored and also takes in to account inefficiencies within the electrical storage system.
Funding sources	• BEIS Innovative Domestic DSR Competition, offers grants of £30,000 for 10 week feasibility studies, and £250,000-£1 million for demonstration projects • Innovate UK, Research Councils and BEIS are expected to invest around £265 million in smart systems research, development and demonstration • As part of this, the BEIS Energy Innovation Programme is investing up to £70 million in the smart energy systems innovation theme • PPAs or export payments from the balancing market could also provide revenue streams
Key stakeholders	Residents' associations, local authorities, DNOs
Delivery mechanisms	• Implementation could be facilitated through the RE:FIT framework or a similar managed list of reliable suppliers • These projects could be delivered utilising some form of Energy Performance Contract, guaranteeing the income generated from the storage and shifting risk away from the council
Next steps	Identify the council-owned housing with high-density of solar PV installations, and apply for funding to commission feasibility into storage deployment and its benefits.

Smart Leeds City Region	
Rationale for intervention	The City Region has a skilled technical and digital workforce, alongside a strong IT sector. In addition, there are numerous sources of funding available for innovation and demonstration projects, including national government grants and competitions, international funding and research grants. Though some progress in rolling out smart technology has been made in the City Region, it has not met the potential of the area, or maximised the local resources available.
Project description	'Smart Leeds City Region' would be an innovation kick-starter project, aimed at delivering a large number of energy system pilot and demonstrator projects in the City Region. It would accept proposals from local authorities, community groups, housing organisations and

	private companies, and match them up with national financing opportunities. Projects could include: Vehicle-to-Grid (V2G), domestic batteries, EV chargers with in-built batteries (offering grid balancing when not in use), DSR, or smart kinetic roads.
Key outcomes sought	Success would be a dozen innovative pilot or demonstrator projects relating to energy systems connected with national financing and taken through techno-economic feasibility and detailed project development to financial close.
Potential carbon savings	Given the wide scope and conceptual nature of this project it has not been possible to calculate a reasonable, accurate carbon saving for this project.
Funding sources	• Innovation in Vehicle-to-Grid V2G Systems Competition, a £20 million fund for EV-to-grid products, services and knowledge projects • BEIS Innovative Domestic DSR Competition, offers grants for feasibility studies, and for demonstration projects • BEIS Energy Innovation Programme is investing up to £70 million in the smart energy systems innovation theme • Canada-UK Smart Energy Systems Challenge, is a joint challenge on smart grids and energy storage, totalling just over £11 million, under development • The Non-Domestic Smart Energy Management Innovation Competition driving innovation in the energy service market for hospitality, retail and schools • Government competition on local flexibility markets for feasibility studies on innovative approaches to value and trade flexibility in the UK energy system • BEIS phase two of the Smart Systems and Heat Programme run by the Energy Systems Catapult, supporting domestic low carbon heating projects • Smart Meter Enabled Thermal Efficiency Ratings (SMETER) Innovation Programme, to develop, test and demonstrate technologies that measure the thermal performance of homes using smart meters • Other Innovate UK and WSFN
Key stakeholders	Local authorities, housing associations or community organisations, developers DNOs, energy service companies, universities and research institutions, BEIS, the local industrial/technology/digital sectors.

Delivery mechanisms	The Combined Authority could play a brokering role, connecting innovation projects with financing options and using its profile to attract interest, potentially incorporating elements of the Accelerator.
Next steps	Confirm an initial list of funding opportunities and request proposal submissions from across the City Region. Those proposals that do match can then be taken forward to a more detailed stage of project preparation.

Priority 5: Efficient and integrated transport

Smart Leeds City Region	
Rationale for intervention	There are now hydrogen vehicles (including cars, buses, lorries and trains) available for purchase. However, uptake of these vehicles are slow due to a lack of hydrogen refuelling facilities across the City Region. There is a need for a project that demonstrates these innovative technologies – both in terms of hydrogen vehicles and fuelling stations. The establishment of the initial project will also provide a foundation for developing integrated 'smart' systems linking hydrogen generation, storage and use, potentially building out H21. The main strengths of this project is in demonstrating innovative technologies – both in terms of hydrogen vehicles and integrated 'smart' systems linking generation, storage and use. In addition, a key strength of the project is its potential to create economic growth, building on H21 to create a specialised workforce in the City Region. This local economy would provide a new clean vector of energy, reducing the strain of huge numbers of new EVs on the grid, and laying the foundations for further green growth. Hydrogen generation for use in transportation systems is not well established yet, and systems like these are relatively novel, therefore the time scales are expected to be longer term.
Project description	This project will deploy hydrogen buses on one City Region bus route, and build two hydrogen refuelling stations, one at each end of the route. It will then enable the incorporation of several hydrogen-powered cars into the fleets of the local authorities, home to these two refuelling stations. The initial target areas that have been identified are Barnsley town centre and Leeds city centre. Building this out further, following the initial transport and infrastructure development, this project will seek to generate hydrogen via electrolysis using local CHP, wind turbines or solar farms, and ultimately integrate with the H21 project (should it go ahead) to import hydrogen into the City Region from the Tees Valley. This larger fuel supply would support the hydrogen switching of more bus routes, and the development or more fuelling stations. This public leadership could then catalyse the widespread roll out of private hydrogen vehicles.

Key outcomes sought	Displacing fossil-fuelled vehicles from the road improves air quality and increasing public transport reduces congestion. Developing hydrogen infrastructure could create economic growth, this could be explosive if combined with H21. It would create a specialised workforce in the City Region, reduce the strain of large numbers of new EVs joining the grid, and laying the foundations for further green growth. Success looks like hydrogen infrastructure built, supporting a reliable hydrogen-powered bus route and a number of council fleet vehicles, with plans afoot to extend to other bus routes and council fleets.
Potential carbon savings	If the Leeds city region is to encourage the uptake of hydrogen vehicles at the rate outlined in the scenario model, and build the necessary infrastructure to accompany the H21 project then the potential carbon savings per year can be estimated as 874 $ktCO_2$. This is without any increases in electric vehicle numbers, and hydrogen vehicles replacing petrol and diesel vehicles.
Funding sources	• Office of Low Emission Vehicles' Hydrogen for Transport Programme will provide £23 million in grant funding until 2020 to support growth of refuelling infrastructure alongside new vehicle deployment • BEIS £20 million Hydrogen Supply Programme • UK H2 Mobility, H2ME Initiative, Fuel Cells and Hydrogen Joint Undertaking, and Fuel Cell Electric Vehicle Fleet Support Scheme
Key stakeholders	The Combined Authority, local authorities (Barnsley and Leeds city councils), local bus providers, Highways England, NGN (H21), BEIS
Delivery mechanisms	• Given the complex multi-stakeholder nature of the project, establishing a hydrogen innovation hub for facilitating discussion between stakeholders such as NGN, Transport for the North (TfN) and local transport operators would be beneficial • The Accelerator could be useful as the umbrella through which the different project elements (vehicles and fuelling) can be brought together
Next steps	Next steps could be to bring stakeholders together and identify a particular bus route for hydrogen switching. Then use this proposal to apply for government funding to conduct a feasibility study, this will feed into a detailed project plan that can be the basis of further grant funding applications.

EV charging and infrastructure	
Rationale for intervention	Leeds City Council and the Combined Authority won funding to install charging points for taxi and private hire vehicles, with 40 charge points (22 rapid) for Leeds. In addition, Leeds City Council was awarded

	£340,000 in March 2018 from CAZ Early Measures to deliver 10 fast chargers and three rapid chargers across 13 sites, with a further six in residential areas. These successes could be built on to drive momentum in City Region EV uptake, and reach the critical mass point of fossil-vs-EV convenience. In particular, there is a need to focus on rolling out smart and rapid charging points that provide maximum convenience and benefit.
Project description	This scheme would deploy dedicated taxi and public EV charging points across the City Region, focusing on rapid technology and high demand locations such as taxi depots, city centre car parks, train stations, service stations, large supermarkets and high streets. Geographically, this will centre on more urbanised, high-density areas such as Leeds, Barnsley, Bradford, Halifax, Huddersfield, York and Harrogate, however the network will need to have City Region-wide coverage. By combining EV charging with battery storage in the same single unit, the grid connection cost of each charger (particularly for rapid chargers) would be reduced. Additionally, this would decrease the electricity costs of the charger (e.g. if the battery is charged off-peak and an EV then connected during peak-time). This decentralised storage also provides benefits to the grid, as when not in use charging an EV, the charging point batteries can be charged and discharged to balance the local grid.
Key outcomes sought	Success looks like the establishment of an extensive network of rapid charging infrastructure , including smart charges, supporting the growth of EVs.
Potential carbon savings	There are significant carbon savings available if the City Region ensures that EV charging infrastructure is in place for a substantial electrification of the transport sector. With an EV rollout as described in the scenario modelling there are approximate potential carbon savings of 565 $ktCO_2$ per annum.
Funding sources	Funding is available through BEIS and Highways England to support charging infrastructure deployment and there are also private finance options. A £400 million government EV Charging Infrastructure Fund, and a Ultra Low Emission Taxi Infrastructure Scheme.
Key stakeholders	The Combined Authority, local authorities, Highways England, DNOs, ESCOs, large fleet operators, landowners.
Delivery mechanisms	This project could be delivered through the Accelerator. The Combined Authority could work with stakeholders to identify target areas, and then make a proposal to the Accelerator. This would help match fund the project with other sources of finance, and retain focus across the diverse landscape of stakeholders.

Next steps	Next steps could be for the Combined Authority to identify the areas of opportunity for electric and plug-in hybrid vehicles, and map demand against local grid constraints to identify where smart chargers would bring most value.

Hyperhubs	
Rationale for intervention	Hyperhubs could form the nucleus of a network of charging and fuelling points across the City Region, crucially helping drive economic growth and new jobs through their installation and maintenance, as well as through partnerships with local large-fleet businesses. Business fleets transitioning to low carbon are deploying liquefied natural gas (LNG) and CNG vehicles due to the power and range that is available. In order to support this growth, and progress it, there is a need for 'alternative fuel service stations' that offer these large fleet vehicles refuelling services. Due to the existence of several different alternative fuels (hydrogen, electric, bio-methane, LNG and CNG), it is most efficient to group these together into one larger refuelling hub aimed at business-scale vehicles.
Project description	This project is for a pilot Hyperhub to demonstrate the concept in the City Region. The initial customer base that would support the maintenance and use of the facility would be the Leeds City Council fleet, providing crucial public sector leadership. Currently the council aims to add 300 fleet EVs by 2020 and this delivery plan has suggested several hydrogen vehicles, these vehicles could be charged and refuelled from the initial pilot Hyperhub. Beyond this initial public sector lead, the key customers would be alternative fuel HGV business fleets of the City Region. Providing the refuelling facilities would increase further LNG and CNG uptake, and European Metal Recycling Ltd. and Amazon, who have large operational CNG HGV fleets, have already expressed interested at a potential Hyperhub site based at the M1 Link.
Key outcomes sought	Success looks like a demonstration Hyperhub offering several types of alternative, green fuels to local authority and large-business fleet vehicles.
Potential carbon savings	We are unable to calculate potential carbon savings for hyperhubs yet these will be a useful advancement in the infrastructure required to help reduce emissions in the transport sector.
Funding sources	• Cenex, Alternative Fuels Infrastructure Grant Programme • Ofgem Network Innovation Competition • Innovate UK • Funding is available through BEIS and Highways England to support charging infrastructure deployment

	• EV Charging Infrastructure Fund, £400 million UK government fund • Private finance options through partnerships with low carbon business fleets
Key stakeholders	Combined Authority, local councils, Highways England, DNOs, large fleet operators, NGN
Delivery mechanisms	This project could be delivered through the Accelerator. The Combined Authority could reach out to businesses with substantial fleets across the City Region and map both demand and geographic spread, and would also act as an umbrella to draw together and focus all relevant stakeholders. CNG Fuels, or an alternative technical specialist could be brought in to assist in the detailed project planning, having now delivered several CNG stations in the UK.
Next steps	Next steps could be to create an initial proposal either based around the M1 Link or an alternative location, and identify interested business fleets that could support the project. Use this as a basis for a feasibility study.

Smart Park and Ride	
Rationale for intervention	Park & Ride projects reduce congestion, improve accessibility, and build public transport links for remote, dispersed populations in the UK. However, this infrastructure has untapped potential beyond modal shift from cars to public buses. By installing a solar PV canopy above the car parking spaces, electricity can be generated and stored in on-site batteries to power an electric fleet of Park & Ride buses. This reduces the costs of running the bus service, and can in fact become a revenue stream for the local authority if the service is not used at full capacity, as the excess electricity generated can be exported to the grid.
Project description	This project would target two new Park & Rides (Stourton and York) as well as identify existing Park & Rides suitable for improvement: • The scheme in Stourton, Leeds, has received some funding from the ERDF. It will combine solar PV mounted over parking spaces with battery storage and deliver 48 chargers for cars alongside bus charging, with any surplus electricity going towards the operation of a local district heating scheme. However, the 1,200 parking space project is facing considerable opposition from local residents. The York proposal is a more traditional extension, it is here that the Combined Authority could seek to progress the 'smart' concepts being deployed in Stourton. • More widely, a list of all Park & Rides in the City Region could be drawn up, with a prioritisation process undertaken to uncover which schemes would be suitable for retrofitting a solar PV

	canopy, storage, electric buses and charging infrastructure, and a grid/private wire export link.
Key outcomes sought	Success would be both the new Park & Ride schemes to be built as 'smart', with one further site being 'smart' retrofitted, and a prioritised shortlist of further Park & Rides created.
Potential carbon savings	Park and ride schemes installed in the City Region could result in approximately 13 $ktCO_2$ being saved each year, assuming each bus could potentially remove 20 cars from a city centre.
Funding sources	• The UK Green Investment Bank – Green Loan for Local Authorities • Department of Transport Challenge Fund • Charging Infrastructure Investment Fund • If additional electricity is generated, it can be exported via a PPA or a private-wire to provide an additional revenue stream • Innovation in V2G Systems Competition could be accessed if EV charging points in the projects are developed to have V2G capabilities • Canada-UK Smart Energy Systems Challenge, is a joint challenge on smart grids and energy storage, totalling just over £11 million, under development • Funding may also be available through Innovate UK, BEIS or Highways England
Key stakeholders	The Combined Authority, local councils, park & ride/ local bus operators, DNOs.
Delivery mechanisms	The Accelerator could be used to delivery this project, however each local authority could also develop their own projects, utilising the model of Stourton and the experience of other local authorities.
Next steps	Next steps could be for the Combined Authority to reach out to the York development regarding 'smart' considerations, request and discuss the Stourton project plans so as to inform the identification and prioritisation process.

Smart Travel Evolution Programme (STEP)	
Rationale for intervention	STEP is a highly innovative project. It would grow the technological understanding of this area and could boost productivity through easing congestion. On a larger scale, it is part of a wider trend towards machine-to-machine communications and 5G connectivity, and therefore could ultimately be transformative for the City Region.

	On a practical level, this transformation is opening up a new sector, which could create highly skilled new jobs in the planning, constructing and operation of the system.
Project description	This project would extend STEP across the City Region, monitoring and analysing real-time journey information to make interventions where vehicles and traffic signals work together to improve the network: • STEP plans to develop and deploy technology to create two-way communications between vehicles and grid. This will have a three-fold impact of reducing grid constraints, congestion and emissions • STEP will also generate a multi-layered, real-time model of traffic, public transport and air quality data, allowing York to better prepare for connected and autonomous vehicles • There is also scope to use collected travel data as well as telematics and the tracking of bus routes to make interventions in inefficient driver behaviours
Key outcomes sought	Success looks like City Region at the cutting edge of smart traffic network communications, delivering transferrable learning to other UK regions and able to leverage its leading position to win more funding and export expertise.
Potential carbon savings	We have been unable to quantify carbon savings arising directly from the STEP, however it would contribute towards reducing transport related emissions by providing innovative infrastructure and data.
Funding sources	• This programme – led by City of York Council – was awarded £2.85 million from the Government's National Productivity Investment Fund in March 2018. Regarding extending the programme to the City Region: • Department of Transport Challenge Fund • Further financing from the National Productivity Investment Fund • The National Digital Infrastructure Fund • A combined request from the City Region's local authorities to the UK Green Investment Bank – Green Loan for Local Authorities
Key stakeholders	The Combined Authority, local authorities, City of York Council (Transport Systems Team), Highways England.
Delivery mechanisms	The initial geographic concentration of this project is already underway, the Combined Authority could place the York team at the core, and create a broader City Region steering group around them, ensuring the initial focus of the project isn't lost, whilst the various voices of the local authorities are heard.

Next steps	Next steps could be to begin discussions with the City of York Council regarding how this project could be extended, and what funding would be required, to feed into a proposal.

Behaviour change schemes	
Rationale for intervention	What is required is the development of a sustainable transport network to reduce car dependence and reduce emissions from the transport sector. City connect is result of a successful bid for £60 million of DfT Cycle City Ambition funding.With the continual development of these types of infrastructure combined with publicity and information campaigns alongside freely available training, there is potential to drive impactful modal shift. Regarding CAZs, if businesses begin to introduce complimentary measures, such as consolidating deliveries to minimise CAZ payments, this will likely bring efficiencies that could help boost productivity, as logistics that are more efficient could help free up staff and resources for additional activities.
Project description	Ongoing effort in the City Region related to the promotion of cycling and walking through behaviour change schemes. • Deploying walking maps across the City Region to increase uptake of walking • Using behaviour data such as data from Strava (currently happening in the US) to plan new cycling routes and infrastructure • Introduce levy charges on old, high-emitting vehicles to enter defined CAZ • Use collected travel data as well as telematics and the tracking of bus routes to make interventions in inefficient driver behaviours • Reinvest money raised from CAZ scheme towards affected drivers and businesses (e.g. Royal Mail) to help purchase hybrid, EVs, or retrofit vehicles
Key outcomes sought	Measurable improvement in air quality, behaviour change and modal shift in transport. Although it is hard to quantify and judge the success of such schemes, in Southampton and Bristol there has been some success in fostering a ‘cycling culture’. Leeds has also already made some successful interventions.
Potential carbon savings	For every extra 1,000 commutes per day, for a whole work year, that are completed using a bicycle as opposed to a car could save approximately 0.5 $ktCO_2$ annually.

	Given the current number of cyclists using the 'CityConnect' cycle route, average cycling distances and vehicle emission data, the current cycle scheme could save approximately 1 $ktCO_2$ per year.
Funding sources	Leeds City Council have bid into the £255 million Clean Air Zone Implementation Fund set up by central government.
Key stakeholders	Local councils, transport providers, residents
Delivery mechanisms	Behaviour change is a delicate process. Academics have identified seven steps to social change that every behaviour change initiative should take into account: • Knowledge: getting people to understand the importance of the initiative • Desire: making people want to change their behaviour • Skills: giving people the tools they need to change their behaviour • Optimism: making people think that change is possible • Facilitation: ensuring it's easy for people to change their behaviour • Stimulation: making it feel like people are joining in a collective behaviour • Reinforcement: ensuring a feedback progress to reinforce messages
Next steps	Next steps could be to complete the initial delivery and plan the expansion of the CityConnect cycling and the CAZ scheme, with a focus on supporting affected drivers. Analyse results from the CAZ second consultation phase.

Conclusion

The evidence resulting from this Energy Strategy and Delivery Plan builds on existing promising developments in national energy and industrial strategies such as the UK Industrial Strategy and Clean Growth Strategy and has the potential to influence future national policy-making.

The City Region is already home to a lot of resource efficiency activities and a number of successful projects and programmes are under way such as the Combined Authority REF, the District Heat Programme, and the newly established Energy Accelerator

Results from the energy and scenario modelling and from the projects forming the delivery plan indicate that:

- There is a solid case to build on the City Region's strengths as a foundation from which to build further clean growth. For example, high energy intensive industries operating in the key strength sectors such as manufacturing can gain substantial benefits by becoming the target of energy efficiency initiatives and projects across the City Region.
- Setting a science based target for the region would both be ground breaking and ambitious in light of the recent government 'Emissions reduction pledge 2020' and the City Region's existing SEP commitment to become a "zero carbon energy economy", and would require the City Region to cut its 2015 emissions (16,472 ktCO2) by 53 percent by 2036.
- Through scenario modelling, specific technology pathways have been identified that could result in the regional science based target being met. These scenarios could also allow the region to benefit from a cumulative 100,000 jobs supported and £11.5 billion in added GVA up to 2036.
- Clear priority areas have been highlighted that could help the City Region cut emissions, these include zero emission vehicles and associated infrastructure; industrial efficiency and waste heat recovery; and efficiency improvements within the built environment and public infrastructure. From the projects outlined in the energy delivery plan, a maximum of 49 percent of the science based target could be met.

West Yorkshire Combined Authority

Find out more

westyorks-ca.gov.uk
@WestYorkshireCA
enquiries@westyorks-ca.gov.uk
+44 (0)113 251 7272

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