Institute for Public Policy Research

NET-ZERO NORTH

DELIVERING THE DECARBONISATION MISSION IN THE NORTH OF ENGLAND

Laurie Laybourn-Langton, Joshua Emden, Darren Baxter and **Hywel Lloyd**

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SUMMARY

60-SECOND SUMMARY

The British economy is at a critical juncture. Its future success depends on overcoming two major, interrelated problems – long-term structural weaknesses in investment, productivity and trade, and the need to decarbonise. In this context, the north of England faces a particular challenge. The North's economy is more carbon intensive than the English average, and its many carbon-intensive industries face a challenging transition. It is also suffering from a lack of investment relative to other regions, particularly London. However, the North has a large economic potential, more of which could be unlocked from directed investment, and is already realising many of the opportunities of decarbonisation, with a vibrant low-carbon goods and services sector and nearly half of England's renewables generation. Other opportunities could deliver further economic benefit to the region, contribute to emissions reductions and address related socioeconomic challenges, such as air pollution.

In order to realise these opportunities within the context of national decarbonisation, the government's industrial strategy should include a mission to secure the greatest socioeconomic benefit to the UK from a reduction in greenhouse gas emissions to net-zero by 2050. An explicit decarbonisation mission within industrial strategy would provide a strong organising basis, bringing together the demand and supply side elements of accelerating decarbonisation, and complementing the government's efforts to meet what they have identified as the 'clean growth grand challenge'. A devolved carbon budget would provide a clear regional demand side focus for the North, enabling regional stakeholders to set and drive progress towards regional missions that promote certain technologies and systems. These regional missions should include transitions in the energy sector, towards more renewable generation and efficient use of energy; carbon-intensive industry, through the development of carbon capture and storage technologies and the recovery of heat; and in mobility, through the development and adoption of ultra low emission vehicles within a more connected, digital transport system.

KEY FINDINGS

- The North's economy is more carbon intensive, at 0.51 ktCO2 per £ gross value added, than the average for English regions, which is 0.44 ktCO2 per £ gross value added.
- In six out of the eight most energy-intensive industries in the UK, the north of England contributed over 30 per cent of the total UK GVA in 2015 including over 50 per cent of the total UK GVA in both the chemicals and coke and refined oil sectors.
- The north of England is already making the most of a number of the industrial opportunities presented by low-carbon technologies. The region accounted for 35 per cent of all jobs in the low-carbon goods and services (LCGS) sector in 2013, and the region generated 48 per cent of all renewable energy in 2015 – the largest of any region in England.
- Our analysis has identified three areas in which there is strong potential for the North to develop currently underutilised expertise or geographic assets: hydrogen, domestic energy efficiency, and mobility.

- Our analysis has identified two key areas in which there is strong potential for northern industries to reduce their carbon emissions, lowering costs and increasing competitiveness, which have particular advantages for the region: industrial carbon capture and storage (CCS) and industrial waste heat recovery.

RECOMMENDATIONS

For central government

- Declare a mission to secure the greatest socioeconomic benefit to the UK from a reduction in greenhouse gas emissions to net-zero by 2050.
- Establish a cross-departmental Decarbonisation Mission Unit in BEIS or the Cabinet Office with responsibility for:
  - measuring and assessing mission progress
  - coordinating the implementation of the Clean Growth Strategy across departments, as part of the decarbonisation mission's supply side strategy
  - working with departments to coordinate public procurement to drive and meet demand
  - developing a legal framework to support industrial strategy.
- Give powers to UK regions to adopt a regional carbon budget that binds a region to reduce emissions by an agreed amount over five-year periods.
- Devolve fiscal powers to local authorities in order to offer low interest loans for energy-efficiency equipment coordinated as part of Local Energy Devolution Deals.

For the north of England

- Central government should establish a Hydrogen Catapult located in the Tees Valley.
- The government should fund the Teesside Collective's proposed industrial CCS project in Tees Valley.
- BEIS and Innovate UK should carry out a feasibility study for the establishment of a CCS Catapult in the next parliament.
- LEPs should coordinate to find vendors to establish the first commercial power-to-gas hydrogen storage project in the UK be in either the Tees Valley or Cheshire and Warrington by 2025.
- Partnerships between industry and local authorities in the north of England should aim to generate at least 15TWh of recovered heat by 2050.
- Transport for the North and local and combined authorities should agree the constituent targets of a regional mobility transition mission.
- Transport for the North and other regional bodies should develop Local Mobility Transition Plans for realising the socioeconomic potential of sustainable transport and new mobility services to:
  - introduce clean air zones
  - ensure integration with all statutory planning processes
  - audit new mobility markets across the region
  - provide a vision and framework for new transport technologies within the existing transport system.

Recommendations for carbon-intensive industries in the North

- Set science-based targets using respected methodologies such as the Sectoral Decarbonisation Approach.
- Commit to sourcing 100 per cent of their electricity from renewables by 2023, while those who cannot should replace existing fuels with biomass and/or hydrogen with a view to these accounting for 15 per cent and 32 per cent of energy use respectively by 2050.

1. INTRODUCTION

Damaging human impacts on the environment have now reached the global scale. This has pushed some natural systems into an 'unsafe operating space', threatening the conditions upon which societies and economies can function (Steffen et al 2015). In turn, the imperative for and potential of sustainability is increasingly entering economic decision-making. Climate change sits at the forefront of this challenge, with the Paris climate change agreement effectively committing nations to reduce greenhouse gas emissions to 'net zero' by around the middle of the century (UNFCCC 2015).[1] The UK's recent Clean Growth Strategy has signalled the government's intention not only to meet domestic commitments at lowest cost, but to maximise the social and economic benefits of the decarbonisation transition (BEIS 2017a). However, while the UK has been successful at decoupling emissions from growth, it is not on track to meet its statutory emission reduction targets, with the Committee on Climate Change warning of a major shortfall in expected reductions arising from current policies (CCC 2017a).

The decarbonisation challenge is one of a number of structural problems affecting the British economy that include: a persistent trade deficit, low productivity and investment, and large geographical imbalances – all of which threaten the economy's ability to deliver prosperity and guarantee resilience as the UK leaves the EU (IPPR 2017). This reality has led the government to pursue a more explicit industrial strategy to improve living standards and economic growth by increasing productivity and driving growth across the country (BEIS 2017b). As the government has concluded, by seeking to affect economic outcomes, industrial strategy is a crucial organising mechanism through which to drive the transition to a net-zero-carbon economy (HM Government 2017).

As the government recognises, industrial strategy must also address the UK's large geographical imbalances, stimulating economic growth and productivity in all regions (ibid). Each region has its own challenges and opportunities when it comes to decarbonisation, all of which are a function of structural economic factors. In the north of England – the subject of this report – these opportunities include a large renewables potential and clusters of leading firms and expertise in the low-carbon goods and services sector. At the same time the North's economy is one of the most carbon intensive in the UK, with a high incidence of carbon-intensive industries that are struggling to adapt to the twin pressures of decarbonisation and increasing global competitiveness. Industrial strategy provides the means by which these challenges can be overcome, and the large opportunity decarbonisation affords to the North can be realised. This will require industrial strategy to integrate supply and demand for low-carbon goods and services, with the direction of demand being set by a national 'mission' to reduce greenhouse gas emissions to net zero. The success of this mission hinges on its effective implementation at a regional level. This report sets out a strategy for the delivery of a net-zero decarbonisation mission in the north of England. In doing so, it builds on the work of the Northern Energy Taskforce, which has developed a Northern Energy Strategy framework within which the North could realise the

1 'Net zero' allows for some emissions to be sequestered, either in natural or geological systems (Evans 2017).

opportunities and overcome the challenges facing the energy sector (Baxter and Cox 2017a).

In chapter 2, we start by exploring the environmental and economic context faced by the UK and the North. Chapter 3 analyses the state of the decarbonisation transition in the region and identifies key areas of potential in the North. Chapter 4 argues for a mission-oriented approach to industrial strategy and provides a framework for national delivery of a net-zero decarbonisation mission. Chapter 5 concludes by using the North as a case study for mission delivery at the subnational level.

This report is the outcome of an extensive research project, which included six workshops across all the subregions of the north of England, involving a broad range of stakeholders from industry, local enterprise partnerships (LEPs), combined authorities, central government and civil society. Workshops were also held with academic stakeholders and environmental groups.

2. CONTEXT

The British economy finds itself at a critical juncture, with its future success dependent on overcoming two major interrelated problems – environmental unsustainability and long-term structural weaknesses. In the case of the latter, the UK is increasingly suffering from a raft of structural problems that have grown steadily in scale and complexity over the last 40 years, undermining its ability to deliver shared and resilient prosperity (IPPR 2017). In the case of the former, global environmental impacts have passed or are threatening a number of safe thresholds. It is critical that developed economies such as the UK make a rapid transition to becoming fully sustainable, including through net decarbonisation (Steffen et al 2015).[2] These problems are closely linked and pose a profound challenge to the UK economy. At the same time this challenge holds transformational potential, providing an opportunity for socioeconomic renewal.

2.1 THE CLIMATE CHANGE CONTEXT

The UK is behind on meeting its climate change obligations

Since the late 1980s, the UK's greenhouse gas (GHG) emissions have become decoupled from GDP growth, with emissions falling as the economy has grown. In particular, the passage of the Climate Change Act in 2008 has seen considerable progress, with an average reduction in GHG emissions of 5 per cent a year since 2012 (CCC 2017a). This progress has resulted from reductions in material- and energy-intensive goods to lower-intensity services, large increases in the efficiency of energy use, and decarbonisation of the electricity system (Jacobs et al 2016).

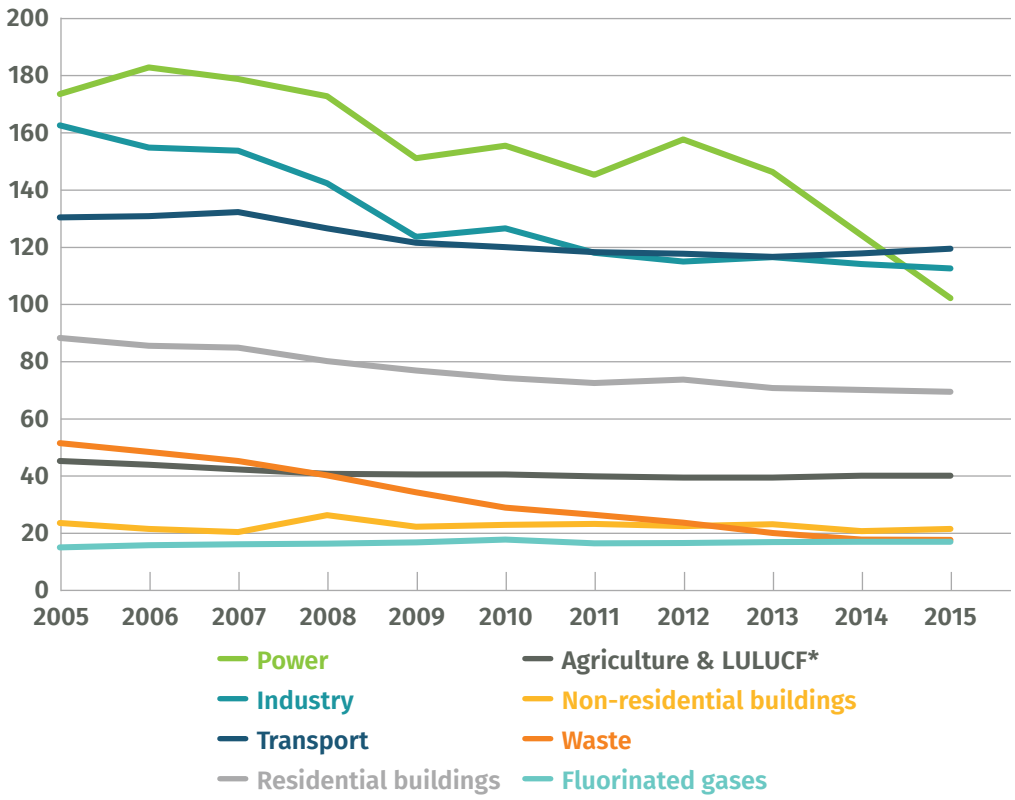
Despite this rapid progress, the UK is no longer on track to meet its statutory emission reduction targets. The Committee on Climate Change (CCC) warns of a 100 MtCO2e shortfall – or 47 per cent – between projected emissions resulting from government policies and those reductions needed to meet the Fifth Carbon Budget, for 2028–2032 (CCC 2017a). An additional 30 per cent, or approximately 70 MtCO2e of emissions reductions, may also not be realised as a result of low levels of funding or a lack of clarity on policy direction. Furthermore, only emissions from power and industry have significantly contributed to reductions since 2005, as shown in figure 2.1. The uptake of low-carbon heating systems – heat pumps and district heating networks – remains particularly low, at around 2.5 per cent of heating supply (CCC 2016a). Transport is the highest-emitting sector, with growing demand increasing emissions faster than fuel efficiency and the adoption of new fuel technologies reduce them (ibid).

2 We recognise that environmental breakdown, over time, poses an unprecedented threat to the UK economy. While recognising this reality, we focus on the UK response to reducing its climate change impact as a case study through which to develop a framework for industrial strategy, as we further explain in chapter 4.

FIGURE 2.1

The UK's overall emissions reductions have largely been due to decarbonisation of the power sector, particularly since 2012

UK greenhouse gas emissions (MtCO2e) by sector, 2005–2015



Source: Committee on Climate Change, *Meeting Carbon Budgets* **(CCC 2016a)**
***Note: 'LULUCF' = 'land use, land-use change and forestry'.**

As a result of these trends, the UK is no longer on a trajectory to meet the 2050 target of a minimum 80 per cent reduction in emissions relative to 1990 levels, as set out in the Climate Change Act (CCC 2016a). Since then the Paris Agreement has revised the global long-term emissions goal, effectively committing its signatories to reducing net greenhouse gas emissions to zero in the second half of the century (UNFCCC 2015). This change reflects projections from the Intergovernmental Panel on Climate Change, which estimates that, for a 66 per cent likelihood of holding warming below 2°C, net greenhouse gas emissions would need to reach zero sometime between the 2050s and 2070s. As the last government acknowledged, this will mean the UK's 80 per cent reduction target for 2050 will have to be revised (Hansard 2016).

The decarbonisation transition is a profound opportunity

The UK has a responsibility and significant capabilities to reduce its carbon emissions and so contribute to mitigating the climate change threat. The economic evidence is that the benefits of doing so are large, while the costs of action are small and vastly outweighed by those of inaction (Stern 2007, Bowen et al 2016). Indeed, the cost of meeting the UK's carbon budgets is estimated at less than 1 per cent of GDP (CCC 2016a). Overall, UK greenhouse gas emissions have fallen by 42 per cent since 1990 while GDP has grown by over 65 per cent (CCC 2017b).

Crucially, this action could deliver additional health and environmental benefits estimated at between 0.1 and 0.6 per cent of GDP (ibid). These 'co-benefits' of

climate action include reductions in household bills through higher efficiency, improvements in health from lower air pollution and active living, more affordable and secure energy, reductions in waste and inefficient resource use, and resilient, more efficient infrastructure (CCC 2017a). Realising these benefits could produce a profound socioeconomic transformation, radically enhancing the sustainability and growth potential of the economy while improving lifestyles for all citizens (NCE 2014).

Indeed, the UK is already benefiting from this transition, with Britain's low-carbon economy producing 2–3 per cent of GDP, a size now comparable to energy-intensive manufacturing (CCC 2017a). This means that Britain is well positioned to compete for the growing global demand for low-carbon goods and services, which is projected to increase from around £150 billion in 2015 to over £1 trillion in 2030, and as much as £5 trillion in 2050 (Carvalho and Frankhauser 2017, Ricardo AEA 2017). The UK is continuing to innovate across the low-carbon economy with the export value of major low-carbon goods and services in 2015 estimated at round £4 billion (ibid). We explore the potential of low-carbon goods and services in the north of England in the next chapter.

2.2 THE ECONOMIC CONTEXT

The UK economy is suffering from a number of structural problems

The Interim Report of the IPPR Commission on Economic Justice, *Time for Change: A New Vision for the British Economy*, shows that the British economy is failing to achieve sustainable and shared prosperity (IPPR 2017). This is because the economy suffers from deep structural weaknesses.

One is in trade. The UK buys much more from the rest of the world than it sells back. The national trade deficit has now exceeded 2 per cent of GDP for 14 of the past 15 years, reaching highs of over 3 per cent many years running (ONS 2016a). Persistent deficits indicate that the economy lacks competitiveness relative to other nations. The UK is overly reliant on service sectors for its exports. Since the 1970s, a trend away from manufacturing and towards service sectors has occurred in all advanced nations, but in the UK this shift has been more pronounced, with manufacturing now making up only 10 per cent of total gross value added (GVA), compared to 23 per cent in Germany (OECD 2016). This shift has negatively affected traditional manufacturing regions in Britain, such as the north of England (Buchanan et al 2009). Furthermore, the development of labour- over capital-intensive sectors has come at significant cost to productivity, which has experienced little to no growth since the financial crisis (IPPR 2017).

Low productivity is caused by, inter alia, low investment, which results from low growth, which is itself a result (in part) of low productivity. As such, the British economy finds itself on a negative path dependency. One dimension of the lack of investment is the stagnation in research and development (R&D) spending in the UK, which has remained flat over the last three decades while increasing in our major competitors – in 2012, the UK invested 1.6 per cent of GDP in R&D compared to 2.1 per cent in the eurozone and 2.8 per cent in the US (Tomorrow's Company 2016). Overall, investment across the public and private sectors has been lower, as a proportion of GDP, than most other developed nations over the last few decades, falling from 1 per cent below the OECD average in 1970 to 5 per cent below in 2014 (World Bank 2016).

The UK economy is one of the most geographically unbalanced in the developed world

The trade deficit, a lack of investment and low productivity are exacerbated at the regional level by large geographical imbalances, which mean the UK economy is failing to deliver broadly shared growth and prosperity. The UK is home to the

richest region in western Europe – inner London – while also being home to 9 of the 10 poorest (Lawrence 2016). London and the South East account for around 40 per cent of national output with the relative inequality between London and the South East and the rest accelerating over the last 20 years (ONS 2015a).

A considerable productivity gap now exists between the north of England and the rest of the UK. Since the Great Recession, growth of GVA per capita in the North has slowed and is now 25 per cent lower than the national average, or 15 per cent when excluding London (GMCA 2016). The same trend is seen in labour productivity, where the northern average is £26.88 of GVA per hour, compared to the UK average of £30.05 of GVA per hour (Cox and Raikes 2015a). These domestic imbalances are greater than almost all other developed nations, with the disparity between GDP per inhabitant in London and the regions being the largest in Europe (Cox and Raikes 2015b). In all these areas, London is an outlier whose development is 'decoupling' from the rest of the UK, skewing economic measures (McCann 2016).

The North needs investment to realise its considerable economic potential

English regions have less power than most other European countries, with no regional tier of governance. Even though the UK is one of the most populous countries in the OECD, local and regional governments have much less power over taxation and spending than most other OECD countries (Jacobs et al 2016). Since devolution in Scotland, Wales and Northern Ireland, and the creation of an elected mayor in London, these parts of the country have received around double the public investment per head afforded to the rest of the UK (Cox and Raikes 2015b). The centralisation of power and resources is holding back the North's economic potential.

While suffering from the effects of regional inequality, the North remains an integral part of the national economy. Its three subregions of the North East, North West, and Yorkshire and the Humber contributed 19.1 per cent of national GVA in 2014 (ONS 2015a). Together, the northern economy is larger than all of the devolved nations' economies combined. If it were a sovereign nation, it would be the eighth-largest economy in Europe (Cox and Raikes 2015a). This is because the North has a number of 'prime capabilities' that represent major economic assets, as identified by the Northern Powerhouse Independent Economic Review (SQW and CE 2016):

- **advanced manufacturing** – with a particular focus on materials and processes
- **energy** – particularly expertise around generation, storage and low-carbon technologies and processes, especially in nuclear and offshore wind
- **health innovation** – with a focus on life sciences, medical technologies and devices, and a growing competence in new service delivery models brought about by e-health and devolution within the health service
- **digital technology** – particularly in high-performance computing, data analytics, cognitive computation, machine learning, and wider strengths in media.

These 'prime' capabilities are supported by three 'enabling' capabilities: financial and professional services; logistics, ensuring ease of access across supply chains and into export markets; and education, providing research capability and vital skills training. Together, these capabilities have enabled the North to develop high-value industries, with manufacturing and the wholesale and retail trade having a GVA contribution above the national average (ONS 2015a). Strong international connectivity has enabled the North to record a positive balance of trade, with £55.2 billion of exports and £54.2 billion of imports in 2014 (Cox and Raikes 2015b). The North East has the highest share of its exports going to non-EU countries of any region, at 61.6 per cent (HMRC 2017).

There is now increased recognition that the North's growth potential is much greater than previously understood or appreciated, and that targeted investment to overcome regional shortcomings could realise this potential. For example, if economic output per head had grown at the national average between 2003 and 2015, the northern economy would be nearly 2 per cent, or £5 billion, larger (Cox and Raikes 2015a). This potential can be realised if the region receives higher levels of investment, through infrastructure spending, skills and industrial policy, and the devolution of economic and taxation powers. For example, Transport for the North, the body set up to plan and oversee transport infrastructure investment, estimates that a proportional level of public investment in the freight and logistics sector, coupled with private sector investment, could deliver £34.7 billion in GVA benefits to the UK economy and £13–20 billion of GVA benefits to the northern economy, as well as between 25,000 to 38,000 additional jobs by 2033 (TfN 2016).

Industrial strategy offers an opportunity to restructure and decarbonise the UK economy

In sum, the patterns and levels of investment and policy over the last few decades have left economic structures that constrain productivity growth, investment and exports have created severe regional imbalances, and entrenched a carbon-centric model of economic development. The impact of Brexit is now creating further uncertainty in relation to both the economic and environmental challenges (Lawrence 2016).

It is in this context that the government is developing an explicit industrial strategy as a means to 'improve living standards and economic growth by increasing productivity and driving growth across the whole country' (BEIS 2017b). While featuring some measures on decarbonisation, this emergent strategy is complemented by the recent Clean Growth Strategy, which seeks to minimise the costs of decarbonisation while maximising its socioeconomic benefits (BEIS 2017a). The move towards a more activist economic policy from the government is a welcome development, presenting an opportunity to overcome the interrelated challenges of decarbonisation and the wider failing of the incumbent British economic model. A restructuring of the economy will be needed in order to combat these problems and achieve key economic goals, shifting the composition, direction and geography of the British economy (Jacobs et al 2017). In chapter four, we explore how Britain's industrial strategy could best achieve decarbonisation. In the next chapter, we assess the state of the decarbonisation transition in the north of England.

3. DECARBONISATION IN THE NORTH

The decarbonisation transition is both a challenge and an opportunity for the north of England. The region's economy is more carbon intensive than much of the UK, with a greater reliance on fossil fuels. Decarbonisation will therefore have a non-trivial effect on the economy of the North and the communities that rely upon it. Yet the transition to a lower-carbon economy is already under way across the region. While the traditional energy economy is declining in its share of national GVA and employment, the region's low-carbon economy has grown significantly; the region is making use of its extensive assets and expertise in the low-carbon and environmental goods and services sector, with specific regional advantages in many technology areas. Therefore, the overall picture for the region should be one of optimism.

This chapter assesses the state of the decarbonisation transition in the North across two areas: the decarbonisation of carbon-intensive industries, and the development of the low-carbon goods and services sector. It sets out five areas of opportunity for the North: three for the low-carbon economy – hydrogen, domestic energy efficiency and the mobility transition – and two technologies that can support carbon-intensive industries to reduce their carbon emissions – industrial carbon capture and storage (CCS) and waste heat recovery.

3.1 THE STATE OF THE DECARBONISATION TRANSITION

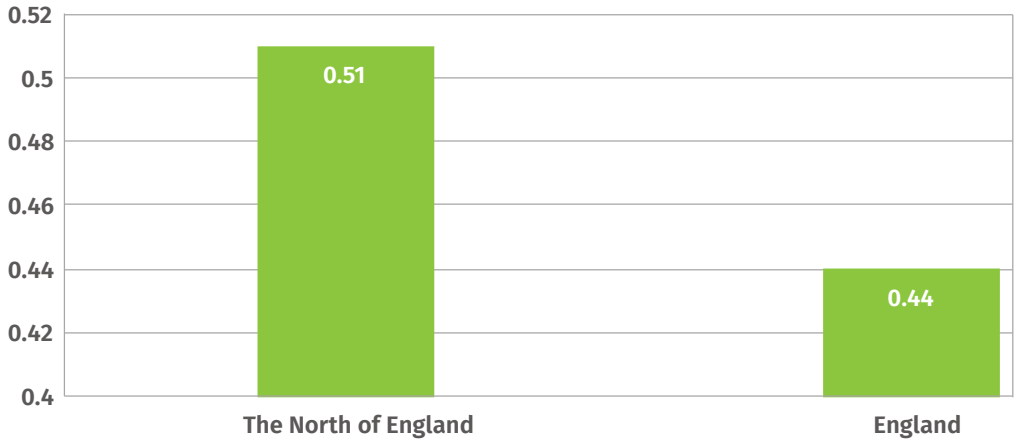
The north of England's economy is more carbon intensive than the English average

Reducing industrial emissions is one of the largest challenges in the decarbonisation of the economy. Direct emissions from industry accounted for around 20 per cent of UK emissions in 2014, and their reduction will require investment in new infrastructure and processes (CCC 2015). This is a challenge with a distinct northern element. The north of England's economy is more carbon intensive than the English average, with a high concentration of carbon-intensive industries clustered across the region. These are defined as iron and steel, agri-food, chemicals, oil refining, food and drink, pulp and paper, cement, glass, and ceramics (DECC 2015). Across these sectors, the North has some of the highest emissions in the country, as shown in figure 3.2.

FIGURE 3.1

The North's economy is more carbon intensive than the English average

Regional carbon intensity (ktCO2/GVA), 2014

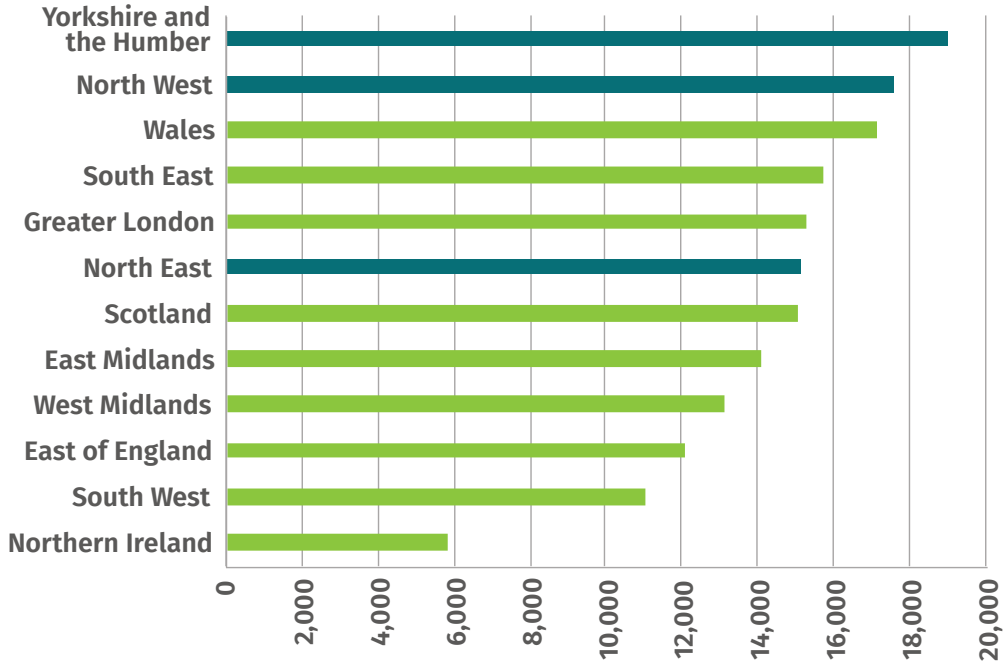


Source: Adapted by IPPR from Department for Business Energy and Industrial Strategy, 'Final UK greenhouse gas emission national statistics', (BEIS 2017c)

FIGURE 3.2

The subregions of the north of England have some of the highest absolute industrial and commercial emissions in the country

Absolute industrial and commercial total emissions for regions of the UK (ktCO2), 2014



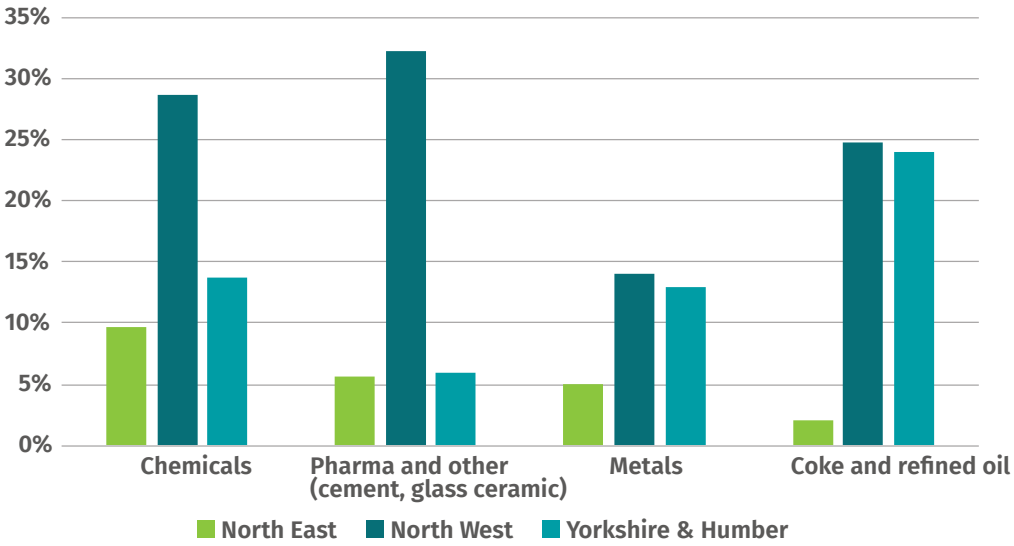
Source: Adapted by IPPR from Department for Business Energy and Industrial Strategy, '2005 to 2015 UK local and regional CO2 emissions' (BEIS 2017d)

These industries make a significant contribution to the northern economy. In six out of the eight most energy-intensive industries in the UK, the north of England contributed over 30 per cent of the total UK GVA in 2015, including over 50 per cent of the total UK GVA in both the chemicals and coke and refined oil sectors.

FIGURE 3.3

Subregions in the north of England make a substantial contribution to national GVA in some of the most energy-intensive industries

Northern subregional contributions (%) to national GVA for energy-intensive industries, 2015



Source: Adapted by IPPR from Office for National Statistics, 'Regional Gross Value Added (Income Approach)' (ONS 2016b)

The transition will be difficult for carbon-intensive industries

The concentration of energy-intensive industry within the North has led to concerns about the disproportionate subregional impact that the decarbonisation transition may have. The geographically concentrated nature of these industries, with clusters in the Tees Valley, the Humber and in pockets around the North West, also means that any economic consequences associated with the low-carbon transition will be unequally distributed among communities within the North.

The landscape analysis of the Northern Energy Taskforce found that the sectors driving an overall decline in the energy economy in the north of England were those associated with fossil fuels – mining and support services, the extraction of crude petroleum and natural gas, and the manufacture, distribution and trade of gas, steam and air-conditioning, matching the broader shift in the nature of energy generation within the North (Baxter and Cox 2017b). Furthermore, the economic impacts of large plant closure are significant. Although not directly related to decarbonisation, the closure of the SSI steel plant in Teesside led to 2,066 people directly being made redundant with a further 849 losing their jobs in supply chain firms (Tighe 2016).

These industries are therefore key to local economies and local wellbeing but are also important in the low-carbon economy. Without the steel or chemical industries, it is not possible to build electric vehicle parts or batteries for electricity storage. This has led many LEP areas to pursue a number of initiatives to both support and exploit the low-carbon transition across industries, as detailed in table 3.1.

TABLE 3.1.

Many northern LEPs are incorporating low-carbon initiatives into their advanced manufacturing activities

LEP Area	Industry	Initiatives
North East	Automotive	Automotive and Vehicle North East Enterprise Zone Centre for Sustainable Advanced Manufacturing
Tees Valley	CCS, Circular Economy	Designing UK centre of carbon utilisation Development areas at SSI site with existing facilities (e.g. coke ovens, power station and gas facilities) Pursuing better product design and production processes to reduce waste, incentives for manufacturing recyclable products and industrial symbiosis opportunities
Humber	Environmental Technology	Humber Enterprise Zone including Marfleet Environmental Technology Park, which collocates renewable and advanced manufacturing companies
York, North Yorkshire and East Riding	Bio-renewables	Broughton Hall Advanced Enterprise Park is a rural business space that will become carbon neutral through heat and energy provided by local forests
Leeds city region	Infrastructure	Several centres of excellence including Institute for Rail Research, Turbocharger Research Institute, Automotive Research Centre and Hybrid Powertrain Engineering Research Centre
Sheffield city region	Aerospace	Advanced Manufacturing Park set up with support from Boeing and housing the University of Sheffield
Cheshire and Warrington	Energy Systems	£23 million development of centre of excellence in Advanced Energy Systems working with University of Chester and other private partners
Liverpool city region	Skills	Between 2014–16, Liverpool city region operated a Skills Capital Investment Fund which invested £21.5 million in areas supporting low-carbon, maritime logistics and advanced manufacturing
Greater Manchester	Graphene	£20 million of public funding for Graphene Engineering and Innovation Centre
Cumbria	Education	Advanced Manufacturing Centres at Furness College and Carlisle College
Lancashire	Engineering	£15 million Engineering Innovation Centre expanding on expertise in advanced manufacturing and energy management

Source: IPPR analysis, adapted from the matrix in table 3.2

The North has a leading low-carbon goods and services sector

The north of England is already making the most of a number of the industrial opportunities presented by low-carbon technologies. The region accounted for 35 per cent of all jobs in the low-carbon goods and services (LCGS) sector in 2013,[3] equating to 21 LCGS jobs per 1,000 jobs in the North, compared to 16 per 1,000 in England as a whole (Baxter and Cox 2017b). In addition, the region generated 48 per cent of all renewable energy in 2015 – the largest of any region in England (ibid).

A qualitative review of the low-carbon economy in the north of England is presented in table 3.2 on pages 22-23. This matrix represents a significant engagement with the local economic partnerships (LEPs) and other key low-carbon goods and services stakeholders across the region. It assessed the extent to which different technologies are part of local economies, with different degrees being marked as:

Expertise that is already **well established** (e.g. nuclear decommissioning in the North West) and natural assets that are already being exploited (e.g. oil and gas in the North Sea).

Expertise, capacity or geographic resources that have often been identified by LEPs as areas that could be **further scaled up**. Extensive research may have been conducted into the potential for these technologies, and often there will be an existing programme, scheme or capacity in place that is either underutilised or is only just emerging.

Technology areas for which LEPs and/or universities may be **seeking funding or beginning to conduct research** programmes.

Blank – Not believed to be present or significant in that locality.

The matrix was developed over three key stages.

- **Stage 1 – Literature review:** An extensive literature review of materials published by all northern LEPs, including their strategic economic plans (SEPs), to assess the extent to which different LCGS technology areas were presented or being developed in their areas.
- **Stage 2 – Low-carbon stakeholder consultation:** The initial literature review was complemented by input from key stakeholders at six roundtables across major northern cities. Stakeholders at these roundtables identified LCGS technology areas in their sub-regional LEPs which they thought were either emerging or well established.
- **Stage 3 – Local economic partnership consultation:** Finally, the colour-coded matrix was presented to representatives from LEPs in order to scrutinise and amend the coding and identify any outstanding gaps. This was an iterative process with changes made in consultation with the representatives from these LEPs over a period of time. Any mistakes are our own.

This process is intentionally qualitative, designed to use a range of data sources and the consultation process of this project. This approach was chosen for two main reasons. First, insufficient data detailing the low-carbon economy exists; the most recent employment figures are for 2013, since when much has changed. In addition, a focus on employment obscures those technologies which are in their infancy, but which may have significant potential in the future. Second, this process was designed to make the most of regional expertise in understanding what technologies were being developed across the region. This allows us to identify technologies that actors in the north of England believe to be significant and in which they are already investing time and effort.

3 The LCGS sector includes those activities that generate products or services which themselves deliver low-carbon outputs. This covers six sector groupings: low-carbon electricity; low-carbon heat; waste processing, waste from biomass; energy efficiency products; low-carbon services; and other low-carbon, which includes low-carbon vehicles (ONS 2015b).

3.2 OPPORTUNITIES FOR DECARBONISATION

Having identified those assets and expertise already existing, emerging or being considered, we now set out the specific, location-based opportunities for the growth of technologies and systems that could drive decarbonisation and deliver socioeconomic benefit across multiple LEP areas.

3.2.1 Low-carbon and environmental goods and services

We have used three main, interrelated measures of success for the realisation of opportunities in LCGS sectors, which were identified by stakeholders throughout the process of this project.

- **Growth in the economic contribution of the sector and increased employment opportunity.** While perhaps the most obvious aim of industrial policy, growing the economy was seen by stakeholders as a key output of any intervention into the LCGS sector. Therefore, selecting technologies which have a high growth potential in the North is essential.
- **High contribution to UK carbon emissions reductions.** Stakeholders highlighted that a key outcome for interventions in the LCGS sector should be the promotion of swift progress towards net-zero emissions by 2050. Accordingly, those areas highlighted correspond with technologies that have the greatest capacity to reduce greenhouse gas emissions.
- **Addressing other socioeconomic challenges.** Stakeholders stressed the need to address socioeconomic challenges alongside the promotion of growth and reductions in emissions. For example, many energy problems sit at the nexus of economic, environmental and social challenges, such as improving air quality or tackling fuel poverty, and this presents an additional dimension for measuring success. In our selection, consideration is given as to how the technologies will combat social problems, and how this may be brought out in policy.

Across these criteria, and in the context of industrial strategy, we have focused on assets that are best suited to 'place-based deals' for industrial strategy, of the kind in which the government has signalled interest (BEIS 2017b). These would be areas of opportunity that are emerging (rather than already established) and largely specific to the north of England rather than the UK as a whole. In the case of nuclear power, for example, the North has a regional advantage but this is already well established and organised. For completeness, box 3.1 lists three key opportunities for the region which we have not included in this report for deeper assessment of their potential.

BOX 3.1 LOW-CARBON INDUSTRIAL OPPORTUNITIES WITH ESTABLISHED OR NATIONAL POTENTIAL

Nuclear

The nuclear sector plays a significant role in the northern economy. Existing generation assets in Cumbria and the North East represent 40 per cent of the UK's installed nuclear capacity, and the region is home to a number of research assets. These include the Dalton Nuclear Institute and Centre for Nuclear Energy Technologies (C-NET) at the University of Manchester, and the Nuclear Advance Manufacturing Research Centre at the University of Sheffield. The nuclear legacy of the region also represents opportunities. Decommissioning at Sellafield represents a key economic opportunity and the Northern Energy Strategy has recommended that it should become a test bed for future innovations (Baxter and Cox 2017a).

The nuclear industry already possesses significant institutional capacity; the Centre for Nuclear Excellence (CONE) convenes the nuclear industry

players in the region, covering nuclear operators, the nuclear supply chain and local government. Working together they have produced a response to the government's industrial strategy and northern powerhouse consultations. This report does not seek to reproduce these efforts.

Biomass

The north of England accounts for 92 per cent of the nation's electricity generation capacity from biomass. This has been driven largely by the biomass conversion of two coal plants at Drax and Lynemouth. In addition, significant supply chain opportunities have been created, for example to the region's ports where there has been major investment in biomass warehousing and distribution facilities. In addition to large-scale generation, there is a wide range of small-scale applications for biomass power including combined heat and power (CHP) projects and smaller plants, which are found across the region. The extensive development of the biomass sector in the region means our focus lies on technologies which are less well developed.

Solar PV

Solar PV deployment falls well below that which is technically feasible. The interim report of the Northern Energy Taskforce found that there is the technical capacity for 1,188 GWh of solar PV and wind on the rooftops of 10 northern cities (Baxter and Cox 2017a). Accordingly, there is scope for a regional push on fitting rooftop solar. However, this is not a uniquely northern opportunity. Rather, the Northern Energy Strategy has argued that combined authorities should work with distribution network operators to bring forward new Local Energy Devolution Deals to central government with a focus on stimulating decentralised approaches to energy efficiency and generation in return for receipts from the carbon floor price (CFP) and emissions trading scheme (ETS) (Baxter and Cox 2017a).

Using the selection criteria above, we have identified three areas in which there is strong potential for the North to develop currently underutilised expertise or geographic assets: hydrogen, domestic energy efficiency, and mobility.

1. Hydrogen

Decarbonising heat and transport present significant challenges as they represent the majority of total UK carbon emissions. Hydrogen presents the opportunity to transform significant amounts of the heat system to run on a low-carbon fuel, alongside being a potential transport fuel and having the capacity to store electricity. The north of England has been leading the way in exploring the use of hydrogen as a potential low-carbon fuel. The H21 project, led by Northern Gas Networks has explored the potential for hydrogen to replace natural gas in existing gas networks (NGN 2016). These plans would initially see hydrogen produced in the Tees Valley, transported to Leeds with excess gas stored in salt caverns in Yorkshire and the Humber, before the infrastructure is expanded to cover other cities and eventually all of the UK.

These plans draw on the North's existing advantage in producing hydrogen by a number of different methods. Tees Valley currently produces around 50 per cent of the UK's hydrogen and Liverpool city region is home to some of the largest chlor-alkali hydrogen producers in the UK (Tees Valley Unlimited 2016, Cadent 2017). Furthermore, while hydrogen as a by-product may meet initial market demand, the north of England is also well placed for scaling up production (ERP 2016). Steam methane reformation (SMR), which is seen as one of the cheapest methods of producing hydrogen, has been used for decades in the North at sites such as the Catalyst Research Centre at Billingham in County Durham (Brightling 2014). The region

also has specific experience with hydrogen produced via electrolysis. In particular, ITM Power in Sheffield has leading expertise in power-to-gas energy storage electrolysis and hydrogen for fuel cell vehicles (ITM Power 2017). While electrolysis is currently seen as an expensive method of hydrogen production and depends in part on renewable surplus to be zero carbon (ERP 2016), by 2030 it is estimated that it could produce around half of hydrogen in the UK (UK H2 Mobility 2017).

Furthermore, the availability of salt caverns means the North is well suited to store hydrogen; in Tees Valley and Cheshire and Warrington, these caverns are already operational and storing other gases, with further potential for expansion (Islandmagee Storage 2017). This is particularly true along the North East coast thanks to a Permian basin extending from the North East down to the Humber estuary, as well as a number of potential sites in a Triassic basin in the North West (BGS 2008, Cadent 2017).

The economic potential of hydrogen production for the north of England is significant. The scale of economic growth and employment for large infrastructure projects like H21 are expected to be substantial and led by the north of England (NGN 2016). In addition, ITM Power is playing a leading role in providing hydrogen for fuel cell vehicles as well as the fuelling stations themselves. Studies conducted for the North East suggest hydrogen production for use in transport could yield cumulative revenues of around £850 million between 2020–2030 (E4tech 2014). The scale of the economic and carbon-saving potential of these plans, combined with their focus on the North, make them an ideal area for greater intervention.

2. Domestic energy efficiency

Improving the energy efficiency of the nation's homes is essential to timely decarbonisation. The CCC has estimated that emissions savings from more energy-efficient buildings alone could generate 19 per cent of the required total savings between now and 2030 (CCC 2017a). Domestic energy efficiency should be a focus for the north of England. Despite receiving more energy company obligation (ECO) measures than any other region, the North has a lower percentage of households with an energy efficiency rating of A or B than the national average, and the highest proportion of households with a D rating (DCLG 2017), as figure 3.4 shows (Emden 2017). The need to address inefficient housing in the north of England is as much a social imperative as it is a low-carbon one. According to government statistics, in 2015 the North East and Yorkshire and Humber had two of the highest levels of fuel poor households at 13.3 per cent (second highest) and 12.4 per cent (fourth highest) respectively (BEIS 2017e).

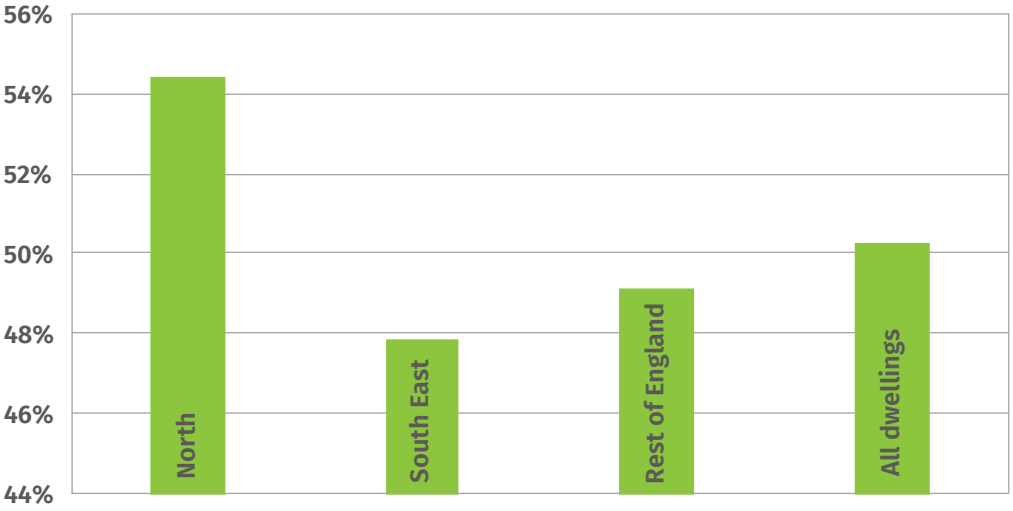
Furthermore, energy efficiency is an example of a high turnover and high employment sector, as figure 3.5 shows (ONS 2017). Consequently, combining a large demand with large employment opportunities suggests the potential for economic growth is substantial.

Accordingly, improving the efficiency of the North's homes is an industrial strategy opportunity with wide socioeconomic and decarbonisation potential. A significant push on improving thermal efficiency will reduce the demand for energy, and resultant greenhouse gas emissions, improve the quality of housing stock and the lives of those in it, and create a large amount of jobs making it an ideal candidate for the focus of a low-carbon industrial strategy.

FIGURE 3.4

The north of England has a far higher number of households with an efficiency rating of D than other areas of England

% of households with energy efficiency rating of D, 2015

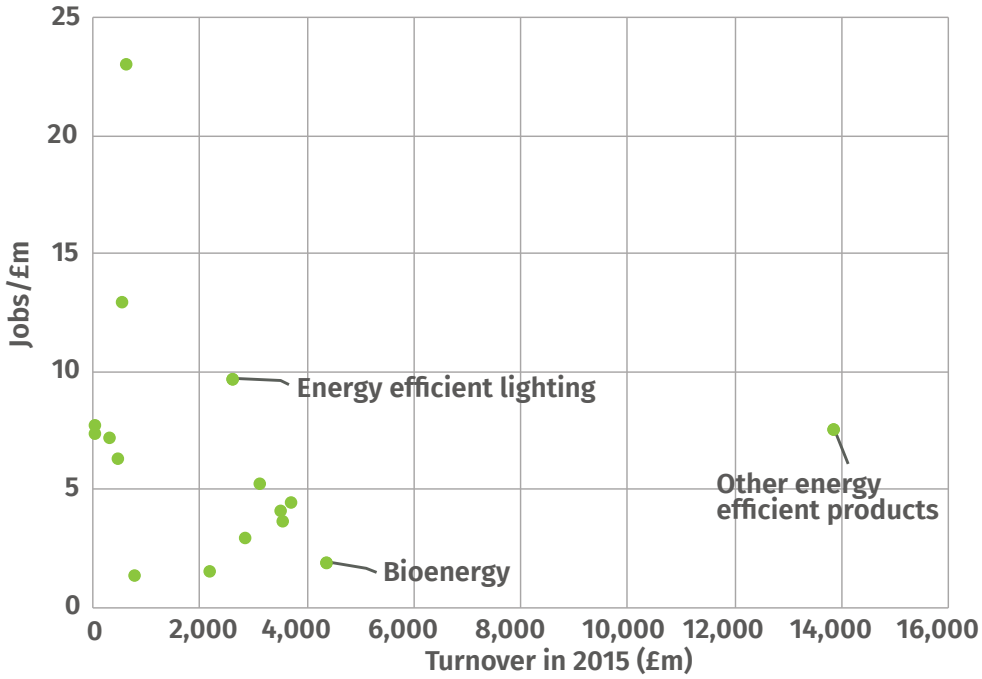


Source: Adapted by IPPR from Department for Communities and Local Government, 'Energy inefficient dwellings' (DCLG 2017)

FIGURE 3.5

The energy efficiency sector has both high turnover and relatively high levels of employment for every million pounds generated

Jobs per £m vs turnover (£m) for the UK low-carbon and environmental goods and services sectors, 2015



Source: Adapted by IPPR from Office for National Statistics, 'UK environmental accounts' (ONS 2017)

3. Ultra low emission vehicles and transport systems

Decarbonisation of the transport system will require a change in the fuels that power our vehicles and how we use them. Large changes in the fuel mix could increase stress on electricity grids, needing a commensurate increase in energy supply. Such an increase underlines the need to decarbonise the energy supply, and, in doing so, a whole-systems approach will be needed, integrating power, heat and transport (Baxter and Cox 2017c). Specifically, energy demand will need to be managed to support the efficient delivery of mass electric vehicle (EV) charging, integrating hydrogen vehicle charging with greater hydrogen penetration of heat networks, and continued research, development and deployment of battery storage technologies.

While the north of England is not the only region attempting to tackle this problem, it does have emerging and existing expertise in relevant disciplines such as smart grids, battery storage, EV manufacturing and transport management. Nissan and Northern Powergrid are collaborating on greater energy system integration for transport by, for example, developing capabilities for EV owners to sell electricity back to the grid (Manning 2017). Indeed, the North plays a leading role in the European ultra low emission vehicles (ULEV) market, with Nissan's flagship plant at Sunderland being at the forefront of the manufacture and export of the Nissan Leaf, the world's best-selling EV (Lima 2017). The North's universities provide a considerable research and development capacity, supporting clusters around ULEV production and markets, including, for example, the Institute for Automotive and Manufacturing Advanced Practice at the University of Sunderland, which has fuel cell and hybrid technology research. This capacity is complemented by the region's skill base, its existing industrial assets and the proximity to innovation centres in the Midlands (Pitas 2017).

At the pan-regional level, Transport for the North (TfN) is developing a Strategic Transport Plan, setting out connectivity priorities for the region including an increase in multimodality across the region away from private vehicle dependency and towards rail and public transport use (TfN 2017). As TfN recognises, the improvement of strategic and local rail connectivity is vital to achieving this vision. At its launch, there was some criticism that TfN's Strategic Transport Plan position statement had too little regard for concerns about future energy supply and the challenges of decarbonisation (Baxter and Cox 2017a). A whole-systems approach to the energy and mobility transitions will also be required. TfN is already planning to improve connectivity between non-carbon energy and research assets located in the North West and North East, but greater systems integration of energy and transport infrastructure is needed. Crucially, this integration must enable the accelerated development and deployment of new mobility technologies and services – such as car clubs, electric vehicles and journey planners – as a means to reduce negative transport outcomes and realise the socioeconomic potential of the mobility transition, including the potential for spatial renewal from increased efficiency in utilisation of transport assets. The economic potential of future mobility systems is considerable; estimates suggests that future transport systems, integrating connected and autonomous vehicles, will be worth £51 billion a year by 2030 (KPMG 2015).

While all UK regions face similar mobility challenges, the north of England has many of the capabilities for developing a cohesive and interconnected low-carbon transport strategy, particularly given the institutional capacity already established by Transport for the North. In addition, given a historic underspend on transport in the region relative to the rest of the country, an industrial strategy focus on new forms of mobility would allow the region to take control of its transport system into the future (IPPR North 2017).

REPORT TEXT CONTINUES ON PAGE 24

TABLE 3.2

Qualitative review of the low-carbon economy in the north of England

OPPORTUNITY	NORTH EAST		NORTH WEST		
	NORTH EAST	TEES VALLEY	GREATER MANCHESTER	LIVERPOOL CITY REGION	CUMBRIA
Advanced Manufacturing	■	■	■	■	■
Onshore wind	■	■	■	■	■
Offshore wind (supply chain)	■	■		■	■
Offshore wind (farms)	■	■		■	■
Oil & Gas	■	■			
Coal	■				
Biomass (heat & power, including anaerobic digestion)			■	■	■
District heating (heat sources, demand and network)	■	■	■	■	
Energy from waste/CHP	■	■	■	■	
Nuclear decommissioning			■	■	■
Biofuels		■	■	■	
EVs	■	■	■	■	
CCS (industrial)		■			
Smart Grid Technologies	■	■	■	■	■
Process Innovation		■		■	■
Electricity storage (including batteries and compressed air)	■	■	■	■	
Public transport management (e.g. cycling, walking, managing traffic)		■	■	■	
Hydrogen (fuels)		■	■	■	
Hydrogen (heat)		■	■	■	
Fracking					
Business (SME) energy efficiency	■	■	■		■
Micro-hydro	■		■		
Domestic energy efficiency (including low carbon construction)	■	■	■	■	■
Industrial heat recovery	■	■	■		
Solar PV	■		■	■	
Hydrogen (mobility)		■	■	■	
Hydrogen (storage)		■	■		
Wave/marine	■			■	
CCS (power)		■			
Tidal				■	■
Heat pumps	■		■		

■ Well or newly established expertise ■ Desires for region with research or funding proposals

Source: IPPR analysis

			YORKSHIRE & HUMBER				SELECTION CRITERIA	
	LANCASHIRE	CHESHIRE & WARRINGTON	YORK, NORTH YORKSHIRE & EAST RIDING	LEEDS CITY REGION	SHEFFIELD CITY REGION	HUMBER	EXPERTISE SPECIFICALLY NORTHERN?	INDUSTRY ALREADY WELL ESTABLISHED?
							Yes	Yes
							No	Yes
							Yes	Yes
							Yes	Yes
							Yes	Yes
							Yes	Yes
							Yes	No
							Yes	No
							No	Y - Yorkshire & Humber
							Yes	Yes
							Yes	Y - North Yorkshire
							No	Y in North East
							Yes	Y in Tees Valley
							No	No
							Yes	No
							No	No
							No	No
							Yes	No
							Yes	No
							Yes	No
							No	No
							No	No
							Yes	No
							Yes	No
							No	No
							No	No
							No	No

Initial scheme, capacity or geographic resource, identified for further possible scale up

Note: Blank squares are those technologies not currently believed to be present or significant in a locality. See page 16 for more information.

3.2.2 Carbon-intensive industries

A more active industrial policy is needed to support the decarbonisation transition for carbon- and energy-intensive industries (Lawrence and Stirling 2016). This is because UK industries are facing two critical pressures. On the one hand, the influence of global markets has put pressure on the competitiveness of some sectors, leading to job losses in carbon-intensive industries like steel (Bowler 2016). On the other, global ambitions to reduce emissions compel many carbon-intensive industries to undergo decarbonisation and incur the cost of doing so. In this context, stakeholders across our research process broadly identified three interrelated measures of success for carbon-intensive industries over the transition: cost reductions, increases in international competitiveness and business model innovation.

Achieving success in these criteria across the transition will require a number of interventions. Carbon-intensive industries will need to switch the fuels they use to lower-carbon alternatives and invest in process innovation to ensure they are using these as efficiently as possible. These will need to happen nationally but efforts will, given the spatial distribution of these industries, disproportionality happen in the north of England, as described in box 3.2.

BOX 3.2 NATIONAL EFFORTS TO DECARBONISE CARBON-INTENSIVE INDUSTRIES

Fuel switching

All carbon-intensive industries will, to some extent, need to switch their fuels to lower-carbon alternatives. This is particularly relevant in the North, where its manufacturing industries are often intensive users of fossil fuels, including coal and natural gas. Switching to low-carbon energy sources provides the opportunity to insulate industries against future price fluctuations and maintain international competitiveness as low-carbon manufacturing increasingly becomes the global norm. There are two particular areas of potential to achieve this in the North: co-firing biomass and waste with existing fuel sources, and renewable power purchasing agreements.

- **Co-firing biomass and waste:** For industries requiring high-grade heat like the iron and steel sector, high temperatures can be reached through the co-firing of biomass and waste products (Brown et al 2012). Specifically, in addition to the expertise in bioenergy mentioned above, the North has emerging expertise in energy from waste facilities. For example, in the York, North Yorkshire and East Riding LEP area, £200 million is planned for investment in an energy from waste facility (Business Inspired Growth 2014). As part of the £700 million energy hub in the Cheshire and Warrington LEP area, energy from waste and resource recovery facilities are also planned for development (871candwep 2017).
- **Renewable power purchasing:** Many of the carbon-intensive industries in the North are large electricity consumers; electricity makes up 42 per cent, 20 per cent and 38 per cent of the chemicals, other non-metallic minerals and basic metals sectors respectively (BEIS 2017f). By pursuing renewable power purchase agreements (PPAs), carbon-intensive industries would be able to ensure a fixed power price for up to 20 years and hedge against any fluctuations in wholesale markets (Bieller 2017). Insulation from future risk would add less than 1 per cent to energy costs for these industries (Smartest Energy 2016). PPAs would also become a faster and more direct way of decarbonising the grid by creating additional demand for renewable energy, which in turn would accelerate the cost reductions in renewable technologies themselves.

Process innovation

Alongside fuel switching, carbon-intensive industries will need to adapt and improve the processes they use. Advanced manufacturing – the use of technology innovations to improve the quality of products and the speed of processes – is an agenda being pursued by almost every LEP area in the North. For each carbon-intensive industry, there are numerous energy-efficient processes and practices that could help to reduce energy costs and insulate against future energy market instability; they also raise industries' productivity and revenue. A Green Alliance report recently found that out of the 48 per cent of Fortune 500 companies who set targets to improve energy efficiency and environmental footprints, 80 per cent of these companies made savings totalling $3.7 billion in savings in 2016 (Francis and Brandmayr 2017). Moreover, because labour productivity[4] is largely contingent on investment in equipment, as equipment becomes more efficient, so productivity will rise.

In addition to those activities which will need to occur across the UK, we have identified two key areas in which there is strong potential for northern industries to reduce their carbon emissions, lowering costs and increasing competitiveness, which have particular advantages for the region. These are industrial carbon capture and storage (CCS) and industrial waste heat recovery.

1. Industrial carbon capture and storage (CCS)

Carbon capture and storage (CCS) refers to a set of technologies that capture the carbon emissions released from industrial processes or energy generation, then securely transports them for storage, avoiding up to 90 per cent of the emissions associated with these processes. Industrial CCS, which captures and sequesters the emissions associated with carbon-intensive industries like cement, steel and chemicals production, will be key in reducing emissions in the north of England. In many cases CCS is the only viable or technically feasible method of reducing emissions in these industries (CCSA 2017).

The North is uniquely well placed to deliver industrial CCS, given its concentration of carbon-intensive industries and their proximity to sites for storage. In particular, saline aquifers in the North Sea off the North East coast are a primary candidate for transporting and storing CO2 from carbon-intensive industries, with a storage potential of up to 14,250 MtCO2 (Smith 2010). To put this into context, these aquifers alone have enough capacity to store the UK's total emissions 35 times over (BEIS 2017c).[5] In addition, the Tees Valley is the only region in the UK which is promoting the piloting of an industrial CCS site, through the Teesside Collective (Teesside Collective 2017).

Industrial CCS has two main areas of economic potential. First, it will be key in allowing the carbon-intensive industries that make up a key part of the northern economy to remain competitive in the context of decarbonisation. This is particularly important as the EU emissions trading system will soon be ratcheting its ambition to raise the price of permits (Emden 2017). Second, CCS presents an opportunity for the North and UK to capitalise on its geological assets to develop knowledge, skills and products that can be exported into global markets. This is a significant opportunity and estimates suggest that the need to install 964GW of CCS globally by 2050 could generate a market worth over £100 billion a year from 2020 (Orion Innovations 2013). Support is needed for the North to capitalise on this opportunity.

4 Labour productivity is the measurable output per hour worked.

5 Based on total emissions for 2015.

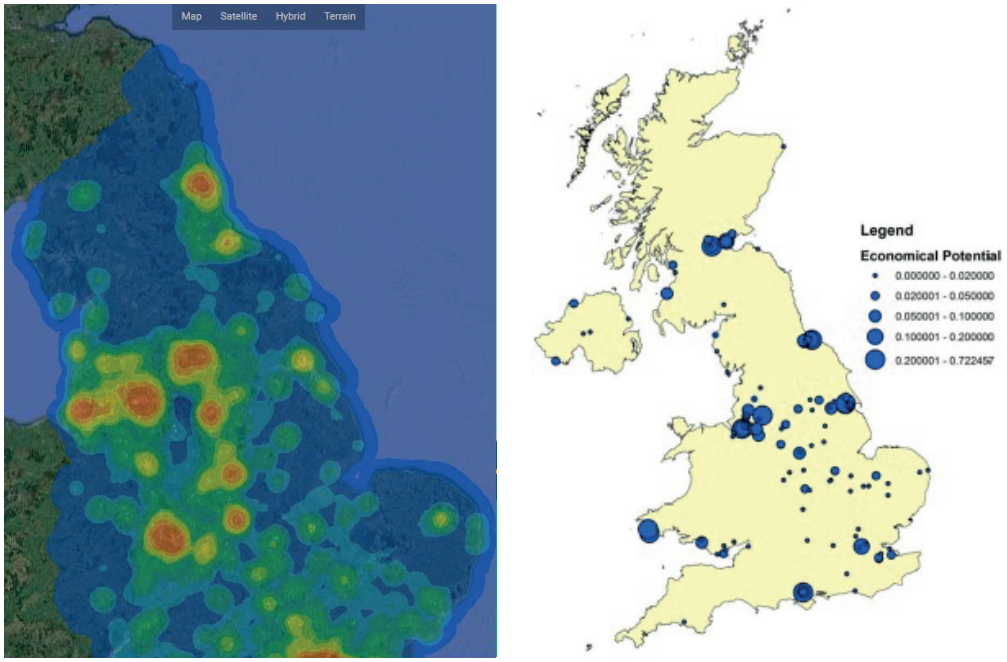
2. Industrial waste heat recovery

A second opportunity for the North to make use of its existing assets to reduce carbon emissions, while improving the competitiveness of industry, is presented in the recovery of waste heat. It is estimated that the UK potential for using waste heat stood at 30TWh, just over 10 per cent of total final industrial energy consumption in 2016 (Foster et al 2015, Waters 2017). The North has a particular specialism in the two industries with the highest heat loads: iron and steel, and chemicals. These industries also have the largest potential for recovery of high (>500˚C) and low (100–500˚C) grade heat (EPSRC 2011). In addition, the landscape analysis of the Northern Energy Taskforce demonstrated that there are three clusters of sites in the north of England which have a high economic potential for the recovery of waste heat (in the North West, North East and Yorkshire and Humber) and each of these sits close to seats of high heat demand (Baxter and Cox 2017b) (as shown in figure 3.6).

FIGURE 3.6

There are three key clusters of sites in the north of England where the economic potential from harnessing surplus heat is high

Waste heat and the potential for its recovery



Sources: (left) Centre for Sustainable Energy, 'National Heat Map' (CSE 2017); (right) Element Energy, *The potential for recovering and using surplus heat from industry* (Element Energy 2013)

Recovering waste heat makes industrial energy users more efficient. This has two clear benefits. First, it reduces carbon emissions by more efficiently using the heat that is being generated. Second, it makes industrial users more cost effective, through the re-use or re-sale of this waste heat (Law et al 2016). However, efforts to scale up the technology to more wide-scale use have faltered due to the complexity of negotiating contracts between industries and district heating schemes and investment barriers to installing heat recovery systems, which are often seen by industrial firms as an energy efficiency requirement that has relatively low importance within corporate priorities due to high up-front costs and long payback periods (Emden et al 2017). Accordingly, making waste heat recovery an explicit part of a low-carbon industrial strategy could help to unlock this potential by brokering between these two parties and effectively demonstrating the economic potential of the technology to firms.

4.
A NET-ZERO DECARBONISATION MISSION

The recent release of the Clean Growth Strategy has established the government's commitment to maximising the socioeconomic benefits of decarbonisation while ensuring it is undertaken at lowest possible net cost to the UK (BEIS 2017a). The success of this approach will be a function of the framework for the delivery of industrial strategy across sectors, value chains, and at different tiers of government.

A supply side approach to industrial strategy is not enough

Over the last 30 years, industrial policies have focused on the supply side of the economy, rather than those to drive demand (Jacobs et al 2017). Within that, supply side policy has been dominated by a horizontal approach that seeks to improve the conditions for private investment through, for example, funding for skills programmes and research and development. The BEIS select committee observes that, since the primary focus of the government's approach is on horizontal policies that do not directly promote demand, they should simply be viewed as traditional economic policy (BEIS SC 2017). IPPR's own report on industrial strategy for its Commission on Economic Justice argues that government should seek to co-invest with the private sector to increase the total level of investment in the economy and directly promote demand (Jacobs et al 2017). It should, at the same time, aim to maximise the positive domestic socioeconomic impacts of co-investments and policies, including directing investment and demand towards goods and services that accelerate decarbonisation. The report notes that such an approach has indeed been taken before to drive decarbonisation when, following the passage of the 2008 Climate Change Act, the government actively sought to attract offshore turbine manufacturing and assembly firms to the UK. It made available land and port capacity on the North Sea coast, supported the improvement of workforce skills and helped other UK companies invest to enter the supply chain (DECC 2009).

Since 2009, governments have generally defaulted towards sectoral approaches when considering more active, 'vertical' intervention into either sectors or technologies – although exceptions do exist, including the Catapult network created under the Coalition government. However, a solely sectoral approach to vertical interventions, though offering a logical organising basis for interventions, does little to recognise the cross-sectoral nature of value chains or the spillover effects needed to drive innovation within economies. It also increases the risk of capture by vested interests, and the promotion and subsequent adoption of suboptimal policies that benefit certain firms or sectors to the detriment of others and the wider public interest (Mazzucato 2017a).

Industrial strategy should include an explicit decarbonisation mission

Increasingly, the concept of key public 'missions' as an effective organising principle for industrial strategy has been informing debate, including the development of Innovate UK's strategy (Mazzucato 2014). Mission-based strategies start with a public policy problem and set a goal to overcome it, mobilising political and public sector support to boost industry in the cause of the goal, encompassing value chains by

necessitating a system-wide view (Mazzucato 2017b). In setting the objectives to be delivered by the economy, government can signal the path of future demand, match it to supply, and thereby improve confidence for private sector investment. In its industrial strategy white paper, the government has recognised the strength of this organising basis, setting out four 'grand challenges' to ensure that the UK is able to take advantage of global changes, including clean growth (HM Government 2017). The white paper also suggests that 'missions' could be developed to tackle particular elements of these challenges.

We recommend that decarbonisation should become an explicit mission for industrial strategy. Indeed, even prior to implementation of the white paper, much of the framework for a decarbonisation mission already exists, with the Climate Change Act providing a clear long-term demand side signal by requiring governments to produce emissions reductions plans every five years, consistent with an 80 per cent reduction on 1990 levels by 2050 (Climate Change Act 2008). These demand signals require a matching industrial strategy to ensure that the UK has the supply side – both in terms of technologies and businesses – to meet its decarbonisation goals. But this requires a decarbonisation mission to be coherently organised.

A national net-zero decarbonisation mission should integrate demand and supply

The organisation of mission-based industrial strategy requires four key elements.

The first is a statement of a clear and consistent goal towards which progress can be measured. In the case of decarbonisation, industrial strategy should be organised around a **mission to secure the greatest socioeconomic benefit to the UK from a reduction in greenhouse gas emissions to net-zero by 2050**. Adopting the net-zero goal would signal an increase in ambition above the current target of 80 per cent reductions, bringing the UK into line with the Paris agreement and continuing its global leadership in combating the causes of climate change. The Climate Change Act would need to be amended to enshrine the new target in law, something to which the previous government signalled its commitment in March 2016 (Hansard 2016).

Second, clear and measurable metrics are needed to measure progress towards the overarching goal (BEIS SC 2017). On one hand, decarbonisation is already measured by the CCC through the process of setting and marking progress towards carbon budgets, and using the Kyoto Protocol basket of greenhouse gases. On the other hand, key economic indicators should measure the economic impact of those low-carbon goods and services sectors driving decarbonisation, covering the effect on GVA, employment, market size and growth, and the number of exports and their value added, as used by current assessments of these sectors (Ricardo AEA 2017). These indicators should also cover wider socioeconomic factors, including geographical distribution of economic impact, the 'quality' as well as quantity of jobs and, in developing clean growth beyond just decarbonisation, the wider environmental impact of low-carbon development. Using the metrics so defined, the government should publish annual reports on progress towards reaching the mission goal. The dashboard should be updated as new data becomes available, ensuring the government is committed to transparency and accountability when meeting the mission, and data should adhere to standards of consistency and be freely downloadable (BEIS SC 2017).

Third, having established a clear, measurable long-term mission, a broad plan is needed for meeting it. Much of this is already established by the Climate Change Act, which requires the government to produce a plan for meeting the carbon budgets, setting out expected emissions reductions across sectors, covering power, buildings (including heat), industry, transport, agriculture, land use, land use change and forestry, and fluorinated gases (CCC 2017a). Released in October 2017, the Clean Growth Strategy sets out the policy framework by which the government

is seeking to reduce greenhouse gas emissions in line with the fourth and fifth carbon budgets, covering the period to 2032 (BEIS 2017a). In doing so, the strategy effectively signals the direction of market development and their size across sectors affected by decarbonisation. This is likely to have a significant economic impact as it provides strong incentives for investment in goods and services to meet the projected demand, reducing uncertainty and risk for firms and investors.

Fourth, in signalling a future direction for demand, the decarbonisation mission needs a supply side strategy to support UK-based businesses in meeting this demand. Such a strategy should have a particular focus on areas in which the UK has an advantage, from academic expertise to industrial specialisation, and, in doing so, should assess the strengths and weaknesses of firms, sectors and value chains and map their geographical location. In improving the conditions in which these firms can seek to meet demand, the strategy should use a full array of supply side measures, many of which are provided by the Clean Growth Strategy. Particular emphasis should be placed on nurturing innovation, strengthening domestic supply chains, developing skills for low-carbon and environmental goods and services sectors and carbon-intensive industries, and growing the 'green finance' capabilities of the finance sector in supporting early stage development of firms. In this way, the decarbonisation mission should provide a strong organising focus for BEIS and departments across government, and the British Business Bank, UK Research and Innovation, and Innovate UK, the latter of which already has a focus on the supply side of decarbonisation.

The decarbonisation mission is a cross-department responsibility

The decarbonisation mission is system-wide and therefore is a cross-departmental responsibility. This is already recognised by central government through the Climate Change Act's disaggregation of emissions by sector. Driving the development and adoption of technologies and systems also affects a number of departments across government. An example of potential systems-change to accelerate decarbonisation across value chains and sectors is the 'mobility transition' towards a more shared, efficient and clean transport system, which has been identified as a 'grand challenge' by the government's industrial strategy white paper (HM Government 2017). This transition should enable digital technology and shared transport models to operate as a network to reduce vehicle use, encourage faster fleet cycling away from unsustainable fuels, and unlock behaviour change that crowds in public transport and walking and cycling (Laybourn-Langton 2017). Such a transition involves the adoption of ultra low emission vehicles (ULEVs) and shared and connected mobility services, such as car clubs, and therefore requires the coordination of a number of different departments of government:

- the Department for Business, Energy and Industrial Strategy (BEIS), through energy policy and the ongoing development of the industrial strategy
- the Department for Transport, which oversees transport across the UK and works with BEIS, through the Office for Low Emission Vehicles (OLEV) and the Centre for Connected and Autonomous Vehicles (CCAV), to drive innovation and adoption across ULEVs and connected transport systems
- HM Treasury and its approval of additional spending and the devolution of certain fiscal powers
- the Department for Environment, Food and Rural Affairs (Defra), whose air quality plans are a key demand driver, alongside carbon budgets
- the Department for Communities and Local Government (DCLG), which works with urban authorities, who must ultimately lead in the rollout of a cleaner, more efficient mobility system.

In order to coordinate the development and implementation of technologies and systems that drive decarbonisation across central government, **we recommend the creation of a cross-departmental Decarbonisation Mission Unit that ensures a systems-wide approach to realising the overall mission is achieved**. This should be located either within BEIS, or (for greater influence over other departments) the Cabinet Office, and work closely with the government's planned independent Industrial Strategy Council (HM Government 2017). Key areas of focus for the unit should cover:

- **responsibility for measuring and assessing mission progress**, working with the Committee on Climate Change to assess and present the state of the mission through the dashboard and annual report
- **coordinating the implementation of the Clean Growth Strategy across departments**, as part of the decarbonisation mission's supply side strategy to support firms and value chains in meeting the demand created by the mission; working with Innovate UK and other agencies, as well as coordinating with subnational bodies and the proposed Industrial Strategy Council
- **working with departments to coordinate public procurement** to drive and meet demand
- **developing a legal framework to support industrial strategy across government** – in particular, integrating demand and supply will require a new set of UK state aid rules to replace the EU rules after Brexit (Jacobs et al 2017).

The decarbonisation mission requires regional powers and institutions

The promotion of the adoption of technologies and systems by which to achieve the decarbonisation mission is also a subnational responsibility. Using the example of the mobility transition, local transport authorities administer the transport systems of urban centres and so are key to the rollout of shared, connected and ultra low emission transport technologies and services. Indeed, experience of regional growth in other developed countries suggests that effective industrial strategy at subnational level requires strong regional authorities (Colebrook 2016). When complemented with greater fiscal autonomy, this would allow for the level of policy integration needed to deliver the decarbonisation mission. the Northern Energy Strategy has set out a framework for realising the potential of decarbonisation of the energy system in the North, identifying devolution of powers from central government to the North and greater collaboration across the region as key enablers (Baxter and Cox 2017a). At the heart of this framework is the devolution of a proportion of the national carbon budget to the North.

Devolution of carbon budgets to the regional level could improve the overall capability through which the decarbonisation mission can be achieved by galvanising local buy-in and driving regional ambition with local actors being able to make decisions over how greenhouse gases are emitted. As such, we recommend that **regions across England should be given powers to adopt a regional carbon budget that binds a region to reduce emissions by an agreed amount over five-year periods**. In doing so, regions should be able to set and drive progress towards regional missions that promote certain technologies and systems across a region (we explore this in chapter 5). For example, if a region wanted to support a more carbon-intensive industry it would have to take much more ambitious action to reduce emissions elsewhere, or look at technologies to abate those emissions. In practice this would place greater responsibility and accountability on to regional leaders and allow them to make the best of local opportunities, while allowing central government to focus their resources on facilitating these efforts. We note that both the Scottish and Welsh governments are developing approaches to carbon budgets.

In the case of the North, the Northern Energy Strategy recommends new settlements with central government through which carbon budgets can be devolved to the northern level, including:

- **Local Energy Devolution Deals:** to give mayors and their combined authorities greater control over energy efficiency funding, building standards and system operations, in order to tackle fuel poverty and drive decentralised energy schemes
- **a Northern Energy Compact:** giving northern stakeholders the ability to adapt policy incentives and regulatory functions to encourage investment in renewable generation and clean technologies in exchange for direct responsibility for a 'northern carbon budget'.

Within this framework, pan-regional institutions would be needed to work with the Decarbonisation Mission Unit and Committee on Climate Change to set regional carbon budgets – beginning with the third budget period covering 2018–2022, and which requires government to reduce UK emissions by 37 per cent of 1990 levels by 2020. These regional institutions would also need to monitor their regional carbon budgets and evaluate progress against a range of strategic goals. In the case of the North, the IPPR Northern Energy Strategy has recommended the creation of 'Energy for the North', a new strategic body with overall responsibility for a northern carbon budget, which may ultimately become a statutory body, much like Transport for the North (TfN). Energy for the North would work with other pan-northern strategic bodies, including TfN and business partnership bodies, with a view to integrating energy issues within other strategic planning issues including the Strategic Transport Plan and any spatial strategy as it emerges.

Similar institutions will be needed in other regions, and will also need supply side capabilities. For this reason, the IPPR Northern Energy Strategy has recommended the creation of the 'Northern Energy Accelerator', an agency that ensures northern energy innovation is translated into both commercial and social success by supporting innovation across its lifetime – from early stages to commercialisation and scale-up – and to coordinate ideas, activities and project development across LEP areas and support integration with centres of research and expertise, such as universities and Catapults. Energy for the North should have oversight of the Accelerator and work with the Decarbonisation Mission Unit to ensure the supply side strategy of the mission is integrated with local approaches enabled by the Northern Energy Compact and Local Energy Devolution Deals.

In sum, successful delivery of a decarbonisation mission requires the integration of demand and supply at both the national and regional levels. For the North, a northern carbon budget should underpin demand drivers across the region, with a Northern Energy Compact being the mechanism through which the region is given powers to deliver on this budget, including powers over supply side interventions. Energy for the North would then act as the linchpin for a strong institutional structure through which the mission can be delivered at the regional level. We now turn to how this framework can operate to realise the potential of those northern opportunities mapped in chapter 3.

5. IMPLEMENTING THE MISSION AT THE REGIONAL LEVEL

In this chapter, we explore how the North can deliver the net-zero decarbonisation mission. Using the framework set out in the last chapter, the North would have a devolved carbon budget allocating responsibility for a proportional amount of the overall national mission. In seeking to realise this goal, the region should be empowered to determine how it drives the development of certain systems and technologies.

We refer to local application as a 'regional mission'. Regional missions are compatible with the government's conception of a 'local industrial strategy' set out in the recent industrial strategy white paper (HM Government 2017). Regional missions would provide a local organising principle by which the process toward achieving net-zero-decarbonisation is delivered.

As is the case nationally, a vast number of technologies and potential systemic changes exist that could drive decarbonisation. We shall concentrate on three case studies to illustrate the application of regional missions in the North, constituting those areas of potential mapped in chapter 3.

- **The energy transition.** The North is faced with a number of challenges regarding the energy system: traditional power generation is in decline; a high incidence of energy-intensive users has led to disproportionately high demand; and reliance on national policy potentially affects its ability to exploit new generation opportunities.
- **The carbon intensives transition.** Carbon-intensive industries are very important to the region, both economically and socially. However, they are already being impacted by decarbonisation as they struggle with higher energy prices and international competitiveness, among other factors.
- **The mobility transition.** The North's transport system is essential to its economy, but is also responsible for – or at least significantly contributes to – major socioeconomic problems, including carbon emissions, air pollution and congestion. Meanwhile, technological change has opened up profound opportunity to limit or accelerate these problems.

Overcoming the respective challenges of each transition, while minimising socioeconomic costs and realising the potential of new and emerging technologies is crucial if the North is to realise its potential, and the nation is to achieve the overarching decarbonisation mission.

5.1 THE ENERGY TRANSITION

As the Northern Energy Strategy has identified, the regional transition to a low-carbon energy system is an example of a regional mission in which the North has substantial capacity to contribute to the national mission because of its regional strengths and resources (Baxter and Cox 2017a). In this section we build on the institutional environment described in the last chapter by exploring how specific technology areas can be supported that have particular northern expertise and do

not already receive support. Based on our analysis in chapter 3, we will set out in more detail two key areas of potential: domestic energy efficiency and hydrogen.

5.1.2 Domestic energy efficiency

Given the high proportion of northern housing stock with an energy efficiency rating of D or worse, and the wide range of socioeconomic benefits that could result from greater efficiency, domestic retrofit is a key priority for the region. Accordingly, the IPPR Northern Energy Strategy has set out how a devolved energy efficiency delivery programme could work. It proposed that the responsibility for the introduction of energy efficiency measures should be switched from energy supply companies to energy distributors (DNOs). In addition, we have argued that mayors and combined authorities should seek to strike Local Energy Devolution Deals with government. Central to these deals is the devolution of the receipts from the carbon floor price (CFP) and emissions trading scheme (ETS). In aggregate, households in the North pay around £260 million in carbon taxes though fuel bills, with an average cost of £70 per bill payer. These tax receipts are not currently deployed to address major infrastructure projects for decarbonisation; devolution would enable local actors to work with DNOs in scaling energy efficiency measures.

Alongside raising existing housing stock to the appropriate standard, the Northern Energy Strategy proposes that local authorities across the North adopt a 'northern low-carbon homes commitment, ensuring that all new build properties meet the original low-carbon homes standards dropped by central government. In the Clean Growth Strategy, the government is ratcheting up support for domestic energy efficiency including two £10 million innovation programmes to develop new power and heat-efficient products on top of £184 million already committed to domestic efficiency improvements between 2015–2021. In seeking to gain from these funding sources, we recommend that the **Northern Energy Accelerator convene a consortium of academic and industry stakeholders to develop a zero-carbon heating standard in the North** in order to help decide which of the most promising heat technologies would warrant inclusion in the low-carbon homes standard.

5.1.2. Hydrogen

The Clean Growth Strategy suggests a pathway where hydrogen could provide up to 62 per cent of domestic heat demand by 2050 (BEIS 2017a). Given the existing asset base for hydrogen described in chapter 3, industrial chemical hubs like Tees Valley and Cheshire and Warrington, combined with demand centres like Liverpool, Manchester, Leeds and Sheffield, should aim to become the first LEP areas to realise this ambition. Indeed, the H21 project is already a leading demonstrator of the potential for hydrogen in existing gas networks. However, as the Climate Change Committee notes, there are still uncertainties around the cost of large-scale conversion of gas grids to hydrogen which would need to be addressed through developing engineering design studies, standards and field trials (CCC 2016b). We note that the government has committed to an additional £25 million to fund projects seeking to use hydrogen as an alternative to natural gas (BEIS 2017a). In order to coordinate findings and serve as a focal point for the studies and demonstration projects required, we recommend that **central government create a Hydrogen Catapult located in the Tees Valley** which would collaborate extensively with, and feedback to, the Northern Energy Accelerator proposed by the Northern Energy Strategy.

With regards hydrogen energy storage, despite a £265 million commitment to smart systems including energy storage, the Clean Growth Strategy does not set any explicit targets for deployment of storage, or which technologies should be used to achieve this. With extensive underground storage potential in the North, we recommend that **the first commercial power-to-gas hydrogen storage project in the UK be established in either the Tees Valley or Cheshire and Warrington by 2025.** In order to identify potential vendors of this technology, relevant LEPs

should coordinate industry roundtables for innovative companies in the hydrogen sector before formally issuing tenders for feasibility studies. Finally, to support this work the Northern Energy Accelerator should be given the funding to establish the new Hydrogen Catapult, which would also fund demonstration projects looking into the potential for power-to-gas storage with a view to meeting the ambition of a commercial project by 2025.

5.2 THE INTENSIVES TRANSITION

As we explored in chapter 3, carbon intensives are a major part of the northern economy. Transitioning industries to lower levels of carbon generation is an example of a regional mission that requires immediate attention to minimise economic costs imposed by national and global decarbonisation. The North also has above-average potential in developing and adopting solutions. Supporting carbon intensives will require the coordination of energy policy and industrial strategy. Our analysis in chapter 3 identified two key arears for intervention: industrial CCS and waste heat recovery. Before examining these it is important to understand what carbon intensives can do to transition to meet the net-zero challenge.

5.2.1. Efforts to transition to a net-zero-carbon-intensive industry

The CCC suggests that direct (non-electricity) industrial emissions will have to be reduced by 41 per cent by 2027 on 2007 levels (CCC 2010). In order to ensure that carbon-intensive industries are aligned with the overarching climate science, we recommend that they should, as a baseline, all seek to **set science-based targets using respected methodologies such as the Sectoral Decarbonisation Approach** (Science Based Targets 2015). Doing so will help carbon intensives develop clear, individualised strategies while contributing proportionately to overall industrial decarbonisation targets. Once science-based targets have been set, carbon-intensive industries will need to access finance for procuring energy-efficient equipment. To this end, in the Clean Growth Strategy, the government has identified industrial energy efficiency as a priority area for reducing emissions, reaffirming a commitment to £9.2 million for an industrial energy efficiency accelerator as well as promising a new industrial energy efficiency scheme.

For those northern industries whose energy supply does not directly impact the method of production (for example the need for high-grade heat in chemical manufacturing), we recommend that **these companies should commit to sourcing 100 per cent of their electricity from low-carbon sources by 2023**.[6] Those sectors where energy is crucial to the manufacturing process itself, and for whom the transition to entirely low-carbon sources by 2023 is unlikely to be feasible, **should replace existing fuels with biomass and/or hydrogen with a view to these accounting for 15 per cent and 32 per cent of energy use respectively by 2050.**[7] Aside from reputational benefits, carbon-intensive industries would insulate themselves from fluctuating carbon permit prices and would be able to sell their own to provide extra revenue.

As part of this scheme, as with domestic energy efficiency, we recommend that the **government should devolve fiscal powers to local authorities in order to offer low interest loans for energy efficiency equipment coordinated as part of Local Energy Devolution Deals** to help carbon-intensive industries meet their science-based targets. To de-risk the take-up of these loans, local authorities should also act as a guarantor that savings from the energy efficiency equipment will always be lower than the interest charged.

6 The date at which the newly contracted CfD-funded offshore wind projects will be completed.
7 According to the hydrogen pathway set out in the Clean Growth Strategy.

5.2.2. Industrial CCS

Industrial CCS was identified as both key to decarbonising carbon-intensive industries and as having major economic potential in and of itself. As mentioned in chapter 3, proposals for industrial CCS already exist in the Tees Valley. As an immediate priority, we recommend that **the government should fund the Teesside Collective's proposed industrial CCS project in Tees Valley** which has an innovative business model where ETS permits are passed back to government which can recoup a large portion of initial revenue through their sale (Teesside Collective 2017). The Northern Powerhouse Partnership estimates that the construction of the required CCS infrastructure in the Tees Valley would require £110 million in investment.

These projects can then generate learnings which should be applied to other industrial clusters in the north of England in Cheshire and Warrington, and Sheffield. The Clean Growth Strategy proposes to set a Carbon Capture Usage and Storage (CCUS) Council to monitor costs and deployment of CCUS. Learnings from funded industrial CCS projects should not only be fed back to this council but, in addition to, or as an extension of this council, we recommend that **BEIS and Innovate UK carry out a feasibility study for the establishment of a CCS Catapult in the next parliament**, to accelerate CSS research, development and deployment through collaboration between businesses and academic and research hubs. It is possible that a Catapult could have responsibility for supporting industrial CCS projects beyond the Tees Valley as well as the exploration of any bioenergy with carbon capture and storage (BECCS) feasibility studies and pilots in the North.

5.2.3. Industrial waste heat recovery

With industries that produce high levels of high-grade waste like the steel and chemical sectors located close to areas of high heat demand, the north of England is particularly well placed to develop industrial waste heat capabilities. As such, drawing from studies exploring the potential of waste heat, we recommend that **partnerships between industry and local authorities in the north of England should aim to generate at least 15TWh of recovered heat by 2050** (Foster et al 2015). The Clean Growth Strategy explicitly states the government's intention to create an industrial waste heat recovery programme which would be well placed to support this target. In addition, where large industries are close to urban centres, we recommend that **the Northern Energy Accelerator should explore industrial waste heat recovery opportunities in collaboration with HNDU-assisted local heat strategies**, as is currently being explored in cities like Stoke-on-Trent. Assistance would take the form of networking between suppliers of heat recovery equipment and the intensive industries in question, funding for pilot projects, connecting industries with HNDU and local authorities and working with partners to develop business models which make heat recovery viable. This may involve a role for the establishment, or expansion, of municipal energy companies, ensuring that local actors capture value in this process.

5.3 THE MOBILITY TRANSITION

While the North's road transport is a major user of energy and contributor to carbon emissions, it is also responsible for – or at least significantly contributes to – major socioeconomic problems, some of which are a factor in its carbon intensity: air pollution, congestion, inefficient use (Laybourn-Langton 2017). These are likely to increase over time, as the growing understanding of the leading role road transport plays in contributing to illegal levels of air pollution has dramatically enhanced the political salience of transport policies. Overcoming these problems will primarily involve changes in the fuel mix of transport fleets and increases in the efficiency of vehicle use.

- **Fuel**: increasing fleet turnover to ultra and zero emission fuels, including electric, hydrogen and gas-powered vehicles.
- **Utilisation**: increasing shared vehicle use, decreasing private use and ownership, consolidation of commercial activities and a transfer to rail and shipping, and reconsidering road building programmes that are likely to induce demand.

Transitioning to a cleaner, more efficient transport system is an example of a regional mission that is already being prosecuted across the UK, with central and local governments increasingly enacting policies to achieve a faster turnover in the vehicle fleets, from diesel and petrol engines to low and ultra low emission alternatives, including electric, hydrogen and gas (Laybourn-Langton et al 2016b). This looks set to accelerate a transition to cleaner, more efficient vehicles that has been under way for decades, partly as a result of the imperative to decarbonise transport fleets in meeting the UK's climate change obligations.

Meanwhile, developments in digital technology have opened up profound opportunities to improve network efficiency, including an increase in shared vehicle use, a decrease in the overall number of journeys and vehicles, and greater penetration of cleaner fuels (Laybourn-Langton 2017). Yet these technologies could also promote suboptimal travel behaviours, including the inducement of short journeys by on-demand private hire services and the crowding out of public and active transport. The direction of policy will decide how transport systems will adapt to these new mobility technologies, and the promotion of ultra-low emission and connected and autonomous vehicles features as a major strand of the government's emerging industrial strategy – having been identified as one of the four 'grand challenges' - and the Clean Growth Strategy (BEIS 2017a, HM Government 2017).

In undergoing a mobility transition to a cleaner, more efficient transport system, the North has resources to help it do so, and an increasingly coordinated policy environment (Laybourn-Langton 2017).[8] However, greater clarity is needed to formalise the mobility transition into a regional mission. As such, we recommend that **Transport for the North and local and combined authorities agree the constituent targets of a regional mobility transition mission**, covering carbon emissions, air pollution, fleet turnover, the adoption of new mobility technologies and their supporting infrastructures. In supporting this, Transport for the North and local and combined authorities should publish easily accessible transport data on air pollution, carbon emissions, congestion and vehicle utilisation rates across the region.

In realising this mission, local authorities and local enterprise partnerships need to work in conjunction with TfN and other regional bodies. In doing so, we recommend that they **develop Local Mobility Transition Plans for realising the socioeconomic potential of sustainable transport and new mobility services**. These plans should cover the turnover of unsustainable vehicles out of fleets, increases in shared mobility and maximisation of the system-wide benefits of more connected transports, including measures to:

- **introduce clean air zones** to increase the cost of driving unsustainable vehicles
- **ensure integration with all statutory planning processes** to support the transition and maximise its benefits; in particular, spatial planning can support the transition to cleaner, more efficient mobility by reducing the need to own a private vehicle

8 As IPPR has argued, action on the national level is an important precondition in overcoming major transport-related problems, particularly air pollution. Therefore, we have called for the introduction of a new Clean Air Act, to accelerate turnover of vehicle fleets, and the introduction of smart scrappage schemes, which incentivise cleaner, more efficient transport behaviours (Laybourn-Langton et al 2016a).

- **audit new mobility markets across the region**, including car share, journey planners and on-demand private hire vehicles, and assess their current and potential effects on carbon emissions and other key transport-related outcomes
- **provide a vision and framework for new transport technologies** in which shared transport and digital technologies are able to realise their potential in driving positive transport outcomes.

As recommended by the IPPR Northern Energy Taskforce, Transport for the North should convene a Northern Transport Energy and Sustainability Working Group to help coordinate Local Mobility Transition Plans, ensuring these efforts are joined up with pan-regional transport strategies. In doing so, Transport for the North should work with other regional bodies, including Energy for the North and the Northern Energy Accelerator, to maximise the economic opportunities of the mobility transition, including in areas of potential covered above. In the case of hydrogen, plans should match the UK H2 Mobility ambition to have hydrogen infrastructure in every major northern metro area and accelerate this process by investing in municipal transport projects that use FCV-based vehicles.[9] This is already happening in some metro areas like Liverpool and Sheffield, but learnings should be shared across the North.

9 Fuel cell vehicle (FCV), also known as fuel cell electric vehicle (FCEV).

6. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Net-zero decarbonisation is a significant opportunity for the UK economy, as well as a profound challenge. This is particularly true for the north of England. Its economy has a higher than average carbon intensity than the rest of the country, which is a partly a result of a high incidence of carbon-intensive industry. These industries are an essential part of the regional economy and are already struggling to keep costs low as they decarbonise and become increasingly threatened by global competition. At the same time, the North is home to a vibrant low-carbon goods and services sector, and the region generates nearly half of England's renewable energy. These goods and services provide large economic benefit to the region and are already supporting carbon-intensive industry in decarbonising. As this report has shown, this is only the beginning, with the North having large potential to grow its low-carbon goods and services sector and support its carbon-intensive industries over the decarbonisation transition.

At the national level, the decarbonisation challenge is one of the British economy's many deep structural problems. The government's development of an explicit industrial strategy and a Clean Growth Strategy provide a strong foundation upon which the economy can undergo the rapid structural change needed to reach net decarbonisation by the midpoint of the century. Yet, more coordination between demand and supply is needed to achieve this. This is why we recommend an explicit mission to decarbonise the British economy as a central organising principle for industrial strategy. While some of the policy structures for delivering this mission already exist, including the Climate Change Act and carbon budget, more focus is needed at the regional level.

Accordingly, regional carbon budgets would enable the North to set and drive progress towards regional missions that promote certain technologies and systems across a region. These regional missions should include transitions:

- in the energy sector, towards more renewable generation and efficient use of energy
- in carbon-intensive industries, through the development of carbon capture and storage technologies and the recovery of heat
- in mobility, through the development and adoption of connected and ultra low emission vehicles and transport systems.

This report has recommended a raft of policies to drive these transitions and, through the devolution of powers and responsibilities, to enable regional stakeholders to realise the North's potential in realising a great national mission to decarbonise the economy.

6.2 RECOMMENDATIONS

We recommend the central government should:

- Declare a mission to secure the greatest socioeconomic benefit to the UK from a reduction in greenhouse gas emissions to net-zero by 2050.

- Establish a cross-departmental Decarbonisation Mission Unit in BEIS or the Cabinet Office with responsibility for:
  - measuring and assessing mission progress
  - coordinating the implementation of the Clean Growth Strategy across departments, as part of the decarbonisation mission's supply side strategy
  - working with departments to coordinate public procurement to drive and meet demand
  - developing a legal framework to support industrial strategy.
- Give powers to UK regions to adopt a regional carbon budget that binds a region to reduce emissions by an agreed amount over five-year periods.
- Devolve fiscal powers to local authorities in order to offer low interest loans for energy efficiency equipment coordinated as part of Local Energy Devolution Deals.

In the north of England, we recommend that:

- Central government establishes a Hydrogen Catapult located in the Tees Valley.
- The government should fund the Teesside Collective's proposed industrial CCS project in Tees Valley .
- BEIS and Innovate UK carry out a feasibility study for the establishment of a CCS Catapult in the next parliament .
- LEPs coordinate to find vendors to establish the first commercial power-to-gas hydrogen storage project in the UK to be in either the Tees Valley or Cheshire and Warrington by 2025.
- Partnerships between industry and local authorities in the north of England should aim to generate at least 15TWh of recovered heat by 2050.
- Transport for the North and local and combined authorities agree the constituent targets of a regional mobility transition mission.
- Transport for the North and other regional bodies develop Local Mobility Transition Plans for realising the socioeconomic potential of sustainable transport and new mobility services to:
  - introduce clean air zones
  - ensure integration with all statutory planning processes
  - audit new mobility markets across the region
  - provide a vision and framework for new transport technologies within the existing transport system.

We recommend that carbon-intensive industries in the North should:

- Set science-based targets using respected methodologies such as the Sectoral Decarbonisation Approach.
- Commit to sourcing 100 per cent of their electricity from renewables by 2023, while those who cannot should replace existing fuels with biomass and/or hydrogen with a view to these accounting for 15 per cent and 32 per cent of energy use respectively by 2050.

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