West Yorkshire Combined Authority

Clean Growth Audit, Sector Analysis and Delivery Plan

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Synthesis Report

September 2019

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Authorisation and Version History

Version	Date	Authorised for release by	Description
1.0	22/08/19	Jon Stenning	Synthesis report, building on earlier drafts of an interim report.
1.1	12/09/19	Jon Stenning	Final draft of synthesis report, addressing client comments on earlier draft.

Contents

1 Introduction

1.1 Background

National policy background

Through the 2008 Climate Change Act, the UK government is committed to long-term, legally binding targets to reduce carbon emissions. The Climate Change Act was recently (June 2019) updated to commit the UK to reducing net carbon emissions (including GHGs measured on a carbon equivalence basis) to net zero by 2050, a higher level of ambition than the previous target to reduce carbon emissions by 80% below 1990 levels by 2050. Progress towards the overall target is managed and monitored by five-year carbon budgets, which have not yet been updated to reach the net zero target.

According to the Committee on Climate Change, who are responsible for assessing whether the UK is on track to meet its emissions targets, the fourth carbon budget covering the period 2023-2027, with a target to reduce emissions by 51% by 2025, is not currently on target to be met. This shortfall in meeting the next carbon budget is partly addressed by the Clean Growth Strategy, announced by the Department for Business, Energy and Industrial Strategy (BEIS). In order to meet future carbon budgets and achieve the 80% emissions reduction target enshrined in these carbon budgets by 2050 (i.e. less ambitious than the revised 2050 target of net zero), the UK will need to reduce carbon emissions by at least 3% per year from the present day. A sustained, annual 3% reduction in emissions is a major challenge, and the Clean Growth Strategy recognises the need for accelerated 'clean growth', whereby economic growth continues while emissions are simultaneously reduced (i.e. achieving absolute decoupling of economic growth and emissions). The strategy sets out how the UK government can support the development of low carbon technologies that improve energy efficiency, improve the share of renewable energy in the energy mix and accelerate the shift to low carbon transport. The Clean Growth Strategy recognises that nurturing the development of these technologies and associated sectors brings many social and economic benefits to the UK.

The themes and objectives of the Clean Growth Strategy are supported by the Government's Industrial Strategy. The Industrial Strategy sets out four 'Grand Challenges', one of which focuses on clean growth and maximising the many opportunities available to UK industry from the global shift to clean growth. A shift to lower carbon and resource efficient alternatives to conventional high-carbon goods and services offers a significant opportunity for the development of new and fast-growing sectors to satisfy global demand. The UK can achieve the clean growth 'Grand Challenge' by utilising its existing strengths to become a first-mover in the development and manufacture of low-carbon technologies and services, offering cheaper alternatives to conventional high-carbon goods and services.

The Clean Growth Strategy, alongside the Government's Industrial Strategy, sets out national plans for decarbonising the UK economy while facilitating economic growth and boosting productivity. Both strategies focus specifically on plans to shape the future UK economy. Meanwhile, the 25 Year Environmental Plan sets out a series of goals for improving and protecting the UK environment, including plans to improve air and water quality, to protect

plants and wildlife, to use natural resources more sustainably and efficiently, to minimise waste and to mitigate and adapt to climate change. The Plan details how central government will work with communities and businesses to achieve these goals. Furthermore, the Waste Strategy supports the pledges made within the 25 Year Environmental Plan by setting out a strategy for minimising waste, promoting resource efficiency and moving towards a more circular economy. The 25 Year Environmental Plan and Waste Strategy have imperative influence on how the aims and objectives of the Industrial Strategy and Clean Growth Strategy are achieved.

Together, all the aforementioned Government initiatives will help determine what goods and services are developed and promoted in the near future, what future sectors may emerge as a result, and how sectoral compositions of economies (both nationally and locally) will change.

Local policy background

The goals of all central government strategies filter down to more local level, influencing the direction of local industrial and environmental strategies. At a local level, Local Enterprise Partnerships (LEPs) are responsible for delivering Local Industrial Strategies - long-term, evidence-based plans aligned to the national Industrial Strategy that, amongst other aims, identify local economic strengths, opportunities and challenges and promote clean growth, the development of a more circular economy and the decarbonisation of the local economy.

As required, Leeds City Region LEP (City Region LEP) is currently in the process of developing its own Local Inclusive Industrial Strategy (LIS). The LIS will build upon the aims set out in the Leeds City Region Strategic Economic Plan (Leeds City Region LEP 2016). To achieve the Plan's overall vision, the City Region pledged to 'make good progress on Headline Indicators of growth and productivity, employment, earnings, skills and environmental sustainability'. 'Clean energy and environmental resilience' is one of the four key priorities of the strategy, achieved through initiatives such as the development of the City Region as a leading centre for low-carbon energy development and making green infrastructure integral to improving the City Region economy.

Similarly, the LIS will take in to account North Yorkshire's Plan to Deliver Economic Growth (North Yorkshire County Council 2017), recognising the Plan's vision for sustainable economic growth. The Plan to Deliver Economic Growth includes various growth enablers, some of which are particularly relevant for the development and promotion of clean growth sectors. These enablers include increasing the skills base of the local workforce, ensuring they are equipped with the right skills for a changing economy, enhancing the natural environment and developing a green economy which utilises the region's natural assets. The Plan identifies future growth sectors in emerging industries, including some related to clean technologies and services, such as agri-tech and biorenewables.

Economic features of the region

Due to a strong industrial sector, the Leeds City Region (City Region) is identified as the largest economy outside of London and the South East, accounting for over 4% of national output. At the same time, the industrial and commercial sectors in the region account for 34% of total energy consumed and energy-related emissions produced in the region. The City Region Energy Strategy Delivery Plan (ESDP) states that energy demand is expected to

increase by 13% in the region over the next 20 years, highlighting the need to further decarbonise the local economy and develop clean growth sectors.

However, the features and activities of clean growth sectors in the West and North Yorkshire (W&NY) region (which includes the City Region and York & North Yorkshire region) are not currently fully understood by the LEPs and Local Authority. It is not clear which industrial sectors in the region are most energy- or resource-intensive or produce the highest levels of emissions. At the other end of the scale, a clearer picture is needed about firms operating in clean technology sectors, and whether there are opportunities to develop, facilitate or support low carbon sectors and clean technology clusters.

1.2 Study aims and objectives

This project provides a Clean Growth Audit for the W&NY region, which includes the districts of Bradford, Calderdale, Leeds, Wakefield, Kirklees, York, Selby, Harrogate, Craven, Hambleton, Scarborough, Richmondshire and Ryedale (shown in Figure 1.1).

Figure 1.1 West and North Yorkshire region

The Clean Growth Audit aims to help the West Yorkshire Combined Authority (the CA) understand the barriers, opportunities and key issues affecting the growth of the low-carbon economy in the W&NY region. The Audit identifies where and how local clean growth sectors can aid the reduction of energy and resource use, and can help to reduce carbon emissions associated with industrial practises (both now and in future).

This report identifies the most energy- or resource-intensive sectors of the local economy (in Chapter 2), identifies and maps local firms working within low carbon and sustainability service sectors and opportunities for forming technology clusters (in Chapter 3), and makes strategic recommendations to advance clean growth sectors and decarbonise energy, resource and carbon intensive industries, building on existing opportunities (in Chapter 4). The

report draws on a range of sources, including published data and engagement with stakeholders. The findings presented in this report align with the local energy strategies and therefore inform the development of the LIS.

1.3 Structure of the report

This rest of this report is structured as follows:

- Chapter 2 identifies and analyses which industries in the W&NY region have the greatest demand for energy and resources and emit the highest levels of GHG emissions.
- Chapter 3 identifies and maps clean growth sectors present in the region and identifies regional strengths and opportunities in low-carbon and clean technologies and services.
- Chapter 4 synthesises all the evidence presented in earlier chapters of the report and identifies the opportunities with the greatest potential to develop clean growth sectors in the region.

2 Identification of local energy- and resource-intensive industries

2.1 Policy background

What are energy- and emissions-intensive sectors?

To meet the UK's carbon budgets, a key part of the transition to a low carbon economy will be the decarbonisation of industrial sectors, including those that are energy-, emissions- and resource intensive. According to the UK Government, a business is deemed to be 'energy-intensive' if it falls within a specified list of economic sectors (including manufacturing sectors such as the manufacturing of chemicals, steel, aluminium, cement and paper & pulp), and if energy costs amount to 20% or more of gross value added (GVA) over a given period (Department for Business, Energy & Industrial Strategy 2019).

Cross-overs between energy- and emissions-intensive sectors

Energy-intensive sectors contribute to total UK emissions both directly, through production processes which include the combustion of fossil fuels and by sector-specific processes, such as chemical processes, and indirectly through high levels of electricity usage. Some industries are both energy-intensive and also directly produce high levels of emissions per unit of output through production processes. Industrial processes were responsible for more than 2% of UK emissions in 2017, originating mostly from cement, lime, sinter, iron and steel, glass and ammonia production. When considering also the emissions from fossil fuel combustion and electricity usage, the business sector accounted for more than 17% of total country's emissions in 2017 (Department for Business, Energy & Industrial Strategy 2019).

On the other hand, other sectors may not be classed as energy-intensive, but sector-specific activities directly produce high levels of emissions. Large sectors such as agriculture, power and transport are therefore considered to be emissions-intensive, but not necessarily energy-intensive.

Agriculture was responsible for almost 10% of all UK emissions in 2017, mostly in the form of methane (CH_4) and nitrous oxide (N_2O) which accounted for, respectively, 56% and 25% of the sector's emissions (Committee on Climate Change 2019). The great majority of farm-related emissions did not originate from the combustion of fossil fuels, but from the digestive process of livestock (47%) and nitrogen fertiliser use (25%) (Committee on Climate Change 2019).

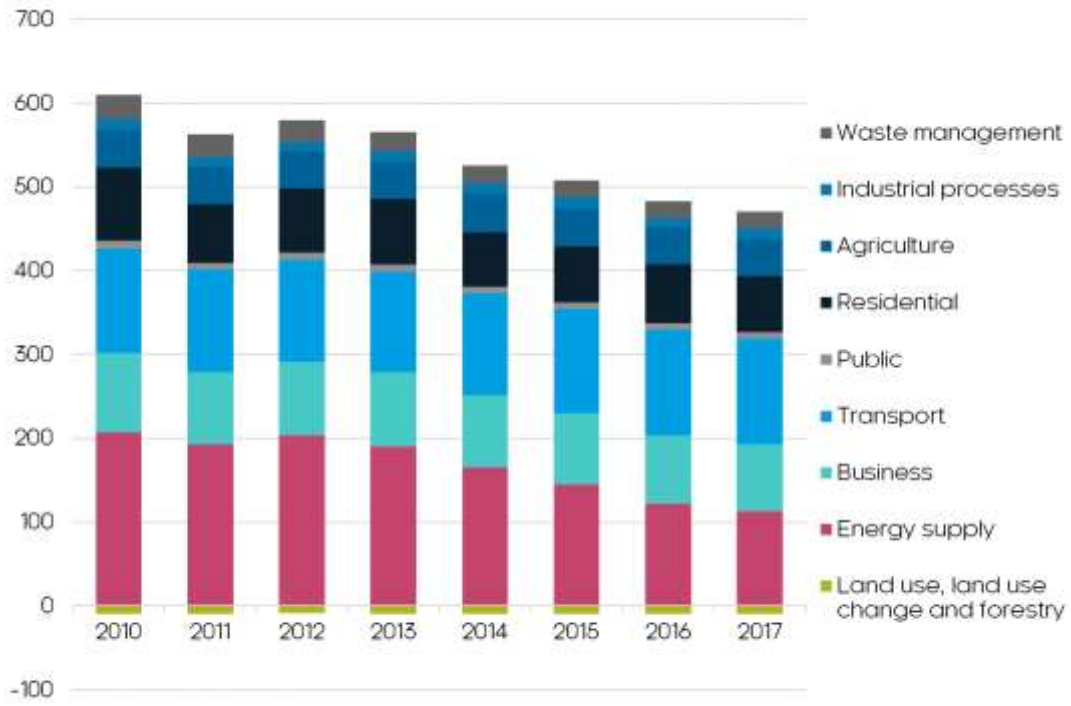
The power sector has been decarbonising rapidly in recent years following the phase out of coal, but still accounted for 15% of the UK GHG emissions in 2018 (Department for Business, Energy & Industrial Strategy 2019). Progress towards full decarbonisation of the sector is however slowing down as the potential to further reduce coal generation diminishes (Committee on Climate Change 2019).

The transport sector has proved to be a problematic sector to decarbonise. Annual sectoral emissions decreased only by 2.2 $MtCO_{2eq}$ (less than 2%) since 1990, while the sectoral contribution to all UK emissions incremented from 16% in 1990 to more than 27% in 2017, making it the largest-emitting sector in the country (Department for Business, Energy & Industrial Strategy 2019). Road transport is by far the largest contributor accounting for 91% of sectoral emissions, followed by shipping (5%), railways (2%) and domestic

civil aviation (1%) (Department for Business, Energy & Industrial Strategy 2019). Numerous and differentiated policies are needed to meet long-term reduction targets for the transport sector, including the introduction of stricter standards for new cars and vans, incentives to purchase cleaner vehicles, installing electric vehicle (EV) charging infrastructure, reducing transport demand and promoting modal shift.

Figure 2.1 summarises the estimated GHG emissions by sector of origin in the UK since 2010.

Figure 2.1 GHG emissions by source category, UK 2010-2017 ($MtCO_2$)



Source: BEIS.

National policy background

Combined, energy- and emissions- intensive industries account for a substantial proportion of UK emissions produced by the public and private sector – up to 45% in recent times (Parliamentary Office of Science & Technology 2012). Decreasing the use of energy and the production of emissions through greater energy-efficiency or through alternative low-carbon technologies will therefore have a key role to play in reducing total UK emissions.

2050 Roadmaps

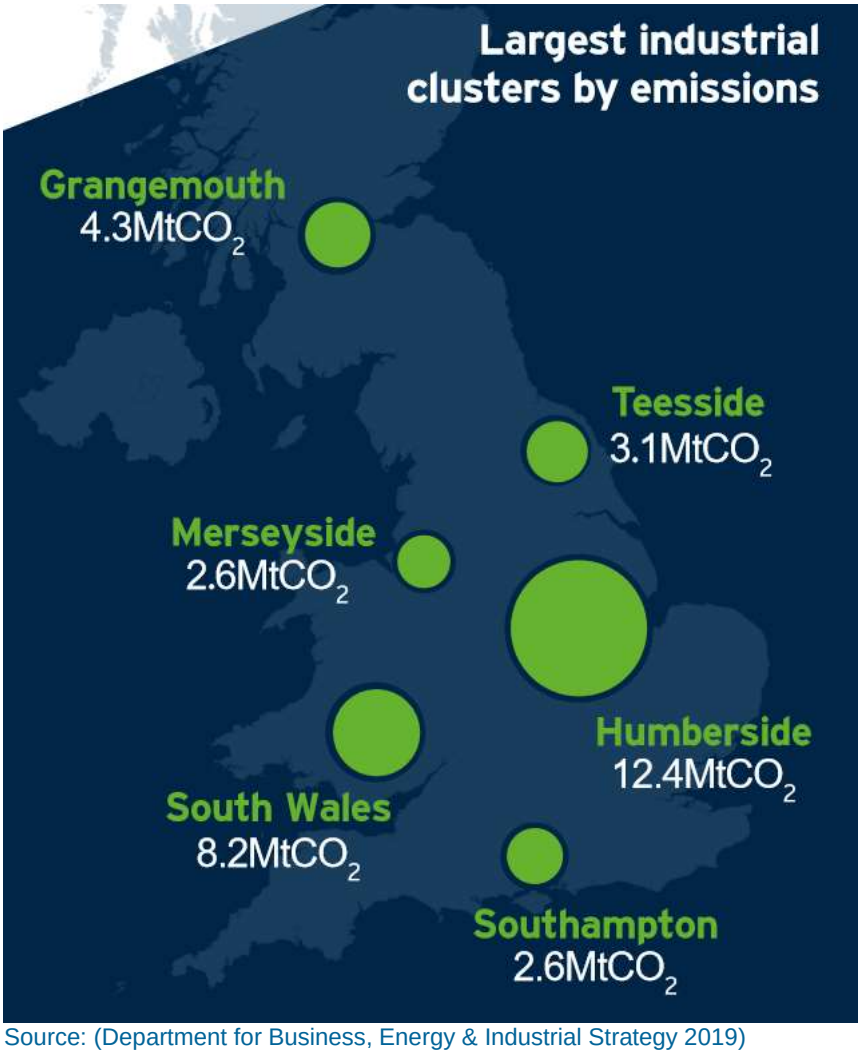
To address the need to decarbonise energy-intensive industries, in 2015, the UK Department of Energy and Climate Change and the Department for Business, Innovation and Skills jointly published a series of Roadmap reports that set out potential pathways to reduce greenhouse gas (GHG) emissions and to improve energy efficiency in eight carbon-intensive sectors of the UK economy, which included cement, ceramics, chemicals, food and drink manufacturing, glass, iron and steel, and pulp and paper (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015). The Roadmaps investigate how individual industries could decarbonise and increase energy efficiency whilst remaining competitive. The Roadmaps acknowledge that while energy-intensive sectors consume a considerable

amount of energy and are responsible for high levels of emissions, they are an integral part of national and local economies, providing many jobs and producing a high level of economic output. As such, energy-intensive industries will play an essential role in the transition to a low-carbon economy, however to keep their competitiveness, it will be key to foster innovation in these industries by promoting resource-smart technologies that bring in new revenue streams.

Industrial Strategy and Clean Growth Strategy

More generally, the Government's Clean Growth Strategy, alongside the Industrial Strategy, sets out national plans for decarbonising the UK economy while facilitating economic growth and increasing productivity. The Industrial Strategy recognises four Grand Challenges facing UK industries, including the global shift to clean growth. Within the 'Clean Growth' Grand Challenge, ambitious missions have been developed to tackle the Challenge. These missions include the establishment of the world's first net-zero carbon industrial cluster by 2040 and at least one low-carbon industrial cluster by 2030. Known as the 'Industrial Clusters Mission', it identifies six clusters of energy- and emissions-intensive industries in the UK, including the 'Humberside' cluster (see Figure 2.2).

Figure 2.2 Largest industrial clusters in the UK



Source: (Department for Business, Energy & Industrial Strategy 2019)

The W&NY region has the potential to be at the forefront of this particular clean growth mission, by being part of one of the first industrial clusters to

substantially decarbonise by 2030. A study of the Humber energy-intensive industries cluster (Carbon Trust 2018) makes recommendations to ensure that the cluster plays a significant and strategic role in UK value creation and identifies opportunities for the cluster such as:

- Leading on 2050 Industrial Decarbonisation and Energy Efficiency Action Plans
- Positioning the cluster for a lead role in the Northern Powerhouse, Industrial & clean growth strategies
- Taking advantage of growing UK and global renewables markets, the potential for more diversity of energy supply and smart energy solutions in the region
- Taking advantage of financial incentives and local and national government support available.

While industries located in the W&NY region do not fall directly within the identified industrial clusters of Teeside and Humberside, many firms within the industrial sectors of the region have the potential to capitalise on their unique local strengths, expertise and assets related to low-carbon technologies and clean growth, and collaborate with industry located in neighbouring regions. Clean or low-carbon goods and services can be exported to neighbouring regions, or joint partnerships formed. Potentially, industries in close proximity to the Teeside and Humberside clusters (namely industry located in the very east or very north of the W&NY region) may have greater opportunities to take advantage of newly emerging low-carbon clusters.

Firms operating within typically energy-intensive sectors in the region have already released plans to work together to establish a zero carbon cluster through a combination of hydrogen production and a carbon capture usage and storage (CCUS) network, removing emissions from industrial plants in the region through the CCUS network centred around the Drax power station (Drax 2019). Should this plan be successful, it will deliver the UK's first large-scale CCUS project, and will contribute progress on a key recommendation made by the Committee on Climate Change (CCC) in their Net Zero report (Committee on Climate Change 2019); greater urgency in the delivery of large-scale CCUS, since large-scale CCUS will be crucial to the delivery of net-zero GHG emissions in the UK.

Resource- and waste-intensive industries and circular economy

Many of the industries responsible for emitting high levels of GHG emissions are also responsible for high levels of resource use and waste, imposing further detrimental impacts upon the environment (agriculture is a key example for this). With increasing consumption and production placing ever more pressure on material resources, and with all products producing a lasting carbon footprint, preventing waste and encouraging a more circular economy are key priorities for the UK Government, as stated within the Resources and Waste Strategy (HM Government 2018c). A circular economy is an alternative approach to a linear economy in which goods are manufactured, used and then disposed of. In a circular economy resources are kept in use for as long as possible, and their maximum value is extracted during their lifetime, by designing and manufacturing products that are made to last, then recovering and regenerating products and materials at the end of each service life (WRAP 2019).

Local policy context

Following on from national-level decarbonisation plans and strategies, individual regions of the UK have recognised the need to decarbonise in completed or work-in-progress local energy, industrial and economic strategies.

This Clean Growth Audit jointly commissioned by the Leeds City Region (City Region) LEP, York, North Yorkshire and East Riding (YNYER) LEP and North Yorkshire County Council follows on from individual local energy and economic strategies developed by each organisation.

The Leeds City Region Energy Strategy and Delivery Plan (Carbon Trust 2018) identifies five strategic priority areas, which describe the role of energy in supporting economic growth across the region, and individual recommendations for achieving these priorities:

- resource efficient business and industry
- new energy generation
- energy efficiency and empowering consumers
- smart grid systems integration
- efficient and integrated transport.

Meanwhile, the YNYER Local Energy Strategy (York, North Yorkshire & East Riding LEP Undated) is built around a strategic framework consisting of four key elements to achieve a low carbon economy:

- place-based strategic priorities
- high-impact low carbon energy technologies
- designing circular systems
- cross-cutting strategic enablers.

Links to local economic strategies

The local energy strategies support individual economic plans drafted by North Yorkshire County Council (NYCC) and the City Region. The headline vision of the North Yorkshire's Plan to Deliver Economic Growth is to create a region 'with a strong economy and a commitment to sustainable growth' (North Yorkshire County Council 2017). To achieve this vision, the NYCC economic plan identifies a key enabler; 'enhancing the environment and developing tourism and the green economy', which includes promoting and improving the region's environment, and supporting low-carbon energy generation (including further development of the Allerton Energy from Waste Park) and the development of economically, socially and environmentally sustainable local communities. Inherently, carrying out these actions will have implications for energy-, resource- and emissions-intensive sectors in the region, as local government will focus efforts on decarbonisation policy and support measures.

Similarly, the City Region Strategic Economic Plan includes as one of its four priorities 'clean energy and environmental resilience' with the aim of becoming 'a resilient zero carbon energy economy underpinned by high quality green infrastructure' (Leeds City Region LEP 2016). Some of the key action areas within this priority are relevant and targeted at energy- resource- and emissions-intensive firms, such as the development of new clean energy generation and the improvement of resource efficiency of businesses. To improve the efficiency of business in the region, the economic plan pledges to

- deliver advice and financial support to businesses to reduce costs associated with resources such as waste, water and energy and,
- drive innovation and growth in energy-intensive industries by promoting resource smart technologies that produce new revenue streams such as carbon capture and utilisation.

Circularity in the local economy

Alongside decarbonising the local economy, local strategies also acknowledge the need for greater circularity in the economy. The York and North Yorkshire LEP (Y&NY LEP) have initiated plans to apply circular economy principles at scale across York and North Yorkshire, exploring local strengths and opportunities for circular economy in the region, the interdependencies between rural and urban areas, and developing interventions that create a more circular economy. And within the Leeds City Region Energy Strategy and Delivery Plan, resource efficient business and industries is identified as a key priority to become a zero-carbon energy economy by 2036. These ambitious plans have the potential to be consolidated and developed further to be applied to the whole W&NY region.

2.2 Overview of this chapter

This chapter provides a greater understanding of which industries and large industrial sites in the W&NY region are the most energy- and resource-intensive, and which produce the highest levels of greenhouse gas (GHG) emissions.

While these sectors and specific industrial sites may be contributing a great deal to the emissions of the W&NY region, they are also expected to continue to be an integral part of the local economy, providing many jobs and producing a high level of economic output. In North Yorkshire, there are energy-emissions- and resource-intensive sectors which are also recognised as core sectors with high levels of productivity (such as agriculture) or as prime enabling sectors, such as high-value manufacturing, food manufacturing, distribution and logistics and energy. Identifying the location of large industrial sites in the region, and tailoring actions to encourage the reduction of emissions and resource use across these sectors will be an important part of the low-carbon transition in the W&NY region, while also ensuring that firms operating in these industries remain competitive (both nationally and internationally), and are retained in the area. Retention of these sectors is of particular concern due to the high numbers of local jobs they support, particularly in locations where a high proportion of the very local workforce are employed by firms within a particular sector. In these cases, large-scale job losses can lead to displacement of workers and further social problems.

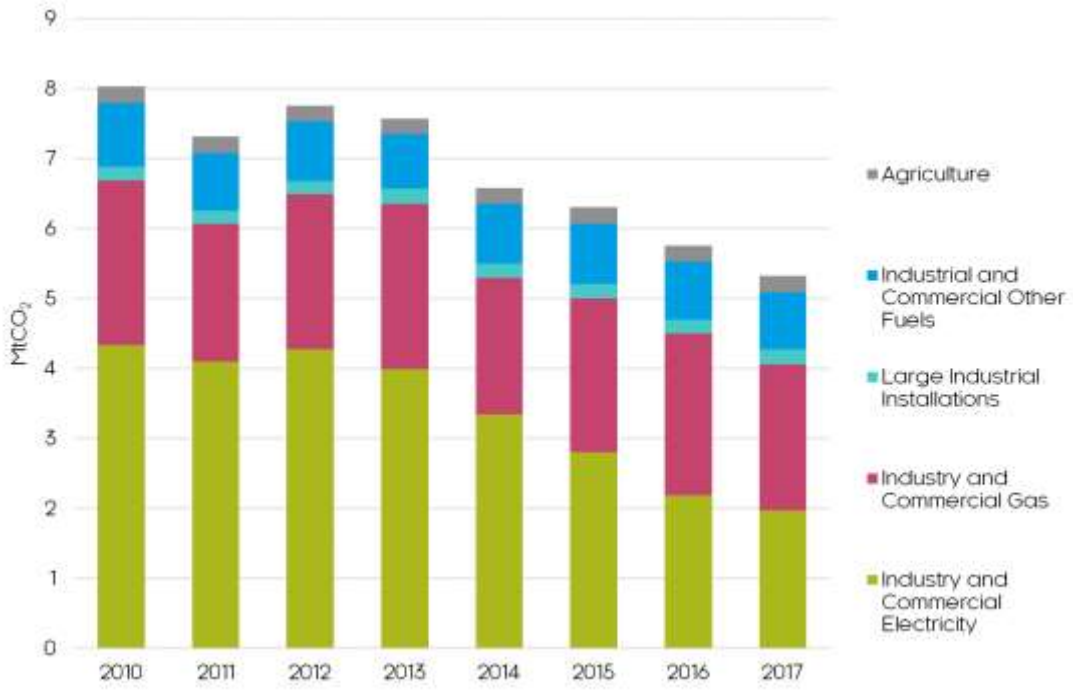
Understanding where and what industrial activities are energy-, resource, and emissions-intensive allows us to develop policy and local government support recommendations for reducing the environmental impact of these industries, while ensuring industries remain competitive and productive.

2.3 Identification of key emission-, energy-, resource- and waste-intensive sectors

This section identifies the key emission-, energy-, resource- and waste-intensive sectors in the W&NY region. The objective was to expand the current knowledge base of production plants located within the region by

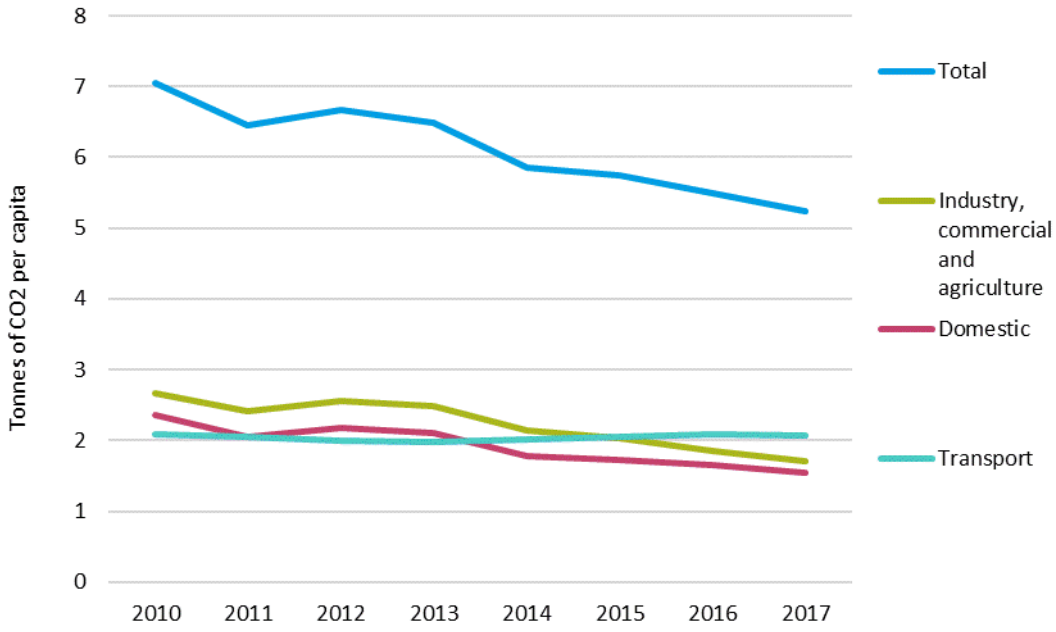
mapping them and identifying the existence of industrial clusters and interlinkages across sectors. The starting point for this analysis was to contextualise the current situation in W&NY by looking at publicly available and local statistics on carbon emissions by sector. As highlighted by Figure 2.3, industrial and commercial emissions have been declining in recent years thanks to the increasing use of renewables to produce electricity, therefore diminishing the average carbon content of electricity from the grid. Emissions decreased from about 9 $MtCO_2$ in 2005 to approximately 5 $MtCO_2$ in 2017. Nevertheless, emissions from fossil fuels (gas, oil, coal and other solids) used in the industrial and commercial sectors reflect some efficiency gains, but relatively less progress over time, highlighting significant difficulties to decarbonise many industrial processes. Carbon emissions from agriculture also remained practically unchanged, and while they still represent a small part of total emissions from businesses, agriculture is indeed a highly resource-intensive industry and a major source of emissions (as illustrated by Figure 2.3). Figure 2.4 shows CO_2 emission estimates for industrial and commercial sectors on a per capita basis for the same period, vis-á-vis the per capita emission of the domestic sector and the transport sector (which, after 2015, has become the largest emitter on a per capita basis in this comparison).

Figure 2.3 Carbon dioxide emission estimates 2010-2017 ($MtCO_2$) for the industrial and commercial sectors in W&NY



Source: BEIS

Figure 2.4 Per capita carbon dioxide emission estimates 2010-2017 (tCO2) for the industrial and commercial, domestic and transport sectors in W&NY



Source: Cambridge Econometrics calculation based on BEIS, ONS

When considering the relative contribution of the industrial and commercial sectors to total carbon emission levels in W&NY, **Error! Reference source not found.Error! Reference source not found.** highlights how the sectoral share has been decreasing over time from 39% in 2005 to 32% in 2017. While the domestic sector also reduced its relative contribution to about 29% in 2017, transport became the largest contributor and in 2017 was responsible for almost 39% of total regional carbon emissions. This is the direct consequence of the dependence on fossil fuels and the increasing demand for transport. A much weaker reduction in emissions from transport (-7%) can be observed compared to businesses (-43%) and the residential sector (-36%) since 2005.

The next step of the analysis was to define which sectors, as categorised in the SIC 2007 3-digit classification, fall into the four considered groups. Fossil fuels such as natural gas and oil therefore still represent important energy sources for energy-intensive industries, increasing their overall climate impact. The most important contributors to total GHG emissions however are the electricity, transport and agriculture sectors which together account for almost 40% of UK emissions (see Figure 2.1 for more details). Emissions from the power sector in W&NY originate from a limited number of power producers as depicted by Figure 2.6, and the sector has experienced substantial reductions in GHG emissions following the increasing penetration of renewables and the phasing out of coal plants.

On the contrary, carbon emissions from transport are of a more dispersed nature as they are produced along minor and major transport routes across the region. The great majority of vehicles still heavily rely on oil and only a small proportion of energy is delivered through alternative fuels such as biofuels, electricity and hydrogen. The agriculture sector on the contrary is not a major contributor to overall carbon emissions, but its main climate change

impacts are attributable to the fugitive emissions of other GHG such as methane and nitrous oxide.

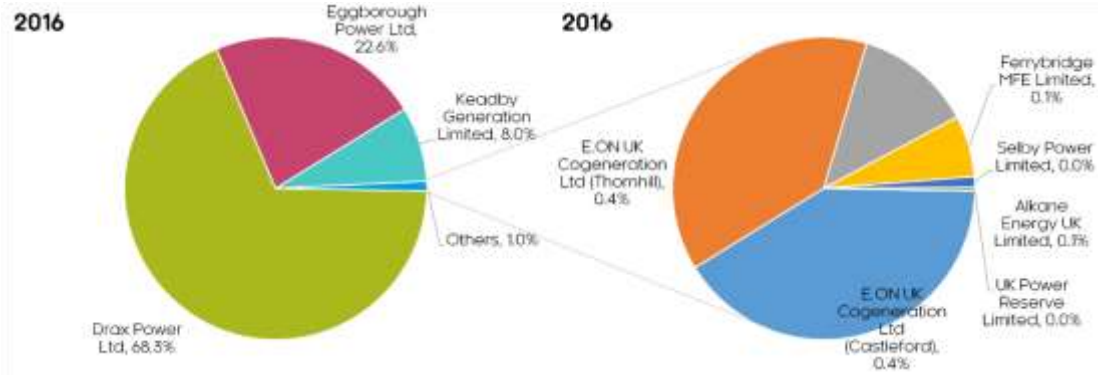
Table 2.1 lists the outcome of this initial selection based on a literature and data review. In some cases, the same sector is included into more than one category due to its overall high environmental impact.

Table 2.1: SIC 3-digit codes of the industries identified for energy-, emission-, resource- and waste-intensive sectors

	Sectors	SIC 3-digit
Energy-intensive sectors	Food & Drink	10.1 – 10.9, 11.0
	Pulp & Paper	17.1
	Oil & Refining	19.2
	Chemicals	20.1
	Glass	23.1
	Ceramics	23.3, 23.4
	Cement	23.5
	Iron & Steel	24.1
Emissions-intensive sectors	Agriculture	01.1 – 01.7
	Electricity	35.1
	Gas	35.2
	Road Transport (incl. wholesale of petrol)	49.3 – 49.4, 46.7
	Rail Transport	49.1 – 49.2
	Transport Other (incl. Pipeline, Air, Water)	49.5, 50.1 – 50.4, 51.1 – 51.2
	Coal & Oil	05.1 – 05.2, 06.1
	Large Industrial Installations (incl. Steel, Aluminium, Chemicals, Oil Refining, Cement, Paper & Pulp)	19.2, 23.5, 24.1
Resource-intensive sectors	Mining & Quarrying	05.1 – 09.9
	Food & Drink	10.1 – 10.9, 11.0
	Construction	41.1 – 43.9
	Transport	49.1 – 52.2
Waste-intensive sectors	Mining & Quarrying	05.1 – 09.9
	Food & Drink	10.1 – 10.9, 11.0
	Construction	41.1 – 43.9
	Transport	49.1 – 52.2

Fossil fuels such as natural gas and oil therefore still represent important energy sources for energy-intensive industries, increasing their overall climate impact. The most important contributors to total GHG emissions however are the electricity, transport and agriculture sectors which together account for almost 40% of UK emissions (see Figure 2.1 for more details). Emissions from the power sector in W&NY originate from a limited number of power producers as depicted by Figure 2.6, and the sector has experienced substantial reductions in GHG emissions following the increasing penetration of renewables and the phasing out of coal plants.

Figure 2.6 Relative contributions of power plants to power sector GHG emissions in W&NY (2016)



Source: NAEI.

On the contrary, carbon emissions from transport are of a more dispersed nature as they are produced along minor and major transport routes across the region. The great majority of vehicles still heavily rely on oil and only a small proportion of energy is delivered through alternative fuels such as biofuels, electricity and hydrogen. The agriculture sector on the contrary is not a major contributor to overall carbon emissions, but its main climate change impacts are attributable to the fugitive emissions of other GHG such as methane and nitrous oxide.

2.4 The relative importance of energy-, emissions-, and resource-intensive sectors to the W&NY region

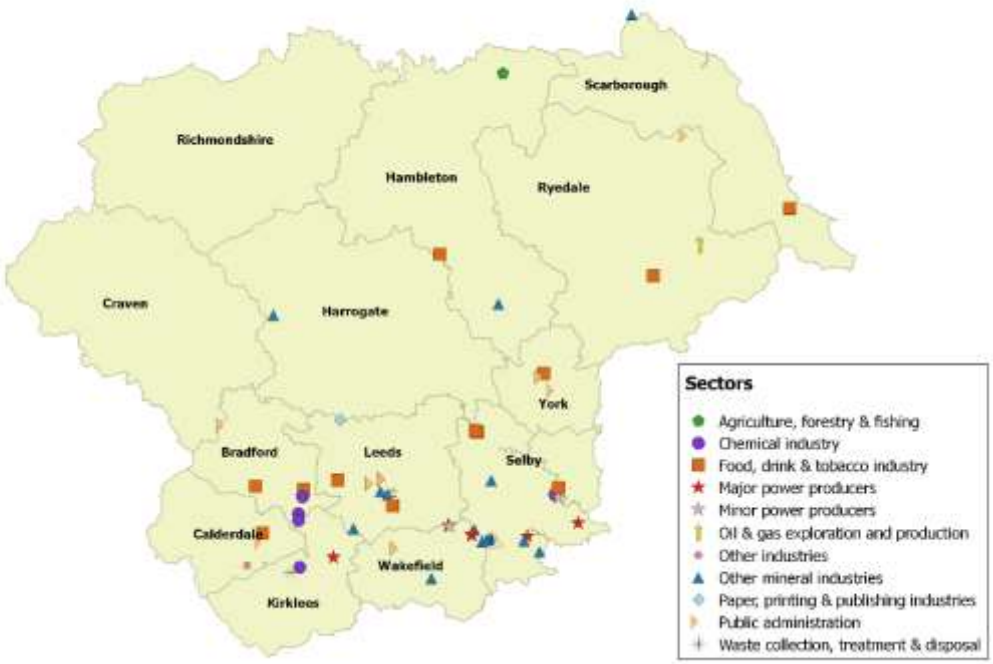
Following the identification of energy-, emission-, resource- and waste-intensive industries at the national level, the analysis focuses on assessing the relative importance and the contribution of these sectors to the local economy in the W&NY region.

To firstly identify the location of emission-intensive companies in W&NY, data from the UK National Atmospheric Emissions Inventory (UK NAEI) was used, covering emissions from point sources in the industrial and commercial sectors in 2016. This dataset gathers four groups of point sources: those regulated under the Integrated Pollution Prevention and Control (IPPC) regulatory regimes; those registered under the EU-Emissions Trading Scheme (EU ETS); those regulated under Local Authority Pollution Control/Air Pollution Control (LAPC/APC) in England and those where emissions are modelled based on some surrogate statistic. The emission data, expressed in CO_2eq terms, were filtered to consider only point sources within the boundaries of the districts included in W&NY.

Figure 2.7 shows the location of GHG emission-intensive companies by sector in the region. The map reports the point sources as listed by NAEI located in W&NY, classified according to the 2007 Standard Industrial Classification (SIC). To guarantee full readability of the map, plants which are responsible for extremely low levels of emissions, mostly belonging to the Water & sewerage and Waste collection, treatment & disposal sectors, were excluded from the representation. Together, the excluded point sources account for less than 0.01% of regional GHG emissions as reported by NAEI.

The map clearly shows how most sites are in densely populated and connected areas within West Yorkshire. However, while sectors like

Figure 2.7: Location of GHG emission-intensive plants by sector in the W&NY region (2016)



Source: Cambridge Econometrics using NAEI data.

Chemicals and Other mineral industries (mostly Glass) are located close to each other in clusters in West Yorkshire, the Food and Drink industry is more scattered and has plants located across both W&NY. Major power producers, including Drax and Eggborough, are located in the Selby, Wakefield and Kirklees districts, also representing the largest emitters in the region. In 2016, the Drax power plant produced about 6.4 $MtCO_2eq$, followed by the Eggborough power plant with 2.1 $MtCO_2eq$ and Keadby Generation Ltd in Ferrybridge C with 0.7 $MtCO_2eq$. Together, they represented 87.6% of all the GHG emissions reported. It is important to note, however, that the NAEI data is from 2016, thus does not reflect recent changes, for example the recent closure of Eggborough coal-fired power station.

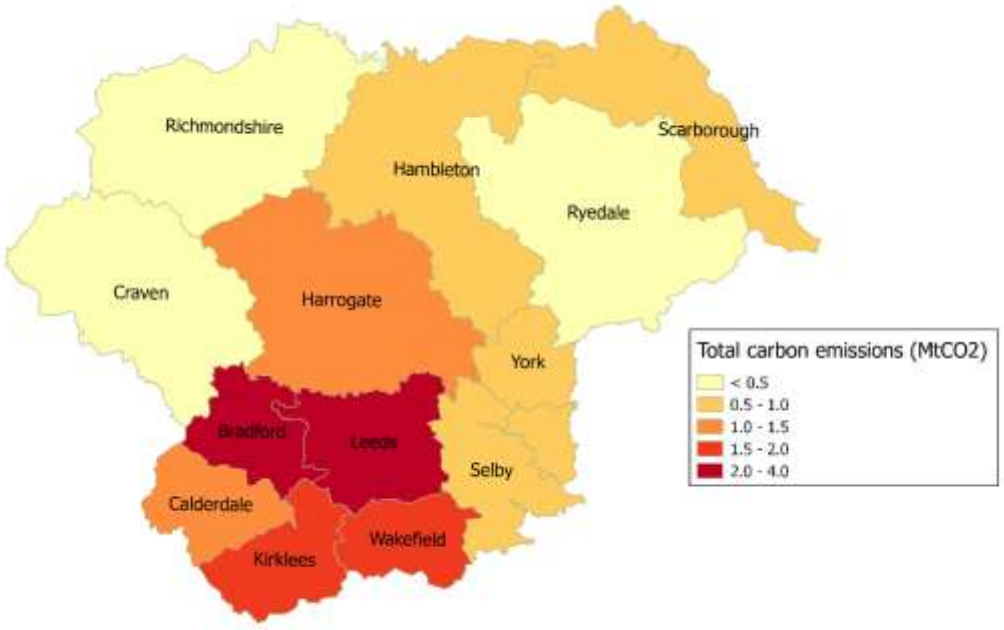
The remaining share of total CO_2eq emissions in 2016 was distributed across various other sectors, as shown in Table 2.2.

Table 2.2 Share in total GHG emissions by sectors in W&NY (2016)

Sectors	Share in total GHG emissions realized in W&NY, 2016
Three largest power producers	87.6%
Other power producers	0.9%
Other mineral industries (Glass)	2.8%
Chemicals	1.9%
Food & Drink	1.5%
Public administration	1.4%
Waste treatment and Water & sewerage	1.4%
Other	2.5%

Source: NAEI.

Figure 2.8 Total carbon emissions by district in W&NY (2017)

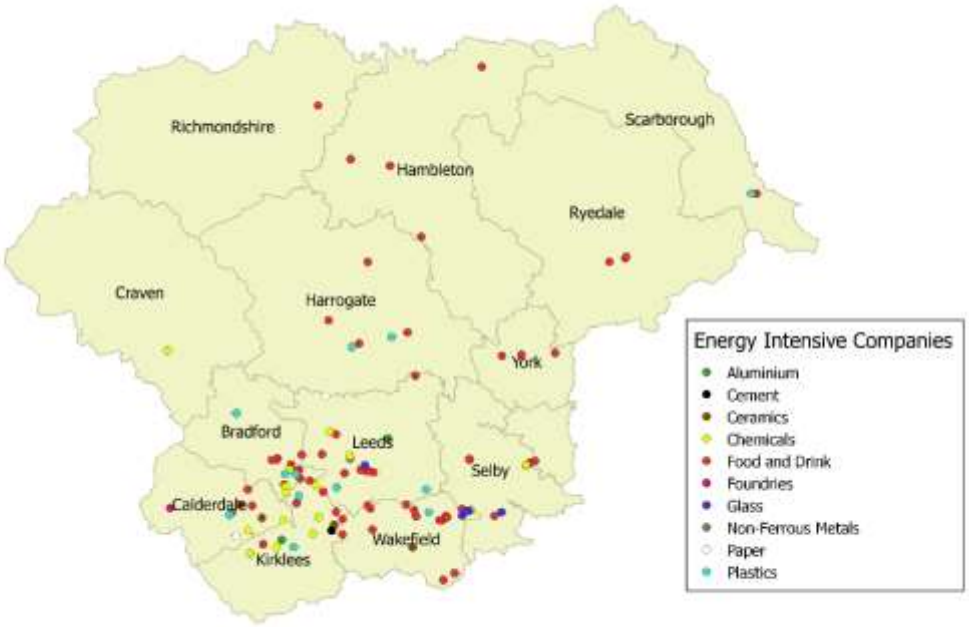


Source: BEIS.

Figure 2.88 shows total carbon emissions for each district in W&NY also taking into account emissions from the domestic and transport sector, together with those from industrial and commercial businesses. Most of the carbon dioxide is produced in Leeds and Bradford, with a total of 3.9 $MtCO_2$ and 2.1 $MtCO_2$ respectively in 2017. This stems from the significant concentration of economic activities and people living and commuting in West Yorkshire. The

same mapping exercise was carried out to identify the location of energy-intensive firms within W&NY. In this case we relied on a dataset from the UK Environment Agency listing the facilities covered by a Climate Change Agreement and included in the Reduced Rate Certificate report[1]. CCAs are voluntary agreements to reduce the energy usage and carbon emissions of industries which, in exchange, benefit from a discount on the Climate Change Levy (CCL) charged on energy bills. The dataset was also integrated with a few additional businesses, namely one cement plant in Calderdale and five glass production plants located within Wakefield, Leeds and Selby, that were identified by contacting industries associations and through desk-based research. Figure 2.9 maps the businesses belonging to these key energy-intensive sectors reported in Table 2.1 within W&NY[2]. Food and Drink businesses are located across most districts of W&NY except for Craven, but there is a notable concentration in West Yorkshire. The Chemical sector is present across Leeds, Bradford, Calderdale and Kirklees, while Glass companies are across Selby and Wakefield. Intuitively, some of the sectors identified as emission-intensive are also energy-intensive, so this overlap is not surprising.

Figure 2.9: Location of energy-intensive plants by sector in the W&NY region



Source: Cambridge Econometrics using Environment Agency data.

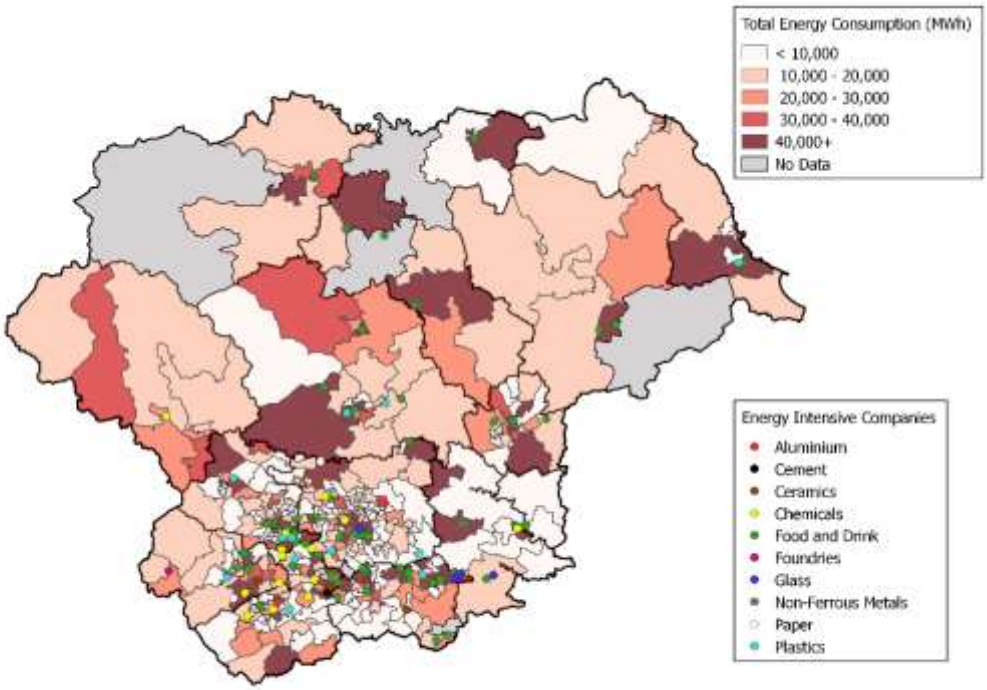
To give a sense of the energy-intensity of these industrial plants, Figure 2.5 depicts annual non-domestic energy consumption levels in each Middle Layer Super Output Area (MSOA). In most cases, energy-intensive firms are located

[1] The list of facilities is available at: https://data.gov.uk/dataset/791f5d8b-ac3b-4669-9e7b-e269ae634f94/climate-change-agreements-reduced-rate-certificates-rrc

[2] For a more complete map of all energy-intensive businesses covered by a Climate Change Agreement in W&NY, please refer to the Appendix.

in dark-coloured areas, suggesting a significant impact on total energy consumption levels from these plants.

Figure 2.5: Location of energy-intensive plants and total non-domestic energy consumption levels by MSOA in 2017



Source: Cambridge Econometrics using Environment Agency and BEIS data.

When combining the NAEI dataset, reporting the major point sources of emissions, with the list of companies covered by a Climate Change Agreement in W&NY, it is possible to select a subgroup of businesses which are both energy- and emission-intensive. The obtained group of companies is reported in Table 2.3. It is important to notice that this represents only a small subgroup of companies, and many others could probably be classified as energy- and emission-intensive. Nevertheless, limited data availability precludes the possibility to clearly identify them in both the NAEI and the RRC report.

Table 2.3 Identified emission- and energy-intensive companies in W&NY

Organisation Name	Sector	District	Postcode	Emissions (tonnes CO_{2eq}) in 2016
Saint-Gobain Glass (UK) Limited	Glass	Selby	DN14 0FD	106,945
Ardagh Glass Limited	Glass	Wakefield	WF11 0HP	67,967
Allied Glass Containers Limited	Glass	Leeds	LS10 1NQ	67,170
BASF Public Limited Company	Chemicals	Bradford	BD12 0JZ	63,541
Allied Glass Containers Limited	Glass	Wakefield	WF11 8DH	52,034
Syngenta Limited	Chemicals	Kirklees	HD2 1FF	41,463

McCain Foods (GB) Ltd	Food and Drink	Scarborough	YO11 3BS	36,869
Nestlé UK Ltd	Food and Drink	York	YO1 1XY	32,703
Stolzle Flaconnage Limited	Glass	Wakefield	WF11 8AP	27,396
Karro Food Limited	Food and Drink	Ryedale	YO17 9HG	10,105
Greencore Grocery	Food and Drink	Selby	YO8 5BJ	8,467
Weidmann Whiteley Ltd	Paper and Pulp	Leeds	LS21 1RP	6,553
Kemira Chemicals (UK) Ltd	Chemicals	Bradford	BD4 7TT	5,014
Britvic Soft Drinks Ltd	Food and Drink	Leeds	LS13 4HT	4,018
Nestlé UK Ltd	Food and Drink	Calderdale	HX3 9XT	3,332

Source: Cambridge Econometrics using Environment Agency and NAEI data.

Once the location of energy- and emission-intensive companies was identified, the analysis focused on assessing the relative importance and the contribution of these businesses to the local economy in the W&NY region. This was done by looking at the available employment estimates at the regional and local authority level for each of the mapped 3-digit industries. Each sector was then evaluated and ranked according to a well-defined set of qualitative and quantitative criteria, with the goal of selecting a list of ‘top-priority’ sectors for the W&NY region.

The criteria were determined to provide an overarching view over each sector at the local level together with some relevant policy considerations from national legislation. First, whether the sector has been identified as a priority target for decarbonisation and other environmental policies at the national level was evaluated. The sectoral energy-, emission-, resource- and waste-intensity was also assessed, as data allowed. The analysis also takes into account the region-specific context and assesses the employment in each sector, the existence of local competitive advantages inducing companies to establish their production plants in the region, and the identification of sectoral targets in local energy and economic strategies. Commonality of strategy in West and North Yorkshire LEPs industrial and energy strategies was also accounted for. The criteria can be summarised as follows:

- Sector identified as a priority within the Government’s Clean Growth Strategy
- Relative importance of the sector in the region (employment, local quotient)
- Sector recognised in existing Local Energy Strategies
- Existence of any competitive advantage in the region.

The information was then organised into a series of tables, and a score was assigned to each criterion. In this way it was possible to create a qualitative rank identifying the top priority sectors within the W&NY region.

2.5 Top priority energy-intensive industries

The outcomes of this analysis are presented for each sector in the following series of tables, and a brief overview is also provided.

Food & drink

Table 2.4 Food & Drink MCA

Criteria	Comments/evidence	Score
Sector properties	• Energy-, Emission-, Resource- and Waste-intensive • Emission statistics (carbon dioxide from fuel combustion only): 2.72 tonnes per job (UK)[1] • Waste: 9.15 tonnes per job (England)[2]	
Sector identified as a priority within the Government's Clean Growth Strategy	• 20% reduction in food & drink waste target in the UK and 20% reduction in the GHG intensity of food & drink consumption by 2025[3] • No food waste entering landfill by 2030[4] • 12% relative emission reduction in 2050 (relative to 2012) for BAU[5]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 2.4% • Employment share in the UK: 1.4% • Location Quotient: 1.7	↑
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Existing: Resource Efficiency Fund Program - help SMEs in Leeds City Region to lower their carbon footprint, energy use and water and waste costs – Food and Drink sector has significant opportunity for energy efficiency[6] • Proposed: Industrial Heat Recovery Support programme (IHRS) - Re-use the recovered waste heat on site to improve process efficiency[7] (+) • Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[8] (+)	↑
Competitive advantage	• The City Region is home to Food & Drink businesses – over 11 times more food manufacturer (macaroni, noodles, couscous and similar farinaceous products) than the UK average[9] • The YNYER region has the highest concentration of food and drink businesses in the UK - 8916 farms, 12% of UK's farmland[10]	↑

1: National Atmospheric Emissions Inventory (NAEI), 2016
2: DEFRA, 2016
3,4: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
5: BEIS Industrial decarbonisation and energy efficiency action plans 2017
6,7,8: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
9: Leeds City Region Advanced Manufacturing Report 2015
10: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

The Food and Drink industry has a substantial environmental footprint in the region, with numerous production plants located in both W&NY providing 2.4% of total employment in the region. Due to its relatively high material-, waste- and energy-intensity, the sector has received particular attention in the national Clean Growth Energy Strategy, and several targets to reduce its environmental footprint were set for the next decade. These include a 20% reduction in the waste and GHG intensity of food and drink consumption by 2025 and a progressive reduction of food waste going to landfill, reaching zero in 2030. The sector also benefits from local programmes for small and medium enterprises (SMEs) to improve their energy efficiency, with further supporting programmes currently under consideration. In terms of competitive advantages, W&NY benefits from the high concentration of food manufacturers and farms, over 11 times higher than the UK average, with the creation of potential clusters and interlinkages across firms (explored in more detail later in this chapter).

Pulp & paper

Table 2.5: Pulp & Paper

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive	
Sector identified as a priority within the Government's Clean Growth Strategy	• 32% relative emission reduction in 2050 (relative to 2012) for BAU[1] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries worth £260 m in 2015 and over £500 m since 2013[2]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.028% (or 420 jobs) • No data available for the UK, and consider the above share to be tiny	↓
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[3] (+) • Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries[4] (+) • No specific plan for pulp & paper sector in existing strategies – included within broader strategies aimed at energy-intensive sectors in general	↔
Competitive advantage	• None identified.	↓

1: BEIS Industrial decarbonisation and energy efficiency action plans 2017
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
4: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

The Pulp and Paper industry is also included among the energy-intensive sectors that are at the focus of the decarbonisation policies set by the Government. However, with only two established production plants, one in Calderdale and one in Leeds, it is not among the major contributors to the W&NY economy, and the number of people locally employed is modest. While Paper and Pulp firms are amongst those that benefit from local energy efficiency programmes, there are few measures which target the sector specifically.

Oil & refining

As with Pulp and Paper, the Oil and Refining sector was not identified as a 'top-priority' sector due to its relatively small economic footprint in W&NY and the absence of significant regional competitive advantages. No energy-intensive plant for this sector was identified in the region.

Table 2.6: Oil & Refining

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive and Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 3,707,559 tonnes in total (jobs data unavailable) (UK)	
Sector identified as a priority within the Government's Clean Growth Strategy	• 44% Relative emission reduction in 2050 (relative to 2012) for BAU[1] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including oil refining) worth £260 m in 2016 and over £500 m since 2013[2]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.034% (or 500 jobs) • No data available for the UK, and consider the above share to be tiny	↓

Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[3] (+) • Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries[4] (+) • No specific plan for oil refining sector in existing strategies – included within broader strategies aimed at energy-intensive sectors in general	↔
Competitive advantage	• Nothing specific is mentioned in the background materials	↓

1: BEIS Industrial decarbonisation and energy efficiency action plans 2017
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
4: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

Chemicals

The Chemical sector, on the other hand, does have a substantial base in the region, with a number of large industrial plants located in West Yorkshire. According to BRES, although the sector represents only around 0.11% of employment in the region, this is slightly above the UK average. The Leeds City Region hosts an important chemical cluster across Bradford and Kirklees, including outstanding institutional and research infrastructure. Numerous manufacturers of pesticides and agrochemical products have also established their plants in W&NY, and this established industrial base represents a major opportunity for the future development of the industry in the region.

Table 2.7: Chemicals

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive and Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 42.9 tonnes per job (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• 31% Relative emission reduction in 2050 (relative to 2012) for BAU[2] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including chemicals) worth £260 m in 2016 and over £500 m since 2013[3]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.108% • Employment share in the UK: 0.101% • Location Quotient: 1.07	↔
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Proposed: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[4] (+) • Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries – e.g. chemicals sector in the Leeds City Region in particular[5] (+)	↑
Competitive advantage	• Leeds City Region is home to one of the UK's leading chemical clusters: dense supply chain and outstanding institutional and research infrastructure[6] • The City region has six times as many manufacturers of pesticides and other agrochemical products as the national average[7]	↑

1: National Atmospheric Emissions Inventory (NAEI), 2016
2: BEIS Industrial decarbonisation and energy efficiency action plans 2017
3: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
4,7: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
5. York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
6: Leeds City Region Advanced Manufacturing Report 2015

Glass

There are a number of glass manufacturers in West Yorkshire providing about 0.15% of total employment in W&NY, with a cluster clearly identifiable on the boundaries between Selby and Wakefield. These companies make use of flint

furnaces to produce glass containers and packaging to be used across various sectors, including pharmaceutics, cosmetics, spirits, food and beverages. Glass is among the industries subject to the nationally-determined decarbonisation targets set for energy-intensive firms, and can potentially benefit from local energy efficiency programmes.

Table 2.8: Glass

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive	
Sector identified as a priority within the Government's Clean Growth Strategy	• 36% Relative emission reduction in 2050 (relative to 2012) for BAU[1] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including glass) worth £260 m in 2016 and over £500 m since 2013[2]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.149% • Employment share in the UK: 0.076% • Location Quotient: 1.96	↑
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Industrial Heat Recovery Support programme (IHRS) - Re-use the recovered waste heat on site to improve process efficiency[3] (+) • Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[4] (+) • Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries – e.g. glass sector in the Leeds City Region in particular[5] (+)	↑
Competitive advantage	• The City Region is home to Glass and Ceramics business[6]	↔

1: BEIS Industrial decarbonisation and energy efficiency action plans 2017
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
4. York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
5,6: Leeds City Region Advanced Manufacturing Report 2015

Ceramics

The Ceramics sector is also an energy-intensive sector that is present in W&NY, but its contribution to total employment levels in the region is very limited (0.02%). Currently it is not covered in any sector-specific plan within the local energy strategies, and falls instead within the broader category of energy-intensive users. Four ceramics manufacturers in W&NY are covered by a CCA, located across the Calderdale, Kirklees and Wakefield districts.

Table 2.9: Ceramics

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive	
Sector identified as a priority within the Government's Clean Growth Strategy	• 27% Relative emission reduction in 2050 (relative to 2012) for BAU[1] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including ceramics) worth £260 m in 2016 and over £500 m since 2013[2]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.018% (or 260 jobs) • No data available for the UK, and consider the above share to be tiny	↓
Recognised in existing Local Energy Strategies	• Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[3] (+)	↔

(and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries[4] (+) • No specific plan for ceramics sector in existing strategies – included within broader strategies aimed at energy-intensive sectors in general	
Competitive advantage	• The City Region is home to Glass and Ceramics business[5]	↔

1: BEIS Industrial decarbonisation and energy efficiency action plans 2017
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
4. York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
5: Leeds City Region Advanced Manufacturing Report 2015

Cement

The Cement sector is present in W&NY, with one plant located in the Kirklees district, but the overall contribution to total employment levels in the region is negligible and no specific competitive advantages were identified.

Table 2.10: Cement

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive and Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 6,16,249 tonnes in total (jobs data unavailable) (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including cement) worth £260 m in 2016 and over £500 m since 2013[2] • 12% Relative emission reduction in 2050 (relative to 2012) for BAU[3]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.001% (or 15 jobs) • No data available at UK level	↓
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Proposed: Industrial Heat Recovery Support programme (IHRS) - Re-use the recovered waste heat on site to improve process efficiency[4] (+) • Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[5] (+) • Potential: Carbon capture, utilisation & storage (CCUS) - decarbonise clusters of energy/carbon-intensive industries[6] (+)	↑
Competitive advantage	• Nothing specific is mentioned in the background materials	↓

1: National Atmospheric Emissions Inventory (NAEI), 2016
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: BEIS Industrial decarbonisation and energy efficiency action plans 2017
4,5: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
6: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

Iron & steel

The Iron and Steel sector also has very low employment levels in W&NY, and accordingly is not identified as a priority sector. The only identified plant is a foundry located in Calderdale processing iron ores, oil sands and hard rocks.

Table 2.11: Iron & Steel

Criteria	Comments/evidence	Score
Sector properties	• Energy-intensive and Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 1,916,911 tonnes in total (jobs data unavailable) (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• 15% relative emission reduction in 2050 (relative to 2012) for BAU[2] • Great importance in making sure the economy remains competitive while cutting emission – package of relief for Energy Intensive Industries (including steel) worth £260 m in 2016 and over £500 m since 2013[3]	↑

Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.015% (or 225 jobs) • No employment data available at UK level	
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Proposed: Advancing Industrial Energy Efficiency – Target the high emission industrial sector (including iron and steel) with an energy efficiency innovation programme, with an aim for an increase of 20% in energy efficiency across the industrial sector[4] (+) • Potential: Industrial Decarbonisation and Energy Efficiency Action Plans – opportunities for energy intensive industries to grow their businesses whilst decarbonising[5] (+) • Potential: Carbon capture, utilisation & storage (CCUS) – decarbonise clusters of energy / carbon-intensive industries including steel production[6] (+)	
Competitive advantage	• Nothing specific is mentioned in the background materials	

1: National Atmospheric Emissions Inventory (NAEI), 2016
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: BEIS Industrial decarbonisation and energy efficiency action plans 2017
4,5: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
6: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

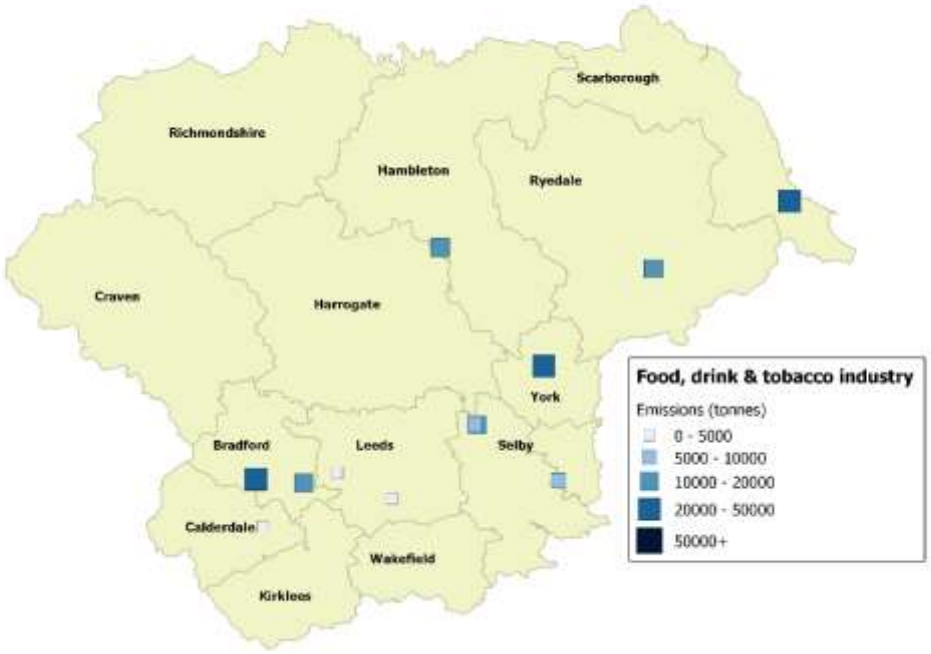
From this initial multiple factor analysis, the following energy-intensive sectors were ranked as 'top-priority' for W&NY due to their importance in national and regional strategies, their significant employment and supply chains in the region and their existing regional strengths:

- Food and Drink
- Chemicals
- Glass

The environmental footprint of key energy-intensive sectors

The next series of maps, produced using the available data from NAEI, shows the GHG emissions levels for the 'top-priority' energy-intensive sectors identified. Figure 2.6 shows the location of Food and Drink companies classified by the annual amount of GHG emissions released in 2016. The largest emitters (between 20,000 and 50,000 tonnes of CO_2eq) are located in the districts of Bradford, York and Scarborough while the smallest (up to 5,000 tonnes of CO_2eq) are in Calderdale and Leeds.

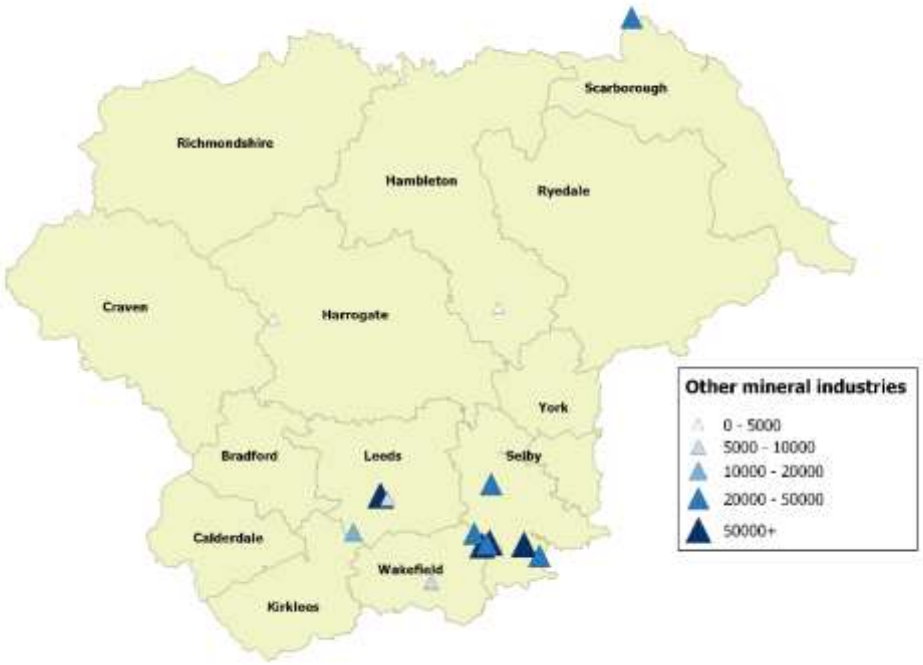
Figure 2.6: Industrial food, drink & tobacco plants located in W&NY by annual GHG emissions (tonnes)



Source: Cambridge Econometrics using NAEI data.

As depicted by Figure 2.7, glass and other mineral industrial plants are mostly located in West Yorkshire, specifically along the borders of the Selby and Wakefield district, and three of them emitted more than 50,000 tonnes of CO_2eq in 2016 (specifically, these business operators were: *Saint-Gobain Glass* in Eggborough, *Ardagh Glass* in Knottingley and *Allied Glass Containers* in Knottingley). Another large emitter (*Allied Glass Containers*) is in the Leeds district, while the only plant in North Yorkshire is in the northern part of Scarborough.

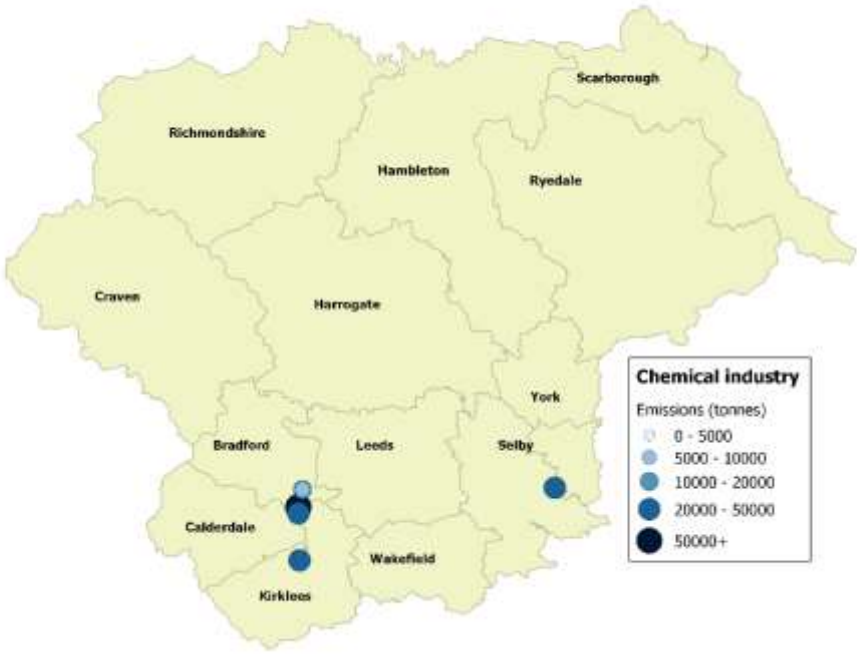
Figure 2.7: Other mineral (including glass) industrial plants located in W&NY by annual GHG emissions (tonnes)



Source: Cambridge Econometrics using NAEI data.

Chemical plants are all located in West Yorkshire, where a cluster exists across Bradford, Calderdale and Kirklees, as showed in Figure 2.8. These industries also emit large quantities of GHG.

Figure 2.8: Industrial chemical plants located in W&NY by annual GHG emissions (tonnes)



Source: Cambridge Econometrics using NAEI data.

2.6 Top priority emission-, resource- and waste-intensive sectors

Agriculture

Agriculture is a key target sector of national and local emission reduction policies, due to its large non-carbon GHG emissions, mostly nitrous oxide and methane. The Clean Growth Strategy dedicates particular attention to the development of possible future pathways to reduce the impact of agriculture on climate change, and the Government has announced the introduction of investments to promote greener agri-environmental techniques as well as to foster innovation in the use of natural resources. Four new centres for agri-tech innovation have also been funded. While focusing on a smaller scale, local energy strategies in W&NY set the clear target to create a circular agri-food economy with the aim of reducing its material and resource usage and, as a consequence, its GHG emissions. On this respect, the sector can benefit from numerous linkages with some complementary sectors that contribute substantially to the W&NY economy, including the Food and Drink sector and the anaerobic digestion plants located in North Yorkshire. The presence of advanced bio-economy research centres and of sectoral clusters in York also provide an important competitive advantage.

Table 2.12: Agriculture

Criteria	Comments/evidence	Score
Sector properties	• Emission-intensive • Emission statistics (from combustion only): 2.48 tonnes per job (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• Possible pathways to 2032: emissions from land use and agriculture falling by 26%[2] • The Government will introduce a new agri-environment system to support future farming and the countryside, as well as deliver better environment outcomes[3] • The Government expects to invest £99 m out to 2021 on innovation in natural resources[4] • 4 centres for Agri-tech Innovation has been funded: Agrimetrics, Agricultural Engineering Precision Innovation Centre (Agri-EPI), Centre for Crop Health and Protection and Centre for Innovation Excellence in Livestock (CIEL)[5]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 1.49% • Employment share in the UK: 1.50% • Location Quotient: 0.99	↔
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Create a circular agri-food sector: Sustainably powered agricultural vehicles, small scale AD on farms and Closed loop farm systems. This is highly likely within YNYER LEP due to the regional strength in the agri-food sectors[6]	↑
Competitive advantage	• Leeds City Region: Significant talent pool and expertise in agri-tech, agri-science and bio[7] • Yorkshire and the Humber covers 12% of UK's farmland[8]	↑

1: National Atmospheric Emissions Inventory (NAEI), 2016
2,3,4,5: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
7: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
6, 8: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy

Electricity

The Power sector has to date played the largest role in recent GHG emission reductions in the UK, and is currently undergoing a profound transformation. This stems from the increasing diffusion of renewable energy sources at the expense of conventional fossil fuel power plants, with coal power plants progressively being decommissioned and legislation for their complete phase out by 2025. However, the overall emissions associated with the sector remain substantial, and about 246 tonnes of carbon were emitted per job in the sector in 2016. Decarbonisation policies will therefore continue to heavily focus on the sector until net zero emissions from the sector can be achieved (presumably some time before 2050), and in the Clean Growth Strategy the Government clearly commits to investments in energy storage, demand side response and new renewable power stations.

There is also an important role for the Power sector in the local energy strategies, where special attention is dedicated to anaerobic digestion plants and to the conversion of part of the Drax and Eggborough power plants from coal to biomass and natural gas. The Drax power station is also running an experimental carbon capture and storage (CCS) trial.

Despite the presence of a number of large power stations in W&NY, these are responsible for only 0.26% of total employment in the region, in line with the UK average. This situation might change in the future with the opening of additional anaerobic digestion and other renewable plants in the region, as the former in particular can be expected to have relatively high employment intensities.

Table 2.13: Electricity

Criteria	Comments/evidence	Score
Sector properties	• Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 246 tonnes per job (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• Phase out the use of coal for electricity production by 2025[2] • Commits to invest £70 m before 2022 to support energy storage and demand side response[3] • Around £180bn of investment already in place to build the power stations needed in the UK to produce clean and secure supplies of electricity[4] • Possible pathway to 2032: power emission fall by 80% (compared to 2017) by growing low carbon sources to over 80% of electricity generation[5] • Anticipation by 2050: close to zero emission from power sectors[6]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.263% • Employment share in the UK: 0.290% • Location Quotient: 0.91	↔
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• CCUS: Drax Power Station is currently running a £400,000 BECCS trial in collaboration with Leeds-based CCUS start up C-Capture, with the target of capturing 1 tonne of carbon dioxide each day[7] • 2020: Drax to convert the fourth of its six reactors to burn biomass[8] • 2023: Drax will develop its remaining two coal reactors to a 3.6 GW CCGT plant, and install 200 MW of energy storage[9] • 2018: Eggborough coal power plant to be decommissioned[10] • 2022: Eggborough to have 2.5 GW of CCGT up and running[11] • Opportunity and capacity for Anaerobic digestion (AD) plants[12]	↑

Competitive advantage	• Substantial existing deployment of AD within YNYER contributing 8% electricity and 6% biomethane to the UK's total capacity[13] • 6 GW of offshore wind is installed, planned or under construction off the coast of East Riding; and at least 400GW of power comes ashore and is connected to the electricity grid in East Riding[14] • Two major power stations in Leeds City Region: Drax power station – UK's largest coal fired and biomass fired power station; and Eggborough[15]	↑

1: National Atmospheric Emissions Inventory (NAEI), 2016
2,3,4,5,6: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
7,12,13,14: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
8,9,10,11,15: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan

Gas

The Gas sector is also expected to experience major changes in the coming years following the introduction of tighter climate policies. This is highlighted in the National Clean Growth Strategy. Natural gas will gradually be substituted with cleaner forms of heating in the residential sector, and low carbon heating systems such as heat pumps will receive further investment. Part of the existing natural gas infrastructure could be converted for use by hydrogen, as will be assessed in the H21 project that will be implemented in Leeds in the next decade. Notwithstanding the increasing role of alternative heating systems, natural gas will likely continue to play a role in the W&NY power sector for some time, with CCGT plants providing electricity generation after the phase out of coal by 2025.

Overall, the Gas sector only contributes a small number of jobs to the regional economy.

Table 2.14: Gas

Criteria	Comments/evidence	Score
Sector properties	• Emission-intensive • Emission statistics (carbon dioxide from fuel combustion only): 7.65 tonnes per job (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• Phase out the installation of high carbon fossil fuel heating in new and existing off gas grid residential buildings during 2020s – invest £10 m to support low carbon heating system[2] • Encourage take-up of cleaner heating system using cleaner fuels such as hydrogen and bioenergy[3]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 0.11% • Employment share in the UK: 0.145% • Location Quotient: 0.76	↓
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• The Leeds City Region: planning for the natural gas CCGT plants to come on line as coal is phased out by 2025[4] • H21 project in Leeds - developed a plan to convert the existing gas network in Leeds to 100 percent hydrogen, which emits zero carbon emissions at the point of use[5]	↑
Competitive advantage	• One of the key activities in Leeds is gas trading[6]	↔

1: National Atmospheric Emissions Inventory (NAEI), 2016
2,3: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
4,5,6: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan

Transport

Transport is now the largest source of GHG emissions in the UK; as emissions from the Power sector have substantially reduced, emissions from Transport

have in fact increased year-on-year, as increased private vehicle usage has outweighed efficiency gains in vehicles. There has also been little progress in shifting mobility to new low-carbon technologies; the road vehicle fleet continues to be dominated by vehicles based upon fossil fuel combustion, as are air and maritime transportation, and the rate of electrification of the railways has slowed dramatically.

More ambitious policies and technological innovations however will likely lead to more substantive changes in the future. The Clean Growth Strategy outlines plans for the rapid deployment of ultra-low emission vehicles, improvements in vehicle energy efficiency, the promotion of public and shared forms of transportation, a shift of freight from road to rail and investments in low carbon fuels. W&NY can benefit from this transition and local transport-specific strategies / plans are already in place. Both West and North Yorkshire have elaborated local transport plans focusing on promoting smart transport systems, funding the installation of new EV charging points and improving the current public transport systems.

W&NY is located at the heart of the UK's transport network, and its strategic importance is likely to increase if/when the HS2 project is completed.

Table 2.15: Transport

Criteria	Comments/evidence	Score
Sector properties	• Emission-, Resource- and Waste-intensive • Emission statistics (from fuel combustion only): 35.9 tonnes per jobs (UK)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• £1 bn supporting the take-up of ultra-low emission vehicles (ULEV)[2] • Investing an additional £80 m, alongside £15 m from Highways England, to support charging infrastructure deployment[3] • Providing £50 m for the Plug-in Taxi programme, alongside £14 m to support 10 local areas to deliver dedicated charge points for taxis[4] • Develop an Automotive Sector Deal to accelerate the transition to zero emission vehicles[5] • Invest £1.2 bn to make cycling and walking the natural choice for shorter journeys[6] • Work to enable cost-effective options for shifting more freight from road to rail[7] • Invest around £841 m of public funds in innovation in low carbon transport technology and fuels[8]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 3.14% • Employment share in the UK: 2.98% • Location Quotient: 1.05	↔
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Major national and pan-northern rail investment including improvements to the TransPennine line and East Coast Main Line, HS2 and Northern Powerhouse Rail[9] • £1bn West Yorkshire plus Transport Fund as a result of 2015 City Region Growth Deal with Government[10] • North Yorkshire Local Transport Plan (NYLTP) - economic growth, road safety, access to services, environment and climate change and healthier travel[11] • West Yorkshire Transport Strategy (WYTS) which targets at: Road network, One system public transport etc[12] (+)	↑

	• Create an energy Smart City of York - Developing a smart transport system, building on the substantial network of EV charging points, and retrofitting existing housing stock with energy efficiency measures[13]	
Competitive advantage	• Leeds City Region: UK's centre for innovative manufacturing, with firms driving this sector forward with technology advancement[14] • Principal transport routes in Leeds City Region e.g. Wakefield is situated at the heart of the UK's transport network[15]	↑

1: National Atmospheric Emissions Inventory (NAEI), 2016
2,3,4,5,6,7,8: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
9,11,12: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
10: West Yorkshire Combined Authority (the CA)
13: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
14,15: Leeds City Region Advanced Manufacturing Report 2015

Construction

While not responsible for a significant share of total direct GHG emissions, the Construction sector uses the most materials, and produces the most waste, in absolute terms, of any sector. Most of the emissions are embodied in construction materials, with the remaining share originating during the lifetime of buildings for heating. Sectoral decarbonisation policies therefore focus on reducing the material footprint (primarily through circularity measures and the recovery of materials) and improving the energy efficiency of new and existing buildings. The Clean Growth Strategy promotes investment to build new energy efficient homes more quickly and cheaper. The Construction sector is recognised as an important component of the local low-carbon economy in the energy strategies within W&NY, which target the promotion of new construction methods and the sharing of best practices and knowledge among local planners.

Construction is an important contributor to the economy of W&NY, particularly in the Leeds City Region, where it is responsible for almost 5% of employment. In recent years some manufacturers of modular houses have established their production plants in the region and are now producing thousands of dwellings each year.

Table 2.16: Construction

Criteria	Comments/evidence	Score
Sector properties	• Resource- and Waste-Intensive • Waste statistics: 99.2 tonnes per job (England)[1]	
Sector identified as a priority within the Government's Clean Growth Strategy	• Building lower cost and low carbon homes: currently tendering a $1.4 m three-year research project address the drivers, barriers, and challenges of new low carbon homes[2]	↑
Relative importance of the sector (location quotient)	• Employment share in W&NY region: 4.58% • Employment share in the UK: 4.94% • Location Quotient: 0.93	↔
Recognised in existing Local Energy Strategies (and other local strategies and information) (+) for shared strategies in The LEP and YNYER LEP	• Grow the skill base for the low carbon economy and address skills shortages in construction sectors- Enable and incentivise local knowledge sharing by Build capacity and sharing of best practice among local planning decision makers, particularly around new construction methods[3] (+)	↑
Competitive advantage	• YNYE: local strength in construction sectors[4]	↑

	• Leeds City Region: Construction is one of the important part of the economy and it has the potential to play an integral part in reducing the energy intensity of the City Region[5] • Modular factories are present in the region and produce thousands of dwellings each year (i.e. Legal & General in Leeds, Ilke Homes in North Yorkshire)[6]	

1: DEFRA, 2016
2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3, 4: York, North Yorkshire & East Riding's Local Energy Strategy -Towards a low carbon economy
5: An Energy Strategy and Delivery Plan for the Leeds City Region - Energy Delivery Plan
6: https://www.peelports.com

The initial criteria-based ranking highlighted the following emission-, resource- and waste-intensive sectors as 'top-priority' for W&NY due to their recognised importance in national and regional strategies, their significant employment levels and their links to existing regional competitive advantages:

- Agriculture
- Electricity
- Transport
- Construction

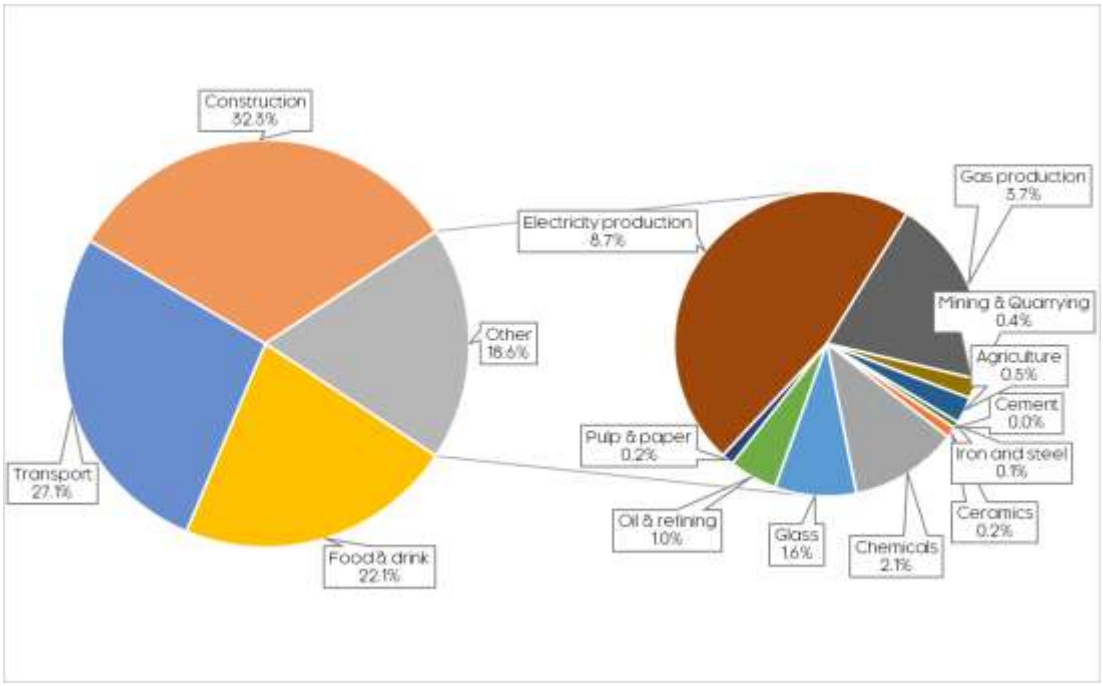
2.7 The economic footprint of key environmentally impactful sectors

The relative importance of the sectors in W&NY was assessed by analysing the latest sectoral employment data available from BRES (2017), together with estimates of Gross Value Added (GVA) calculated using productivity data available at the more aggregate level[3].

[3]The implicit assumption here is that labour productivity was the same for the 3-digit SIC sector in the W&NY region as evidenced in the official ONS Regional Accounts data at the 2-digit SIC sector for the Yorkshire & the Humber NUTS1 region.

Focussing on a sub-set of the data to consider GVA and employment only in those sectors which have the largest environmental impacts (i.e. those shortlisted above), in 2017 the largest share of regional GVA across the W&NY region was in the Construction sector (32% of total across all environmentally impactful sectors). Transport (27%) and Food & Drink (22%) also played a considerable role in terms of regional GVA, while the fourth highest value added (almost 9% of total across most environmentally damaging sectors) came from Electricity production in the region.

Figure 2.9 GVA by sector in W&NY in 2017 (£2016m)

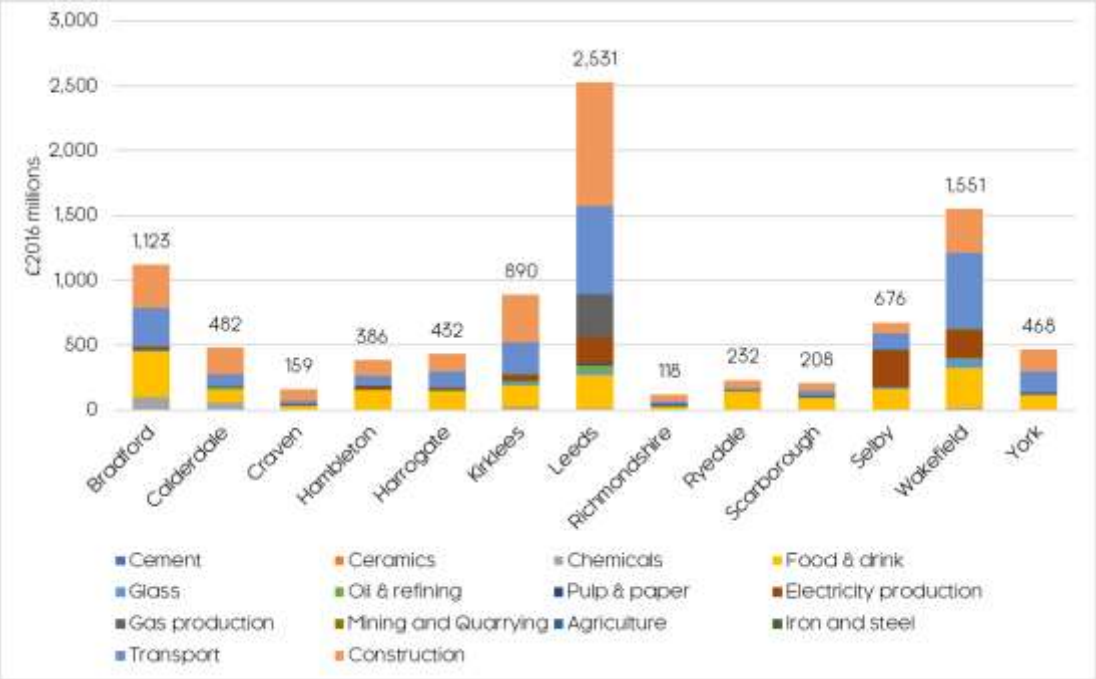


Source: Cambridge Econometrics, based upon BRES and ONS Regional Accounts.

There is considerable variance in sectoral proportions across local authority districts (as illustrated in Figure 2.9). Leeds has the highest GVA from these sectors, and while Construction is the largest contributor, it represents a smaller share of value added in Leeds than in some other local authorities.

As well as substantial differences in share by sector, the absolute values also vary widely. In Leeds, total GVA is approximately twenty times higher than total GVA in Richmondshire when assessing value added from these environmentally impactful sectors. For detail GVA data, please refer to Table 2.18.

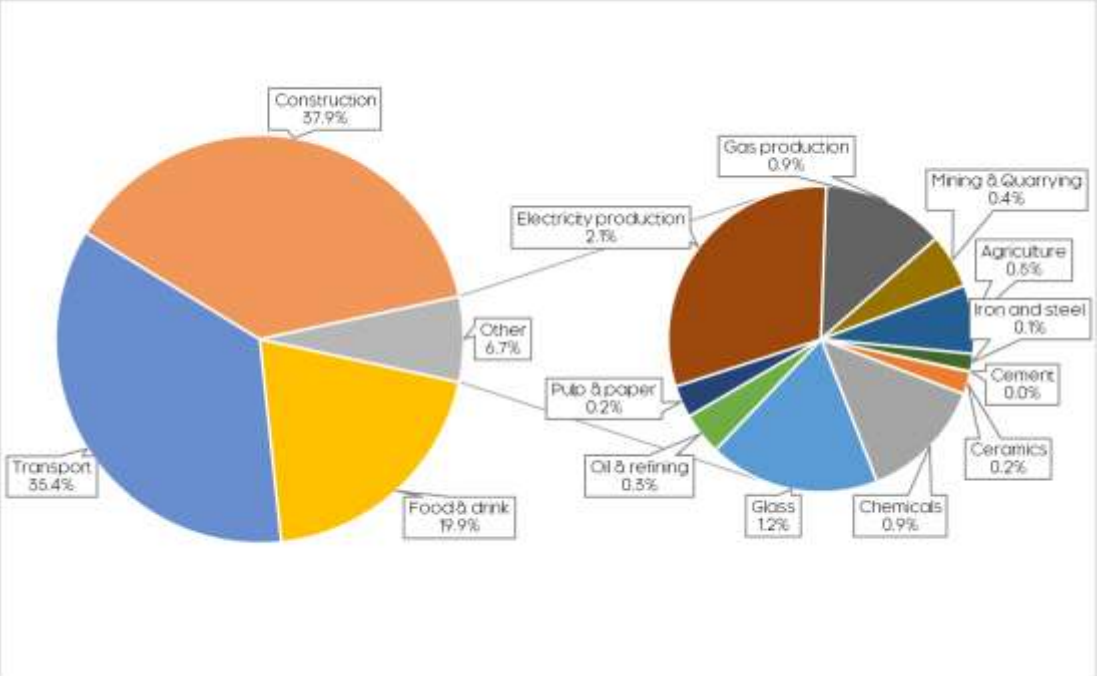
Figure 2.10: GVA by sector in each local authority of W&NY in 2017 (£2016m)



Source: Cambridge Econometrics.

The sectoral distribution of employment as showed in Figure 2.16 is largely similar to that of GVA in the region. The prevalence of Construction and Transport is even more pronounced, accounting for 38% and 35% respectively of total employment across the sectors with the largest environmental impacts in 2017. Food and Drink is the manufacturing sector with the higher share of both GVA and employment in W&NY.

Figure 2.11: Employment by sector in W&NY in 2017

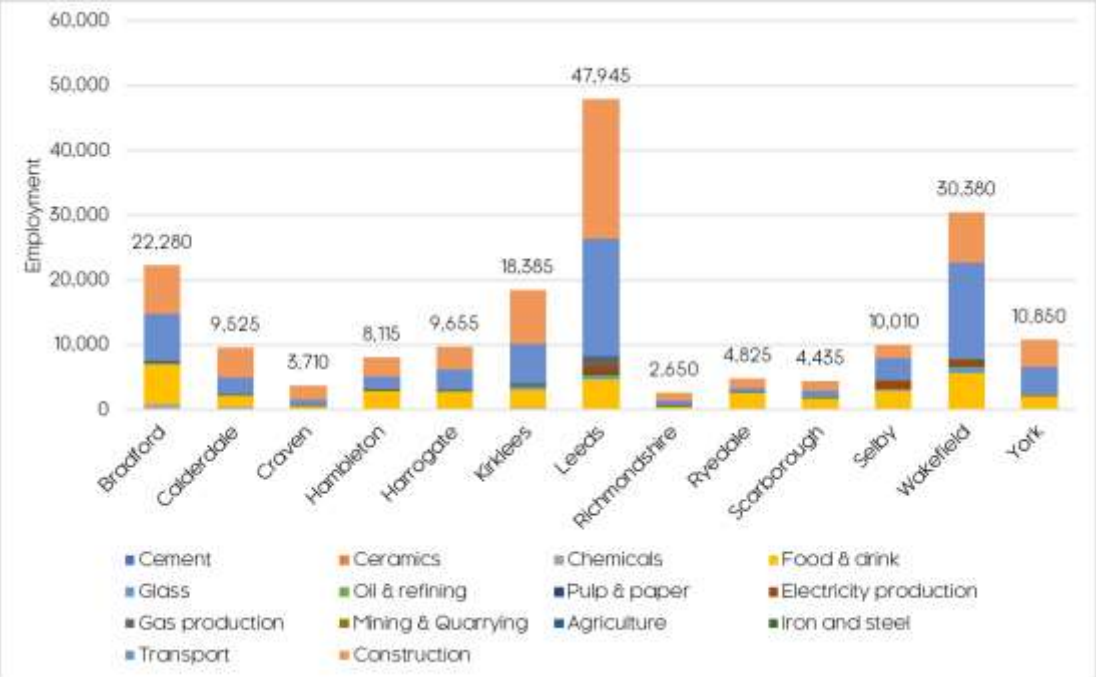


Source: Cambridge Econometrics using BRES data.

At the district level, the sectoral distribution of employment closely follows that of GVA in the majority of cases. While Construction has the largest GVA share in most districts, the relative share of Food and Drink (in percentage terms) is larger in districts with lower total GVA (e.g. Hambleton, Harrogate, Ryedale or Scarborough). Wakefield, Leeds and Bradford host most of the Transport-related employment. For detail employment data, please refer to Table 2.17.

This confirms the strategic importance of the identified 'top-priority' sectors in the W&NY region, with the Construction and Transport sectors in particular generating the largest GVA and employment. Food and Drink is by far the most important manufacturing sector in the region, while the remaining shortlisted sectors (Electricity, Glass, Chemicals and Agriculture) represent non-negligible shares of total value added and jobs.

Figure 2.17: Employment by sector in each local authority in W&NY in 2017



Source: Cambridge Econometrics using BRES data.

Table 2.17: Employment by sector in each local authority in W&NY in 2017 (as a % of the sum Employment in the identified environmentally impactful sectors in the local authority)

	Bradford	Calderdale	Craven	Hambleton	Harrogate	Kirklees	Leeds	Richmondshire	Ryedale	Scarborough	Selby	Wakefield	York	W&NY
Cement	-	-	-	-	-	0.1%	-	-	-	-	-	-	-	-
Ceramics	-	0.3%	-	0.4%	0.1%	1%	-	-	-	-	-	0.2%	-	**0.2%**
Chemicals	4%	5%	-	-	0.1%	1%	0.2%	-	-	-	0.4%	0.3%	0.2%	**1%**
Food & drink	28%	17%	17%	35%	28%	15%	9%	18%	54%	38%	29%	18%	19%	**20%**
Glass	1%	1%	0%	-	-	2%	1%	-	-	0.2%	2%	3%	0.4%	**1%**
Oil & refining	-	1%	0%	-	-	0.3%	1%	-	-	-	-	0.3%	-	**0.3%**
Pulp & paper	0.2%	1%	1%	-	-	0.1%	0.4%	-	0.2%	-	0.2%	-	-	**0.2%**
Electricity production	0.4%	0.1%	-	1%	0.1%	1%	2%	-	0.1%	1%	12%	3%	0.5%	**2%**
Gas production	-	-	-	-	0.4%	0.3%	3%	-	-	-	-	-	-	**1%**
Mining & Quarrying	0.2%	1%	3%	0.4%	1%	1%	0.1%	2%	1%	0.5%	0.5%	0.3%	-	**0.4%**
Agriculture	0.2%	0.2%	1%	2%	1%	0.1%	0.2%	8%	1%	1%	1%	0.1%	0.4%	**0.5%**
Iron and steel	0.2%	0.4%	-	-	-	0.1%	0.1%	-	0.4%	-	-	0.2%	-	**0.1%**
Transport	32%	25%	22%	24%	33%	33%	38%	25%	11%	26%	33%	49%	40%	**35%**
Construction	34%	48%	58%	38%	36%	45%	45%	48%	32%	34%	21%	25%	39%	**38%**
Total	**22,280**	**9,525**	**3,710**	**8,115**	**9,655**	**18,385**	**47,945**	**2,650**	**4,825**	**4,435**	**10,010**	**30,380**	**10,850**	**182,765**

Source: Cambridge Econometrics using BRES data. Note: Last row (Total) shows the sum of Employment in the identified environmentally impactful sectors in the local authority.

Table 2.18: GVA by sector in each local authority of W&NY in 2017 (as a % of the sum GVA in the identified environmentally impactful sectors in the local authority)

	Bradford	Calderdale	Craven	Hambleton	Harrogate	Kirklees	Leeds	Richmondshire	Ryedale	Scarborough	Selby	Wakefield	York	W&NY
Cement	-	-	-	-	-	0.1%	-	-	-	-	-	-	-	**0.1%**
Ceramics	-	0.4%	-	1%	0.2%	1.1%	-	-	-	-	-	0.3%	-	**0.2%**
Chemicals	9%	11%	-	-	0.3%	2%	0.4%	-	-	-	0.7%	0.8%	0.6%	**2%**
Food & drink	32%	20%	21%	40%	34%	18%	10%	21%	61%	43%	23%	20%	24%	**22%**
Glass	1%	1.0%	-	-	-	3.0%	1.2%	-	-	0.3%	2.0%	4%	0.6%	**2%**
Oil & refining	-	3%	-	-	-	1%	1.9%	-	-	-	-	1.0%	-	**1%**
Pulp & paper	0.2%	1.1%	0.7%	-	-	0.1%	0.4%	-	0.2%	-	0.2%	0.0%	-	**0.2%**
Electricity production	2%	0.2%	-	6%	0.5%	5%	8%	-	0.5%	4%	41%	14%	2%	**9%**
Gas production	-	-	-	-	2%	1%	12%	-	-	-	-	0.1%	-	**4%**
Mining & Quarrying	0.2%	0.6%	4%	0.5%	0.8%	0.4%	0.1%	2%	0.7%	0.7%	0.5%	0.3%	-	**0.4%**
Agriculture	0.1%	0.1%	0.9%	2%	2%	0.0%	0.1%	12%	2%	1%	1.0%	0.1%	0.6%	**1%**
Iron and steel	0.2%	0.4%	-	-	-	0.1%	0.1%	-	0.4%	-	-	0.2%	-	**0.1%**
Transport	26%	19%	19%	19%	28%	27%	27%	22%	9%	21%	19%	38%	36%	**27%**
Construction	30%	43%	53%	31%	32%	42%	38%	43%	27%	29%	13%	22%	36%	**32%**
Total	**1,123**	**482**	**159**	**386**	**432**	**890**	**2,531**	**118**	**232**	**208**	**676**	**1,551**	**468**	**9,256**

Source: Cambridge Econometrics. Note: Last row (Total) shows the sum of GVA in the identified environmentally impactful sectors in the local authority.

2.8 Interlinkages between sectors

In a number of cases, the emission- and energy-intensive sectors form part of the same value chains. While clearly energy (and therefore the Power sector) is a key input into all identified sectors, and transport plays a major role in all sectors (particularly Construction, Agriculture and Food and Drink), there are other interlinkages. For example, while the Glass sector provides containers and packaging for beverages and spirits, Agriculture provides the majority of inputs to the Food sector. Both of these supply linkages are as likely to be local in nature (i.e. Agricultural firms supplying Food and Drink manufacturers also in the region) , with companies taking into account the costs of transportation (in the case of Glass and other construction materials) and the ubiquity of produce (in the case of the Agricultural sector).

The implication of these links is that sector-specific policy (or changes in consumer preferences) does not just impact upon the direct target, but effects can cascade through supply chains. For example, higher carbon prices will have the largest impacts on energy-intensive industries such as Chemicals and Glass which rely on natural gas as main fuel input, but increases in the costs of these goods will lead to higher costs in the industries that they supply (e.g. Construction, Food and Drink), meaning that the potential for job losses and (in the most severe cases) carbon leakage extend across the whole supply chain. However, it is important to note that, while theory suggests that national or regional policy can create the risk of carbon leakage (where firms relocate production to areas with lower costs of complying with environmental legislation), there is little concrete evidence of such phenomena.

2.9 Conclusions

This analysis presented in this chapter illustrates that both energy- and emission-intensive industries are present in the W&NY region, with varying degree of economic importance in different parts of the region. The existing sectors with the largest environmental impacts are largely (although not exclusively) focussed in West Yorkshire, in Leeds and the surrounding area. This reflects in part the population density of the area, but also the highly connected nature of that part of the region (in terms of transport infrastructure) as well as the considerable interdependencies between firms along supply chains.

In many of the identified industries, such close geographical proximity is important to business models, since transportation costs of the goods produced by these industries is often a sizeable proportion of total costs. However, in the shift to a low carbon and more circular economy, the use of goods produced by these industries might be expected to decrease due to greater material and resource efficiency across the economy.

Reduced demand for materials and inputs has particular implications for West Yorkshire where the decline of once-prominent sectors could have serious employment and social implications. Industries will need to adapt to changes in both policy and demand for the products they produce to ensure they remain competitive, and survive. Utilising clean technologies developed within new clean growth sectors will be key to reducing the environmental impacts (and associated costs) produced by the sectors, and new sub-sectors within the broader, traditional sector should be developed, to take advantage of

emerging opportunities presented by decarbonisation. In some cases, it may be that opportunities arise in some parts of the region that were previously disadvantaged, such as North Yorkshire, where the precise reasons that it has previously been disadvantaged (in terms of remoteness and relatively low levels of urbanisation) can be strengths (for example in agri-tech and energy from waste sectors).

3 Identification of clean growth sectors

3.1 Clean growth policy background

National policy background

The Government's Clean Growth Strategy defines clean growth as 'growing our national income while cutting greenhouse gas emissions' (HM Government 2017). This means continuing to increase the incomes of businesses and households through continued economic growth, while at the same time protecting and improving the natural environment through reduced GHG emissions (and achieving a complete decoupling of economic growth and emissions). In this sense, the UK government has recently committed to a long-term and legally binding target to achieve net zero GHG emissions by 2050, which will require stricter five-year carbon budgets and more ambitious annual reductions.

The Clean Growth Strategy sets out plans to meet the fourth and fifth carbon budgets (covering the periods 2023-2027 and 2028-2032), for which a substantial acceleration in the pace of decarbonisation is required (without taking into account the recent upgrading of the target for 2050 to realising a net-zero economy). The plan includes a wide-ranging set of policies and proposals that aim to accelerate the pace of clean growth.

Key policies and proposals in the Government's Clean Growth Strategy include:

- Accelerating Clean Growth, through the development of world leading Green Finance capabilities
- Improving Business and Industry Efficiency, improving energy productivity and commercial building standards, delivering industrial energy efficiency, investing in industrial innovation
- Improving our Homes, upgrading energy efficiency across a million homes, strengthening building standards, rolling out heat networks, phasing out of high carbon heating
- Accelerating the Shift to Low Carbon Transport, supporting the take-up of ultra-low emission vehicles, developing electric vehicle charging network, shifting freight from road to rail and innovation in Connected and Autonomous Vehicles and electric batteries
- Delivering Clean, Smart, Flexible Power, phasing-out of coal, developing new ways of balancing the grid through electricity storage and demand response,
- Enhancing the Benefits and Value of Our Natural Resources, supporting agriculture, a new network of forests, zero avoidable waste by 2050, managing emissions from landfill
- Leading in the Public Sector, setting a voluntary 30 percent public sector carbon reduction target by 2020 and funding for energy efficiency improvements in England.

Clean growth sectors

Transitioning towards a greener economy will require major structural change, both in terms of developing and widely using renewable energy sources, and in terms of emitting lower levels of harmful greenhouse gases (IILS-ILO 2011).

These structural changes will cause shifts in production and consumption throughout all sectors of the economy, particularly shifts from high-carbon-intensive sectors to low-carbon-intensive sectors.

Areas for action identified in the Clean Growth Strategy are broad and cover most conventional sectors. For example, 'Improving Business and Industry Efficiency' has implications for sectors such as repair of machinery and equipment, waste collection, treatment and disposal and business support services. 'Accelerating the Shift to Low Carbon Transport' has implications for the manufacture of motor vehicles and associated supply chains such as the manufacture of electric components, batteries etc. and promotes modal shifts to cleaner forms of transport. What makes a sector a 'clean growth' sector is that there are activities being carried out within the sector that directly contribute to decarbonisation of the economy. For example, in the manufacture of electrical components sector, while not all activity is related to clean growth, some technologies and products being manufactured are specifically used within an end-product that is a low-carbon technology, such as electric vehicles or wind turbines.

The Clean Growth Strategy touches on the UK's competitive advantages in new economic opportunities that arise through clean growth. Early action in developing new low-carbon technologies and services has meant that the UK has a broad range of low carbon industries, i.e. subsectors of conventional/ traditional sectors that are focusing their activities on developing low-carbon or sustainable goods and services. Opportunities also arise for another subset of companies which centre their activities around developing new ways to minimise resource use and waste, fostering the transition towards a circular economy. The Government's recently published Resources and Waste Strategy for England aims to make England a world leader in using resources efficiently and reducing the amount of waste generated. One way to achieve this is through establishing resource efficiency clusters where businesses can share knowledge and practices to innovate and reduce their material footprint.

Engagement with local stakeholders highlighted that the definition of the clean growth sector itself is viewed as problematic; respondents highlighted that there is no clear definition of the clean growth sector yet and establishing a definition is an essential first step to carrying out a clean growth audit. One respondent commented that clean growth is not a sector in itself but a 'government tag', therefore the focus should be on clarifying what is meant by 'clean growth' to existing sectors.

Local policy context

Within the combined regions of City Region and YNYER there have been various initiatives to encourage the decarbonisation of conventional sectors, including numerous initiatives on sustainable transport, and to improve energy- and resource- efficiency across businesses and households. Both regions aim to build on their unique local economic strengths and natural capital assets to realise an equitable transition to a low-carbon economy.

In the case of YNYER energy generation, energy- and resource-intensive manufacturers, bioeconomy and natural capital assets are the focal points of the local energy strategy which, amongst other things, aims to consolidate the local circular economy agri-food sector and to establish resource efficiency clusters. Reducing material and resource usage would generate notable cost savings for firms, as outlined in the Resources and Waste Strategy (HM

Government 2018c), and closely located industries could benefit from resources and waste as well as opportunities to share best practice. Given the high concentration of Food and Drink companies and their relevant contribution to the local economy of YNYER (as evidenced in Chapter 2 and illustrated in Figure 2.6), the introduction of circular economy principles could unlock substantial cost savings and income generating opportunities while drastically reducing GHG emissions.

City Region has an economy generating £70 billion in Gross Value Added per year, with strengths in numerous sectors including finance, manufacturing, health and digital innovations (Leeds City Region LEP 2016). Energy generation also plays an important role in the local economy of the Leeds, Wakefield and Selby districts, particularly in the production of electricity and trading of gas. A key target of the LEP is to reduce GHG emissions through a profound transformation of the region's economy centred around reductions in resource and energy usage while preserving the competitiveness of local industries (West Yorkshire Combined Authority 2018). To help deliver this, numerous energy efficiency programmes are in place including the Energy Accelerator and the Resource Efficiency Fund for small and medium enterprises (SMEs). Given its strategic location along the principal transport routes of the UK's transport network, the City Region plans to continue to invest in the local transport infrastructure and maintain good quality infrastructure. The local transport plans highlight this and presents clear strategies to improve local air quality and road safety by promoting low carbon transport modes and by taking advantage of the strong local digital industry, particularly in relation to smart transport systems (West Yorkshire Combined Authority 2017).

Why do businesses locate here?

Factors identified by stakeholders as affecting the decision of clean growth sector businesses to locate in the region include:

- The presence of high-value jobs and a knowledgeable and skilled workforce
- A healthy university and HE sector, with many skilled graduates coming out of the region each year;
- Access to a variety of renewable resources: wind, solar, tidal etc.;
- Space to operate in the rural areas, but with good connectivity/transport links in the conurbations;
- Funding from LEPs;
- Supportive local authorities and a generally supportive general public; and
- Designation of Humberside as an Industrial Cluster.

Future development of the sector

The national commitments to net zero emissions, energy supply moving toward further decarbonisation and a growing market for cleaner transport and energy efficiency mean that expansion in the sector is expected. Local authorities have highlighted that collaboration at a regional level in the future could provide opportunities to support projects of greater scale and impact.

Future opportunities in clean growth sectors might include:

- Greater focus on bio renewables and biomass energy production;

- Investment and incentives to invest in clean growth for businesses in all sectors;
- Enterprise zones specifically for clean energy and waste reduction businesses;
- Support for waste valorisation research and activities (i.e. technologies aimed at reusing, recycling or composting from waste, residue or by-products in industrial processes);
- Support for the closing of the 'protein gap' through insect protein; and
- Building on existing strong sectors, such as low carbon processing in food and drink.

Our methodology for the analysis and forecasting of the clean growth sectors

Our approach to developing forecasts for the clean growth sectors was based upon a desire to make use of as much existing data as possible. There are three key sources of data; one is existing BRES employment data, available at different levels of sectoral detail for the local authority districts of the W&NY region. The second is the shares of traditional industries that are defined as 'clean growth', as set out by BEIS in *The size and performance of the UK low carbon economy* (Department for Business, Innovation & Skills 2015). The final useful dataset is the existing economic forecasts that are utilised by the W&NY local authorities, which provided us projections of GVA and employment out to 2036.

Based upon this data, we developed an approach to produce economic projections out to 2036 (i.e. consistent with the existing economic forecasts for the region). Under this approach, we took the existing economic projections (by broad sectors which correspond to aggregates of 2-digit SIC codes), and apply two modifiers; first, a modifier which calculates the percentage of the broad sector that is represented by specific industry that we are interested in. For example, this calculates what proportion of the "Food, Drink & Tobacco" broad sector is engaged in agri-tech (whether 'clean' or otherwise), and is calculated by comparing the sum of the BRES data for the relevant 3-digit sectors to the historical data in the W&NY forecasts for the equivalent broad sector. Generally, this proportion is not expected to change over time. The second modifier is the proportion of industry that is engaged in 'clean growth'. In our example, this would assess the proportion of agri-tech that is 'clean'. This modifier is expected to change substantially over time; changes are introduced by assumption, typically starting from the values proposed in BEIS (2015), and aiming to reflect the increasingly 'clean' nature of these industries over time.

The two modifiers were then applied to the W&NY economic forecasts (by broad sector) to produce projections for the economic size (in terms of employment and value added) of each clean growth sector over time, that are consistent with the overall path for the W&NY economy contained within the broad forecasts.

3.2 Overview of this chapter

This chapter of the report provides a greater level of understanding about the current features of clean growth sectors in the W&NY region, including where and who is currently operating in the low carbon and sustainability service sectors, the supply chain sectors associated with clean growth technologies and services, the size of the clean growth sector in terms of economic output, value added and jobs, and the current low-carbon R&D strengths in the region.

A greater understanding of the existing clean growth sectors in the region allows us to identify current opportunities and challenges faced by individual sectors, and develop appropriate policy recommendations which will feed in to a forthcoming Action Plan.

The remainder of this chapter (Section 3.3 onwards) explores in detail various sectors, which were selected based on various criteria including whether the sector is identified as a priority within the Government's Clean Growth Strategy, the relative importance of the sector in W&NY region in terms of GVA and employment, whether the sector is recognised in existing Local Energy Strategies (and other local strategies and information), the future potential of the sector and whether the region boasts any competitive advantages relevant to the clean growth sector in question. The sectors examined in this chapter, found to have the most potential within the region in terms of growth opportunities, opportunities for current and future employment, and regional advantages are:

- Clean agri-tech
- Bio-energy
- Hydrogen
- Low carbon transport
- Smart city
- Circular economy
- Construction

3.3 Clean agri-tech

Definition

The clean agri-tech sector typically includes activities related to the production of food and animal feed and the manufacture of innovative bio-based materials using the by-products from agriculture, aquaculture and forestry. It involves the adoption of advanced technologies to improve the sustainability and productivity of the agri-food supply chain by reducing emissions and material usage.

Given these characteristics and the collected literature and data, clean agri-tech can be classified as a low-carbon subset of the following SIC 3-digits sectors:

- 011: Growing of non-perennial crops
- 012: Growing of perennial crops

- 013: Plant propagation
- 014: Animal production
- 015: Mixed farming
- 016: Support activities to agriculture and post-harvest crop activities
- 101: Processing and preserving of meat and production of meat products
- 102: Processing and preserving of fish, crustaceans and molluscs
- 103: Processing and preserving of fruit and vegetables
- 104: Manufacture of vegetable and animal oils and fats
- 105: Manufacture of dairy products
- 106: Manufacture of grain mill products, starches and starch products
- 107: Manufacture of bakery and farinaceous products
- 108: Manufacture of other food products
- 109: Manufacture of prepared animal feeds
- 110: Manufacture of beverages

Altogether, the listed 3-digit SIC codes represent the wider Agriculture and Food & Drink industries of which the clean agri-tech sector is only a part. Anaerobic digestion processes and activities are also included in the Clean agri-tech subsector, thus policy context, as well as the current economic size (i.e. GVA and employment) estimates and the future growth projections of the sector all cover anaerobic digestion.

Strong interlinkages exist between clean agri-tech and laboratories/research centres; the latter are developing innovations in physical, biological and chemical processes that can be applied to accelerate growth and productivity of the food supply-chain. These entities however represent only a small fraction of the broad chemicals and scientific and research consultancy sectors, and for this reason were not included in the above list. While such firms are be captured in the bottom-up analysis of firms (where relevant), they are *excluded* from the top-down estimates of the economic footprint of the sector that are presented here.

Relevant national policy and local policy context

The North of England is an important bio-economy hub with a strong industrial and research base. More than 16,000 related businesses have already established their headquarters or primary site in the region, employing about 415,000 people and generating £91 bn of annual turnover (University of York 2017).

With its specialisation in agri-food and bio-economy, W&NY has significant competitive advantages compared to other regions and has the potential to lead the transition towards a decarbonised and environmentally friendly agriculture and food sectors in the UK. The City of York is home to an important innovation cluster for the bio-economy industry (BioVale) which enhance local industry's capabilities by sharing the latest research, expertise and funding, and facilitating networking amongst the bio-based companies and research organisations in the region.

The local energy strategies of West and North Yorkshire emphasise the importance of the sector and aim to foster the progression to a circular agri-

food industry. This is in line with the recommendations in the Government's Clean Growth Strategy, which allocates £99 m to research innovative technologies for agri-tech and land use and target the creation of a new climate-friendly agriculture in the UK. In 2018 BEIS also published a vision strategy for the bio-economy setting out a clear target of doubling the sector's size by 2030.

Table 3.1 Clean agri-tech

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• Designing a new future agricultural support to address climate change (post Brexit)[1] • Target to double in size the UK bio economy sector (reaching £440 bn) by 2030[2] • £99 m investment for innovative technology and research in agri-tech and land use[3]	↑
Relative importance of the sector in W&NY region	• More than 16,000 bio economy related companies in the north of England, employing 415,000 people with a £91 bn total annual turnover[4] • North Yorkshire specialisation in agri-food and food & drink sectors	↑
Recognised in existing Local Energy Strategies (and other local strategies and information)	• YNYER - a global leader in agri-food and bio-economy – is aiming at creating a circular agri-food sector[5]	↑
Future potential	• The Biorenewable Development Centre at the University of York has recently been awarded £1.5 m to support innovative SMEs of the sector in the Leeds City Region[6] • Large potential for innovations in food & drink (i.e. novel foods with improved nutritional value, novel food and energy crops, biodegradable packaging)[7]	↑
Competitive advantage	• BioVale as an innovation cluster for the bio economy in the W&NY region, focusing on biowastes and biorefining • North of England has research capacity in the science of bio economy, sectoral expertise and industrial capacity which outperforms the rest of the country[8]	↑

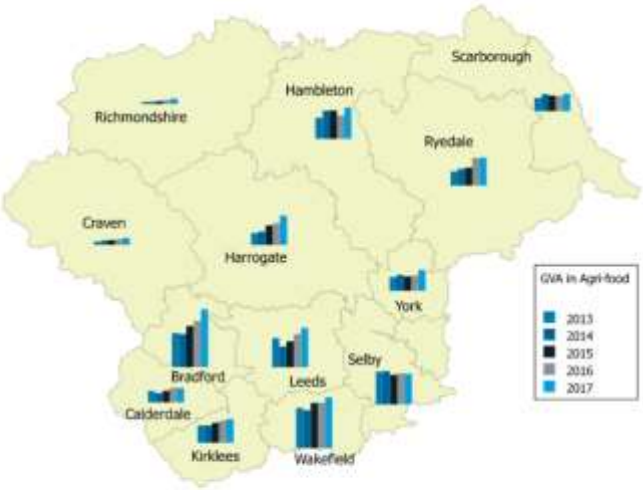
1,3: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
2,7: HM Government (2018), Growing the Bioeconomy
4,8: University of York (2017), The Bioeconomy in the North of England
5: YNYER Local Energy Strategy
6: https://www.york.ac.uk/news-and-events/news/2019/business/bdc-funding-erdf/

Recent changes in size of the wider sector

In recent years the wider Agri-food sector has rapidly expanded in the W&NY region. Since 2013 annual gross value added has increased by 45%, to an estimated £2,038 m in 2017. The sector is also creating more and more jobs with an estimated 37,145 people employed in the same year. Note that Figure 3.1 includes data for all SIC codes identified above, and do not seek to separate out 'clean' and 'non-clean' activities. While no precise employment numbers of the purely clean agri-tech sector in the region exist, (Capital Economics, TBR and E4tech 2016) estimated that 3.9% of employment in Yorkshire and The Humber could be attributed to the transformative bioeconomy in 2014. This macro-sector is larger than the clean agri-tech sector considered here and includes additional activities such as water and remediation, forestry and logging and bioenergy.

Figure 3.1: Gross Value Added for the wider agri-food sector by district (2013 – 2017) (£2016 m)

GVA (£2016m) in 2017	Wider Agri-food sector	% of York, West & North Yorkshire
Bradford	329	16%
Calderdale	83	4%
Craven	40	2%
Hambleton	179	9%
Harrogate	169	8%
Kirklees	136	7%
Leeds	225	11%
Richmondshire	31	2%
Ryedale	160	8%
Scarborough	100	5%
Selby	174	9%
Wakefield	291	14%
York	119	6%
York, West & North Yorkshire	**2,038**	**100%**



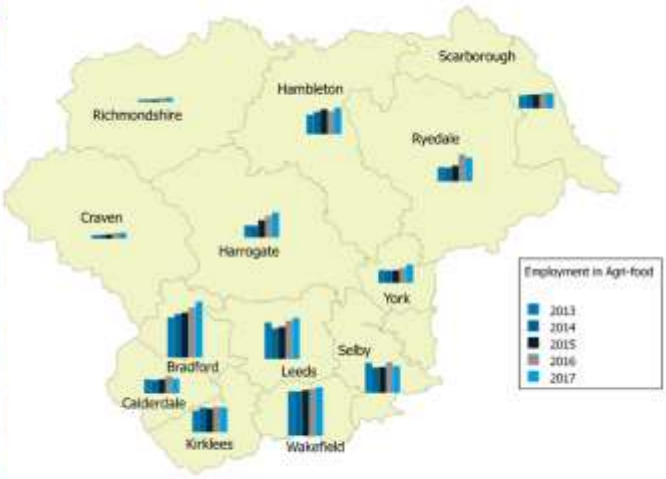
Source: Cambridge Econometrics.

All districts in the region experienced increases in GVA in the sector over this period, with the exception of Selby. Large parts of the accrued value added was generated in Bradford, Wakefield and Leeds (see Figure 3.1) as large part of the Food and Drink companies are located there. Nevertheless, Food and Drink as well as Agriculture companies are also present in North Yorkshire.

The distribution of employment across districts is similar to value added, with most jobs located in West Yorkshire. Employment increased in all local authorities between 2013 and 2017 (again with the exception of Selby, where it decreased by about 11%). Overall, the total number of people estimated to be working in agri-food in W&NY grew by 25% over the period.

Figure 3.2: Employment in the wider agri-food sector by district (2013 – 2017)

Employment in 2017	Wider Agri-food sector	% of York, West & North Yorkshire
Bradford	6,225	17%
Calderdale	1,665	4%
Craven	645	2%
Hambleton	2,985	8%
Harrogate	2,830	8%
Kirklees	2,800	8%
Leeds	4,950	13%
Richmondshire	490	1%
Ryedale	2,670	7%
Scarborough	1,700	5%
Selby	2,995	8%
Wakefield	5,430	15%
York	2,090	6%
York, West & North Yorkshire	**37,145**	**100%**

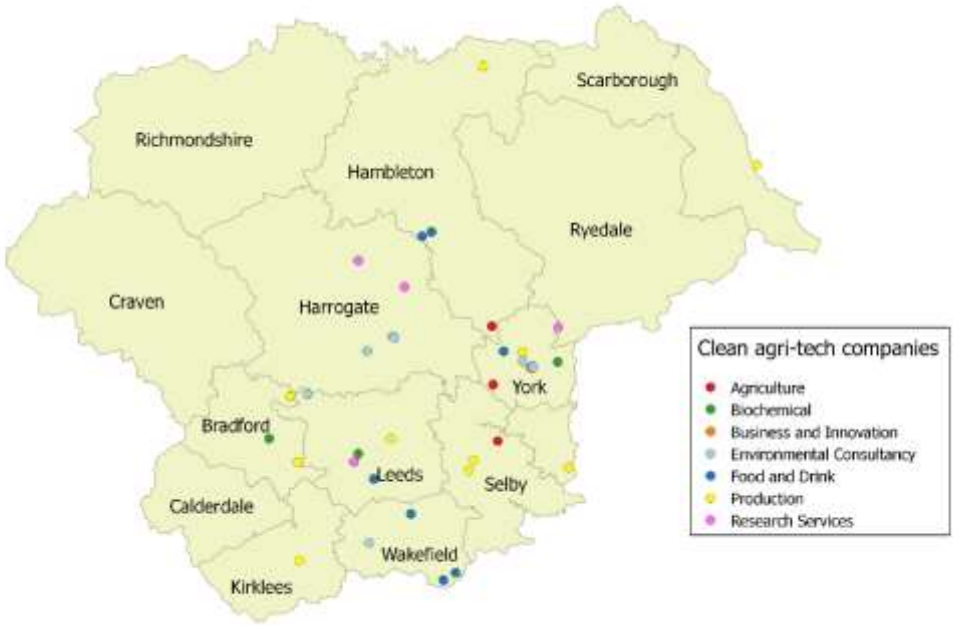


Source: Cambridge Econometrics, based upon the Business Register Employment Survey.

Agri-tech business locations

Figure 3.3 depicts the location of firms that have been identified through a desk-based research and interaction with stakeholders as contributing to the agri-tech industry in W&NY, organised into broad sectors. The City of York is an important cluster for this low-carbon sector and is able to attract businesses providing market-based research on the bioeconomy as well as some local laboratories and manufacturing. Other companies are distributed across W&NY, with high concentrations in Leeds, Harrogate, Hambleton, Selby, Bradford and Wakefield.

Figure 3.3: Location of companies involved in agri-tech in W&NY

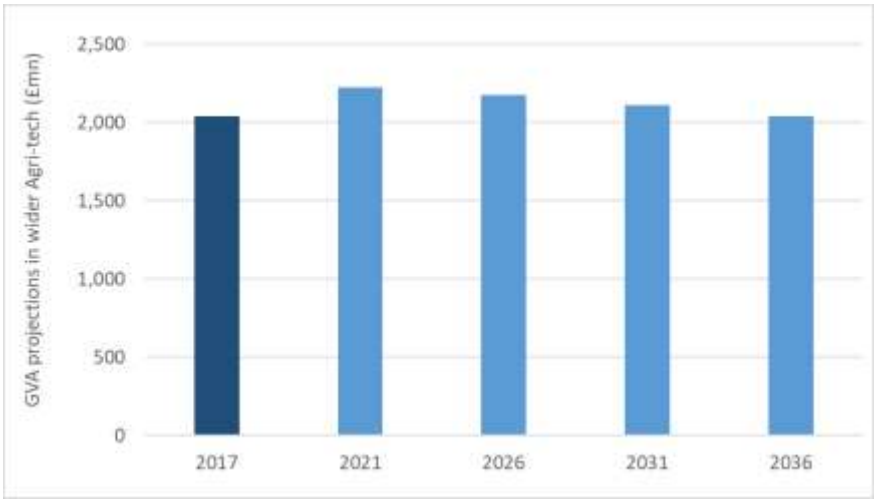


Source: Cambridge Econometrics, based on Companies House data and desk research.

Future projections of the size of the sector

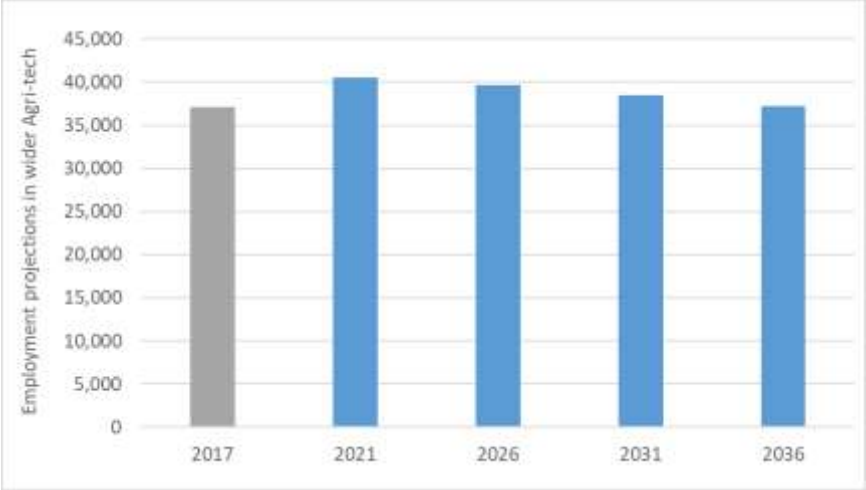
Projections for the future scale of the agri-tech industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall agri-tech industry and the 'clean' part of this industry. It is estimated that the level of employment in the agri-tech industry will largely stagnate compared to the 2017 level at around 37,000 in total in 2036, while the GVA associated with the industry will be just over £2bn.

Figure 3.4 GVA projection for the wider agri-tech industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.5 Employment projection for the wider agri-tech industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

Including further assumptions about the proportion of the agri-food industry that is engaged in 'clean growth' activities[4], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Section 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. It is estimated that approximately 3,400 people will be engaged in clean agri-tech by 2036 (compared to around 1,450 as of 2017) and the GVA associated with the clean agri-tech industry could reach £123 m by 2025 and £184 m by 2036. Our approach to estimate the future size of the clean growth sector is, of course, subject to uncertainty, as we have made assumptions on two parameters (the percentage of the broader sector that is represented by agri-tech; and on the proportion of the identified agri-tech industry that is engaged in 'clean growth') - thus in reality this figure can be higher or lower.

SWOT analysis

Table 3.2 provides an overview of the strengths, weaknesses, opportunities and threats for the clean agri-tech sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance. Within the SWOT, the term agri-tech is considered to encompass the use of bioscience and bioengineering to improve agricultural productivity (University of York, 2017), whilst agri-food refers to the wider agricultural sector covering production of food.

Table 3.2: Summary of SWOT for clean agri-tech & organic/environmentally friendly agriculture subsector

Positive	Negative
Internal to the sector	
Strengths	Weaknesses

[4] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time.

- More than 16,000 bio-economy related companies in the north of England, employing 415,000 people with a £91 bn total annual turnover (University of York, 2017). Considering the whole study area, employment in agri-tech is highest in Bradford, Wakefield and Leeds
- North Yorkshire has a specialisation in agri food sectors and the North of England has research capacity in the science of bio economy, sectoral expertise and industrial capacity (University of York, 2017)
- In excess of 400 individuals work in the Agri-tech R&D subsector in York and North Yorkshire, with further R&D opportunities in private sectors firms such as Nestle and McCain, which are outside of the SIC codes (YNYER, 2018)
- The Biorenewables Development Centre (BDC) at the University of York is an open access research and development centre linking academia and industry. Agri-tech related work includes testing products that have been developed to stimulate plant growth, investigating germination rates and developing products from food waste. The BDC has been awarded £1.5m to support innovative SMEs in the sector in the Leeds City Region (Biorenewables Development Centre, 2018)
- The Agri-Tech Catalyst helps place agri-tech products onto the market, however, funding for this has now ceased (RSB, 2017)
- The development of the W&NY cluster (e.g. in terms of geographic situation, personnel and funding) can alleviate fragmentation of supply chains and barriers to innovation (RSB, 2017)
- Agri-tech forms one of the priorities for YNYER LEP in their EU Strategic Investment Funds Strategy (YNYER, 2016)
- Short term problems of low profitability and uncertainty have resulted in a low rate of entry into farming (the proportion of workers aged 35 or less is around 3%) (Defra, 2018)
- Researchers experience difficulties in finding commercial partners and translating R&D outputs into the marketplace. The cessation of funding through the Agri-Tech Catalyst means that there is a lack of funding to enable late-stage research when commercialising products (RSB, 2018)
- Embedded investments in traditional methods means there has been insufficient investment into new technologies (e.g. robotic farming products) (RSB, 2017)
- Farmers need information and advisory services to enable them to access, contribute to and benefit from agri-tech (RSB, 2018)

- Grow Yorkshire, which is supported by the YNYER LEP, aims to encourage collaboration amongst those who offer support to agricultural businesses, to identify needs and secure funding to meet these needs (Grow Yorkshire, 2019)

External to the sector

Opportunities

- £99 m investment in innovative technology and research for agri-tech, land use, greenhouse gas removal technologies, waste and resource efficiency (HM Government, 2017; Clean Growth Strategy)
- Stimulation of industry-academia collaboration through the Agri-tech catalyst (HM Government, 2017; Clean Growth Strategy)
- The introduction of higher-level apprenticeships
- £160 m Agri-Tech Strategy (Defra, 2012)
- Target to double in size the UK bio economy sector (reaching £440 bn) by 2030. Following publication of the national strategy, the next phase is to develop delivery mechanisms, with coordination between government, industry and research organisations being key (stakeholders from the study area may be able to contribute to this). The strategy notes that work is needed to support the development of technology platforms and provide a regulatory framework fit for growth of the bio-economy (HM Government, 2019).
- York & North Yorkshire - a global leader in agri-food and bio-economy – is aiming at creating a circular agri-food sector (YNYER, 2018)
- The BDC is involved with the THYME project, a partnership between the University of Hull, University of Teeside and University of York. Work is to involve converting bio-waste to new products, re-purposing industrial sites for bio-

Threats

- Climate change (Defra, 2012)
- The agri-food sector will have to adapt to any loss of subsidies or new competition from non-EU producers in the event of a “no-deal” Brexit (NFU, 2019). This could have implications for agri-tech in terms of e.g. bringing improved crop varieties into commercial use
- Potential competition with other sectors for raw materials that enable agricultural production e.g. soya and palm oil in animal feed
- Reliance on local and national government policy (and subsidy) to deploy clean technology (e.g. carbon capture and storage) (BEIS, 2019)

manufacturing and bringing together research and commercial interests to grow the bio-economy (THYME, nd).
- Opportunity to build on the strengths of the bio-energy sector due to links between agri-tech processes and production of fuel (e.g. bio-refining raw materials from agriculture) (University of York, 2017)
- The 'Transforming food production: from farm to fork' programme aims to increase the incentives for investment in sustainable agriculture, helping to grow the markets for innovative technologies and techniques (HM Government, 2017; Industrial Strategy)[10]
- Humberside benefits from being identified as one of six Industrial Clusters (BEIS, 2019), in which opportunities to decarbonise will be greater as the UK moves towards net-zero carbon emissions in 2050 (industry stakeholder; pers. comm). The definition of the area covered by the cluster is not clear, but stakeholders in the study area feel the cluster includes them and view it as an opportunity.
- Potential opportunities to consider closing the protein gap through insect protein) (with stakeholder engagement indicating that researchers in the YNYER area are interested in this)
- Changes in agricultural policies as a result of the UK's departure from the EU could bring opportunities for agri-tech in terms of new technologies and systems being used to manage land in different ways. The NFU has just launched a vision for achieving net zero greenhouse gas emissions by 2040 (NFU, 2019a). The vision covers boosting productivity and reducing emissions; farmland carbon storage; and coupling bioenergy to carbon capture, utilisation and storage. Ideas mentioned include smart

farming, having a network of demonstration farms and the possibility of biochar (powdered charcoal) being applied to soil to save greenhouse gas emissions

The agri-tech sector has many potential opportunities involving both research and industry stakeholders. There are opportunities for the region in terms of Humberside being named as one of the Grand Challenge industrial clusters (note that the geographical area covered by the cluster has not been defined). The clusters are aimed at attracting investment and innovation, with BEIS noting that the intention is to establish at least one low-carbon cluster by 2030 (BEIS, 2019). Being located within or close to a cluster is therefore expected to increase the likelihood of firms attracting investment. Having businesses working towards a common goal (low carbon) within one location is also expected to lead to greater collaboration, with expected benefits for innovation as companies bring together their different areas of expertise. Stakeholder engagement indicates that industry outside these initial clusters is likely to struggle due to the limited ability to decarbonise. This is because they will lack access to the physical infrastructure (e.g. pipework), as well as the levels of investment that are expected to be made within clusters.

Other opportunities relate to funding and investment, including the award of funding to the BDC at the University of York and the investment in technology and research for agri-tech. Examples of the types of work underway in the sector include research by the University York to determine how to convert woody plant material into biofuel, as well as collaborations by organisations such as BioVale. There are additionally opportunities for skills development in agri-tech, as highlighted by the Humber Industrial Strategy Perspective (published in June 2019). This notes that the Yorkshire and Humber Institute of Technology is going to allocate some of its £10 m investment in the development of facilities to support training in the sector.

Products and services within the sector include conventional agricultural products, as well as newer ones such as fuels developed from plants and microbes. Developments in agri-tech are resulting in new commercially viable products, for example, work by BioYork and an agricultural contractor (Velcourt) has resulted in the development of oilseed rape that provides oils that can be used to produce thermally stable, biodegradable lubricants for high temperature frying[5]. Other products are expected to be developed through the THYME project. This has three objectives, one of which focuses on growing productivity of the bioeconomy through bringing together research and commercialisation. It is run by a collaboration between the University of York and two institutions outside of the City Region and YNYER.

Distinctive features of the study area include the presence of the National Agri-Food Innovation Campus (NAFIC) which hosts both public and private sector organisations. Stakeholder engagement has indicated that having public sector support for innovation is crucial for ensuring newer (and potentially initially more costly) technologies and processes are taken up by companies. Having public and private organisations coexisting is likely to

[5] BioYork (2019): Case study: Feed, accessed at: https://www.york.ac.uk/bioyork/our-approach/feed/ on 27th June 2019.

encourage such collaboration, as is the presence of existing organisations such as Grow Yorkshire that are aiming to encourage organisations to work together to provide support to farming businesses.

Export opportunities exist through being able to promote the uptake of new technologies as well as skills developed in the region. This could include the knowledge and experience gained through the potential creation of a circular agri-food sector.

Policy recommendation for the sector

Considering overall development of the sector, agri-tech appears to be quite strong in the study area although currently there is some geographical variation in employment and GVA by local authority district. Of the total agri-tech GVA generated across the study area in 2017, 16% was in Bradford, 14% in Wakefield and 11% in Leeds. Employment followed a similar pattern, with 17% of the estimated 37,145 jobs being in Bradford, 15% in Wakefield and 12% in Leeds. However, there are companies working in areas such as food and drink, and research, within YNYER.

City Region: going forwards, evidence from the literature suggests that there is a need to develop clusters to help alleviate fragmentation in supply chains, which can lead to barriers for innovation. However, stakeholder evidence indicates that local growth strategies do not necessarily appear to define or distinguish clean growth as a sector in itself with some confusion over what the sector actually covers. Thus, for the City Region, it is suggested that there needs to be clear communication about what clean agri-tech involves and where the existing businesses are concentrated (based on current employment data, locations to concentrate on include Bradford, Wakefield and Leeds). This could help attract others to the area, thus decreasing the risk of fragmentation and enabling innovation. Note that the recent innovation audit (RSM, 2019) highlighted how having uncoordinated and indirect (i.e. fragmented) links between stakeholders can limit capacities for innovation.

YNYER: many of the potential opportunities for agri-tech relate to research and development activities, with several of the examples identified being located in YNYER. Stakeholder engagement has indicated a need for policy that enables the deployment of newly developed technologies and products. Such technologies may be more expensive than existing ones, thus support is needed to encourage their initial uptake within the region. This suggests that for YNYER, future policy needs to provide support for emerging technologies that may be developed from research activities (e.g. from BioVale and NAFIC). This could include building on existing collaborations that are already in place between the public and private sector. Evidence indicates that science parks, for example, can enable supply chain collaborations in several sectors including clean agri-tech. This would help the benefits of new agri-tech to be extended beyond the main population centres, for example, into Hambleton which generated around 9% of the study area's agri-tech GVA in 2017.

Both LEP regions: Across both the City Region and YNYER, raising the profile of the agri-tech sector could increase the opportunities for collaboration and thus support projects of greater scale and impact, aligning the aims of the sector with those of the local authority growth strategies. Indeed, collaboration has been highlighted by the recent innovation audit as being important for innovation (RSM, 2019). However, whilst larger projects could help support

growth, the challenge is to make sure that appropriate support is available for smaller enterprises (e.g. SME farmers). This will enable them to benefit from the uptake of new tech and avoid more rural areas such as Craven and Richmondshire in YNYER (which currently have lower levels of employment in agri-tech, with each representing around 2% of the study area's jobs in the sector) from being left behind.

3.4 Bio-energy

Definition

The bio-energy sector covers all activities related to the production of heat and electricity using fuels such as biomass, waste and other by-products from different sectors of the economy. This technology is generally considered to be renewable in the sense that its carbon footprint is neutral or small when burning natural feedstock such as wood, or even negative when disposing fuels such as waste, manure or wastewater sludge which, otherwise, would generate methane and other GHG emissions.

The bio-energy clean growth sector was classified as a subset of the following 3-digit SIC codes:

- 351: Electric power generation, transmission and distribution
- 352: Manufacture of gas; distribution of gaseous fuels through mains
- 370: Sewerage
- 382: Waste treatment and disposal.

Relevant national policy and local policy context

The latest national Clean Growth Strategy highlights the potential role of bioenergy, together with hydrogen, as a clean fuel to decarbonise sectors like transport, industry and heating. With particular reference to the last point, biomass boilers could substitute for high-carbon heating systems relying on coal and oil providing a low carbon heating alternative for rural communities not directly connected to the natural gas network. The Government allocated £4.5 m between 2016 and 2021 to promote innovative low carbon heat technologies, including biomass boilers, through the reform of the Renewable Heat Incentive (RHI) for homes and businesses. Energy-intensive firms will also increasingly rely on biomass as an alternative to fossil fuels to reduce the carbon emissions originating from their production processes.

Within W&NY there is a reasonable supply of biomass fuels (Carbon Trust 2017), and the share of waste disposal to produce heat and electricity in biomass and anaerobic digestion plants could potentially increase. Bioenergy production could also be complemented with CCUS to produce negative emissions allowing to capture carbon dioxide from the atmosphere and to meet the 2050 net zero target. In this sense, a first pilot project on bioenergy carbon capture and storage (BECCS) has recently been announced for Drax's biomass power generation. Overall, there is a significant potential to enlarge the local supply chains and generate new opportunities for job creation and economic growth.

Besides biomass from natural sources, animal and food waste represent an alternative fuel to be used in anaerobic digestion plants producing biogas, electricity and heat energy which can be distributed in district heat networks. The technology is relatively mature and widely adopted within North Yorkshire, which currently hosts 28 plants and produces 8% of electricity and 6% of the UK's biomethane. This technology already received special attention in the

local energy strategies of YNYER and LCP due to its synergies with the clean agri-tech sector and as an alternative way to dispose of available feedstocks of food waste, animal manure and slurry.

To date, however, AD plants have been developed in small scale to make use of the available waste resources and produce enough fertilisers and compost for the local agricultural sector. These plants can produce negative externalities in terms of ammonia and other local pollutant emissions, therefore damaging air quality. The Clean Growth Strategy highlighted the need to minimise these negative impacts, and stricter air quality limits can be expected in the future.

Table 3.3 Bio-energy

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• Need to minimise the impacts of AD in relation to air quality and reducing CH4 emissions[1] • No reference to Government's investments in this technology • Phase out the installation of high carbon heating in new and existing homes off the gas grid in the 2020s, reform the RHI with £4.5 bn for innovative low carbon heat[2] • Energy intensive industries switching from fossil fuels to biomass[3]	↓
Relative importance of the sector in W&NY region	• YNYER as hotspot: 28 AD facilities contributing to 8% electricity and 6% biomethane to UK's total capacity[4] • Much of AD is restricted to small scale farm use[5] • About 800 domestic biomass boilers installed during the RHI in W&NY (6.2% of UK's total)[6]	↔
Recognised in existing Local Energy Strategies (and other local strategies and information)	• AD and biomass for heat are among the prioritised low carbon technologies in the YNYER Local Strategy[7] • Industrial areas surrounding York, Leeds and Wakefield identified as geographic focus areas for AD and biomass[8]	↑
Future potential	• AD can use feedstocks like food waste, animal manure, slurry, municipal solid waste and commercial/industrial waste • Deployment limited to areas without air quality restraints and to local feedstock supply[9] • Biomass boilers can replace most existing oil and solid fuel boilers (63% of domestic biomass installations within the RHI displaced oil or coal)[10] presenting an opportunity for biomass heat uptake locally[11] • Uncertainty persist on the carbon footprint of wood-based fuels	↔
Competitive advantage	• YNYER has a competitive edge in AD technology, household waste AD facility and bioeconomy research assets and innovation clusters[12] • Support from LAs for the development of local value chains and to establish a cluster for AD • The Leeds City Region has 34 university centres of excellence and research competences in bio-renewables[13] • YNYER has high employment in manufacturing sectors that contribute to the manufacture and installation of biomass boilers[14]	↑

1,2,3: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
4,7,9,11,12,14: YNYER Local Energy Strategy
6,10: RHI monthly deployment data, BEIS, March 2019
13: https://investleedscityregion.com/system/files/uploaded_files/170901%20BROCHURE_MANUFACTURING2.pdf
5: Carbon Trust (2017), LCR and YNYER LEP Energy Strategy – Energy Technology Appraisal
8: Carbon Trust (2018), An Energy Strategy and Delivery Plan for the Leeds City Region

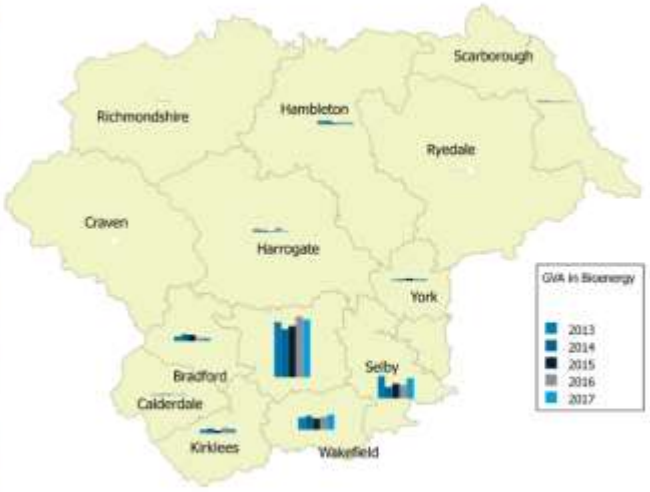
Recent changes in size of the sector

Bioenergy is a subset of the wider electric power generation, gas, sewerage and waste disposal sectors which are mostly concentrated in Leeds and in the remaining part of West Yorkshire. As of 2017, almost 8,500 people were employed in the sector, a 7% increase on 2013. Sectoral GVA was more than £1,200 m in 2017, although it had slightly decreased over the previous five years.

Making use of the estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), we assume that approximately 11.8% (~1,000) of current employment in the wider sector can be attributed to the clean growth sector component. Our approach to estimate the current size for the clean growth sectors is, of course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with the development of clean growth activities, employment and GVA associated with clean growth economic activities has also grown. However, in reality the GVA and employment figures presented here could be higher or lower.

Figure 3.16: Gross Value Added for the wider bio-energy sector by district (2013 – 2017) (£2016 m)

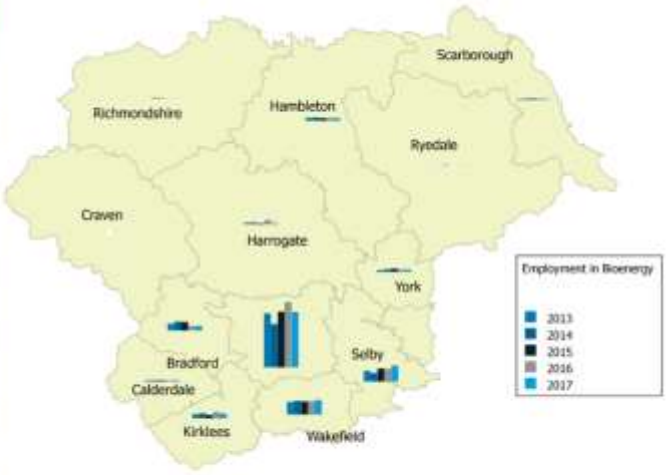
GVA (£2016m) in 2017	Wider Bio-energy sector	% of York, West & North Yorkshire
Bradford	38	3%
Calderdale	12	1%
Craven	0	0%
Hambleton	22	2%
Harrogate	9	1%
Kirklees	49	4%
Leeds	665	54%
Richmondshire	1	0%
Ryedale	2	0%
Scarborough	9	1%
Selby	232	19%
Wakefield	177	14%
York	20	2%
York, West & North Yorkshire	1,235	100%



Source: Cambridge Econometrics.

Figure 3.17: Employment in the wider bio-energy sector by district (2013 – 2017)

Employment in 2017	Wider Bio-energy sector	% of York, West & North Yorkshire
Bradford	375	4%
Calderdale	120	1%
Craven	0	0%
Hambleton	210	2%
Harrogate	110	1%
Kirklees	395	5%
Leeds	4,475	53%
Richmondshire	10	0%
Ryedale	25	0%
Scarborough	70	1%
Selby	1,290	15%
Wakefield	1,185	14%
York	200	2%
York, West & North Yorkshire	**8,465**	**100%**

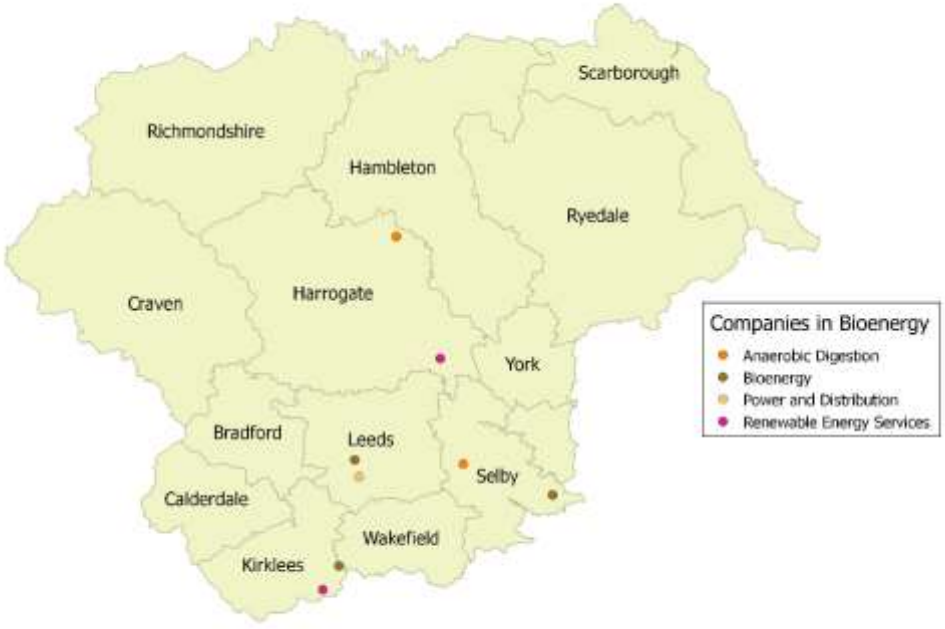


Source: Cambridge Econometrics, based upon BRES data.

Bio-energy business locations

Figure 3.18 depicts the companies identified as operating in the bioenergy sector, which utilises waste and by-products from agriculture and other sectors of the economy as a source to produce energy and heat. To date, a small number of bioenergy firms have been identified, and their locations set out in the figure below. Noticeably, there are not many AD plants identified, which (as identified in the agri-tech analysis) have a greater focus in West Yorkshire.

Figure 3.18: Location of companies involved in bioenergy in W&NY



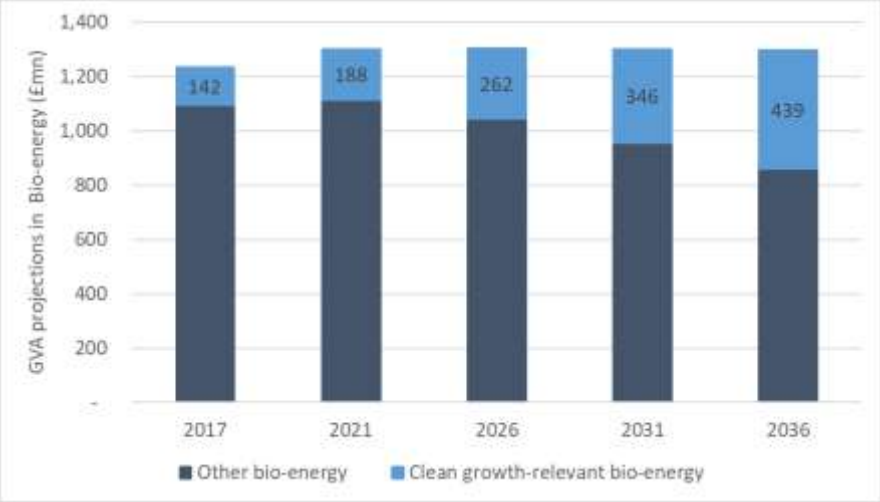
Source: Cambridge Econometrics.

This is primarily because they are often co-located on farms (and therefore not captured in the SIC codes identified); the two identified sites are commercial sites dedicated only to AD activities. Across the firms identified, there is no observable geographical cluster, although a number of firms are located in Harrogate and parts of West Yorkshire.

Future projections of the size of the sector

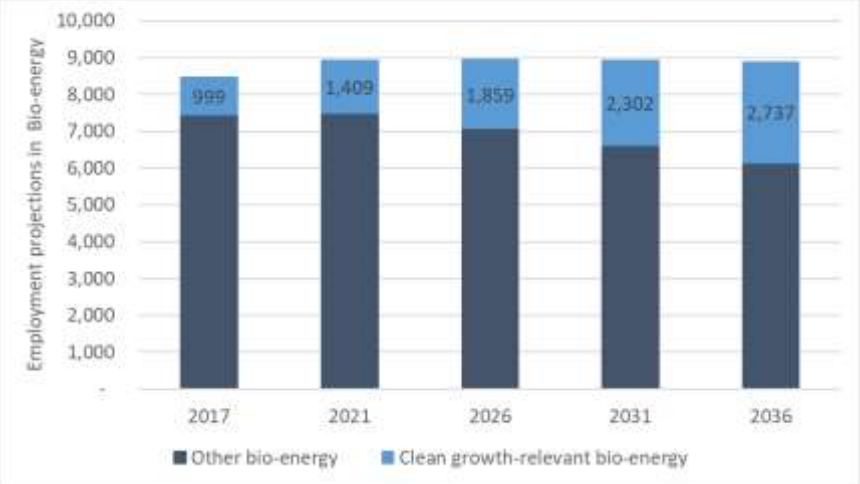
Projections for the future scale of the bio-energy industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall bio-energy industry and the 'clean' part of this industry. It is estimated that the level of employment in the bio-energy industry will slightly increase compared to the 2017 level to reach around 8,900 in total by 2036 (compared to 8,400 in 2017), while the GVA associated with the industry will reach £1,300 m.

Figure 3.19 GVA projection for the wider bio-energy industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.20 Employment projection for the wider bio-energy industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

Further investigating the economic projections, we include further assumption on the proportion of bio-energy that is engaged in clean growth. Our approach for making assumptions is presented at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. We estimate that about 2,700 people will be engaged in clean bio-energy by 2036 (compared to 1,000 in 2017) and the GVA associated with the clean bio-energy sector would reach £250 m by 2025 and £440 m by 2036. Our approach to estimate the future size of the clean growth sector is, of course, subject to uncertainty, as we have made assumptions on two parameters (the percentage of the broader sector that is represented by bio-energy; and on the proportion of the identified bio-energy industry that is engaged in 'clean growth') - thus in reality this figure can be higher or lower.

SWOT analysis

Error! Reference source not found. provides an overview of the strengths, weaknesses, opportunities and threats for the bio-energy sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.4: Summary of SWOT for bio-energy subsector

Positive	Negative
Internal to the sector	
Strengths • More than 16,000 bio economy related companies in the north of England, employing 415,000 people with a £91 bn total annual turnover (University of York, 2017). In York, North Yorkshire and East Riding (YNYER) LEP, the bioeconomy generates £8.7 bn GVA and employs 105,000 people • YNYER have recognised the bioeconomy as a strategic sector. Strengths of this LEP include bioenergy along with food and drink, agriculture and agri-tech. Leeds City LEP view the importance of the bioeconomy for low-carbon energy with universities, Drax, BioVale, Biorenewable Development Centre and Brockelsby viewed as bioeconomy assets for the region • Significant research in the region, with the University of Leeds ranked number 1 for bio-energy research funding in the UK (University of Leeds, 2019) • The BioVale innovation centre based at the University of York supports the promotion and	Weaknesses • Researchers experience difficulties in finding commercial partners and translating R&D outputs into the marketplace (pers. comm.) • Bio-energy investment is lacking particularly for energy crops due to competition with the oil sector (pers. comm.) • Financial constraints with the potential for growing energy crops dependent on the wheat price (AECOM, 2011) • Constraints on the land available for crop production for bio-energy and environmental issues need to be considered e.g. biodiversity (AECOM, 2011)

development of the bioeconomy in Yorkshire and Humber (BioVale, 2018)
- The Biorenewables Development Centre (BDC) at the University of York helps businesses convert biowaste, microbes and plants into profitable green products (Biorenewables Development Centre, 2019)
- Biomass is a significant renewable energy resource available in York and North Yorkshire (AECOM, 2011), with a large amount of farmland in the region for biomass potential (pers. comm.)
- Commercial bio-energy (from waste) facilities in the region (Esholt and Knostrop)
- Presence of a green energy supply chains nearby to the region (RSB, 2017)

External to the sector

Opportunities
- Bio-energy is one of BBSRC's strategic research priorities (University of York, 2017)
- Funding opportunities for bio-energy through the domestic/non-domestic Renewable Heat Incentive and the Renewables Transport Fuel Obligation
- UK Government is spending £4.5 bn through its Clean Growth Strategy on low carbon technologies for homes and businesses between 2016 and 2021 through the RHI scheme (West Yorkshire Combined Authority, 2018)
- The BDC at the University of York has recently been awarded £1.5m to support innovative SMEs in the sector in the Leeds City Region (Biorenewables Development Centre, 2018).
- There could be a greater focus on bio renewables and biomass energy production (FERA, 2019)
- Industrial bio-energy sector is estimated to quadruple in the next twenty years due to the potential for new products and

Threats
- Constant policy changes such as for future biomass subsidies have an effect on investor confidence and hinder long term planning (pers. comm.)
- Policy framework for biofuels and bio-energy with no renewables initiatives for biomass in higher value products (pers. comm.)
- Lack of a policy framework for bio-energy that is beneficial and supportive (Renewable Energy Association, 2019)
- There is a risk of losing supply chains and expertise as there is a lack of large-scale projects currently in development (Renewable Energy Association, 2019)

markets (Renewable Energy Association, 2019)
- Humberside benefits from being identified as one of six Industrial Clusters (pers. comm.), in which opportunities to decarbonise will be greater as the UK moves towards net-zero carbon emissions in 2050 (BEIS, 2019) (note that the geographical area to be covered by the cluster is yet to be defined)
- Activities in other regions e.g. biofuel production facilities at Brocklesby (North Cave) could provide opportunities to grow the supply chain in the City Region and YNYER

There are opportunities for the region linked to Humberside being named as one of the Grand Challenge industrial clusters, with stakeholder engagement indicating that industry outside these initial clusters is likely to struggle due to the limited ability to decarbonise since they will not have access to the physical infrastructure (and investment is also expected to be lower). Opportunities also exist in terms of research and funding in the bioenergy sector. The University of Leeds is ranked first for bioenergy funding in the UK with research being used to influence policy debate at the United Nations (University of Leeds, 2019), whilst there is potential funding for SMEs involved in producing energy from renewable biological resources from the Biorenewables Development Centre at the University of York. One relevant aspect of work being performed at the centre is on biorefining. The sector is also expected to expand substantially in the future.

Products and services within the sector include commercial facilities for converting waste into bioenergy. Yorkshire Water, at Esholt wastewater treatment works, have developed a £34 m bioenergy facility. This involves using thermal hydrolysis to treat and dispose of waste sludge (Morgan Sindall, 2019). Yorkshire Water have also recently opened a £72 m anaerobic digestion at Knostrop. The digesters at the facility convert sludge into fertiliser. The fertiliser is used for agriculture and also creates a biogas, which in turn is converted into green electricity (Yorkshire Water, 2019). There are also plans for an anaerobic digestion facility in Huddersfield (Yorkshire Water, 2019a), whilst bio-energy carbon capture and storage (CCS) is being piloted by Drax (West Yorkshire Combined Authority, 2018).

Distinctive features in the region include the presence of the Biorenewables Development Centre at the University of York, which is an open access research and development centre between academia and industry. The presence of the centre will encourage collaboration between industry and academia. The Centre is currently discussing with Circa regarding the creation of a full value chain in the UK (University of York, 2019). The availability of land and biomass for bioenergy in the region has been highlighted from both literature review and stakeholder consultation.

Export opportunities exist through the promotion of bio-energy generation from waste as well as the skills developed. This could include exporting the significant expertise in bio-energy in the region e.g. from experience gained in regional products and universities.

Policy recommendation for the sector

Jobs and GVA from bio-energy are currently concentrated within the City Region, with Leeds in particular having a significant proportion (in 2017, 54% of the study area's GVA associated with bio-energy was generated by Leeds itself). However, there are significant centres of research activity within YNYER, e.g. the Biorenewables Development Centre. Furthermore, Selby supports 15% of the study area's bio-energy jobs.

YNYER: promoting existing research and opportunities could raise awareness of the developments in the bio-energy sector and help researchers identify commercial partners for collaboration. This could increase the likelihood of R&D outputs getting into the marketplace and contributing to commercially viable products and services. Within YNYER, there are expected to be outputs from the Biorenewables Development Centre; policy for this region could therefore focus on supporting and encouraging public/private partnerships that develop, enabling products to be put on the market sooner than would otherwise be the case. There is also the potential to carry out awareness raising and knowledge dissemination activities with organisations such as Yorkshire Water who have already developed bio-energy facilities in the region. Future policy should therefore cover the development of a communication strategy to promote information sharing and good practice examples (building on existing employment which is currently concentrated in Selby).

City Region: in the City Region, having the University of Leeds ranked first for bioenergy funding in the UK provides the opportunity to influence the way in which funding is used, to encourage new developments, building on the high number of jobs that already exist within the wider bio-energy sector in Leeds(53% of the study area's 8,465 jobs in 2017). As for YNYER, policy should focus on ensuring that collaboration between academics and commercial organisations takes place so that new ideas reach the marketplace and spread out beyond Leeds to other local authority districts within the region.

Both LEP regions: having a regional policy/position on bio-energy could also help mitigate the impacts on investor confidence and long-term planning that have been identified by stakeholders as resulting from constant policy changes. As in the hydrogen sector, working with those who are developing the Humberside cluster (which is not yet defined) could help ensure the region is fully involved in the cluster and able to take advantage of any funding and support associated with it. This would avoid the cluster becoming something external to (and in competition with) the region. This policy recommendation is relevant to both the City Region and YNYER, since the Drax site, which is expected to contribute to the cluster (pers. comm.) is covered by both regions.

3.5 Hydrogen

Definition

Hydrogen has been identified as a low-carbon alternative to conventional fuels, that has real potential to substantially decarbonise the UK economy.

Hydrogen is already used as an industrial feedstock, for example as a raw material in the chemical industry for the production of ammonia and for petroleum refining, as a reductor in the metallurgic industry and as a carrier gas in the electronics industry. However, hydrogen could also be used to provide low carbon heating in the residential, commercial and industrial sectors as well as an energy fuel in transport. It can effectively be considered a carbon-free fuel when produced through water electrolysis relying on renewable electricity, which is also a way to make use of excess power and stabilise the grid when renewable electricity production is excessive. However, most of hydrogen is currently produced through steam methane reforming (SMR) which uses natural gas as feedstock, requiring additional carbon capture and storage technology to be carbon neutral.

In its recent Net Zero report, the Committee on Climate Change (CCC) highlight that in order for the UK economy to reach Net Zero by 2050, greater emphasis should be placed on using hydrogen as an alternative to natural gas for heating, as an alternative in some industrial processes, and as an alternative to liquid fuels for HGVs and ships. The CCC report states that by 2050, UK hydrogen production capacity should be comparable to the size to the UK's current fleet of gas-fired power stations (Committee on Climate Change 2019).

As stated in another CCC report, focusing specifically on the potential for hydrogen in a low-carbon economy (Committee on Climate Change 2018), hydrogen offers the largest decarbonisation potential as a low-carbon alternative to natural gas for heating buildings and for heat used in industrial processes. In this Clean Growth Audit we consider the potential for developing the hydrogen for heat sector in the W&NY region, specifically using hydrogen as an alternative to natural gas for generating heat, reflecting existing activity in the region, and do not consider it as an alternative to liquid fuels. On this basis, the hydrogen sector can be classified as a low-carbon subset of the following 3-digit SIC sectors:

- 352: Manufacture of gas; distribution of gaseous fuels through mains
- 495: Transport via pipeline

Relevant national policy and local policy context

Hydrogen is defined in the latest national Clean Growth Strategy as a clean fuel that could potentially be used to decarbonise various sectors in the economy including transport, industry and to provide residential and commercial heat. The Strategy proposes an example of a decarbonisation pathway to 2050 highly centred on hydrogen, where the existing gas infrastructure is adapted to deliver hydrogen for heating and an extensive network of hydrogen refuelling stations is deployed to fuel vehicles. Following an initial stage where hydrogen is produced using natural gas and capturing the carbon emissions using CCUS, electrolysis would then become the main hydrogen production process relying on electricity produced from renewables.

Notwithstanding its potential, currently hydrogen as a heating fuel is an expensive and far from mature technology, and more tests are needed to assess its usage into existing gas grid and district heating networks. In this sense, the 2016 H21 Leeds City Gate has been a pioneering study exploring the technical and commercial feasibility of converting the UK’s natural gas

distribution networks into 100% hydrogen to effectively decarbonise heating. Currently the critical safety-based evidence for this conversion is being gathered through laboratory tests on assets such as pipes, valves and joints and field tests on their functioning under background conditions within the Hy4Heat and H21 NIC programmes (to be provided by 2023). Following the initial study, H21 North of England has been developed to propose a design plan for the conversion of the gas network in the North of England to hydrogen between 2028 and 2035. The plan includes the installation of 3.7 m meter points across major urban areas in the North of England including Leeds, Bradford, Wakefield and York, the realisation of a 12.15 GW hydrogen production plant, 8 TWh of storage and carbon capture and storage technologies by 2035.

With the aim of improving its commercial viability, both the Government and local authorities in W&NY are introducing pioneering plans to foster the adaptation of current heating infrastructure. £4.8 m have been allocated by the national Government to build twelve hydrogen refuelling stations for road vehicles, together with additional support schemes for fuel cell electric vehicles and a further £23 m provided to create the hydrogen fuel infrastructure. Within W&NY, the H21 project represents one of the first major projects in the UK aimed at converting the existing gas grid to hydrogen to provide low carbon heat (zero carbon emissions at the point of use). The successful execution of the pilot scheme would then allow the roll-out across the rest of the UK. The W&NY region also has the opportunity to benefit from positive spillovers from the nearby Tees Valley, where most of UK's hydrogen is currently produced (with the potential of relying on renewable electricity from wind farms), and establish the first UK hydrogen corridor. With hydrogen offering an innovative way to store energy, the region could potentially make use of the salt caverns located in East Riding to collect the hydrogen produced through electrolysis and steam methane reforming.

Table 3.5 Hydrogen

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• Tests are needed for H2 to be used in existing gas network and as domestic and industrial fuel[1] • Not clear whether H2 can be part of the most cost-effective strategy[2]	↓
Relative importance of the sector in W&NY region	• Great part of H2 facilities currently located in the nearby Tees Valley[3] • Feasibility studies and tests, technology still expensive	↓
Recognised in existing Local Energy Strategies (and other local strategies and information)	• YNYER to explore opportunities for H2 storage and as transport fuel[4] • H21 project in Leeds City Region[5]	↔
Future potential	• H21 North of England (2028) converting 3.7 UK homes and businesses from natural gas to hydrogen (also covering Leeds, Bradford, Wakefield, York)[6] • Salt caverns in East Riding for H2 storage, hydrogen produced from renewables using electrolysis	↑
Competitive advantage	• Existing gas infrastructure can be adapted to distribute H2; H21 project as first-mover advantage[7] • Great part of UK's H2 is currently produced in the nearby Tees Valley (hub of expertise)	↑

1,2,6: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3,5,7: Carbon Trust (2018), An Energy Strategy and Delivery Plan for the Leeds City Region
4: YNYER Local Energy Strategy
6: Northern Gas Network

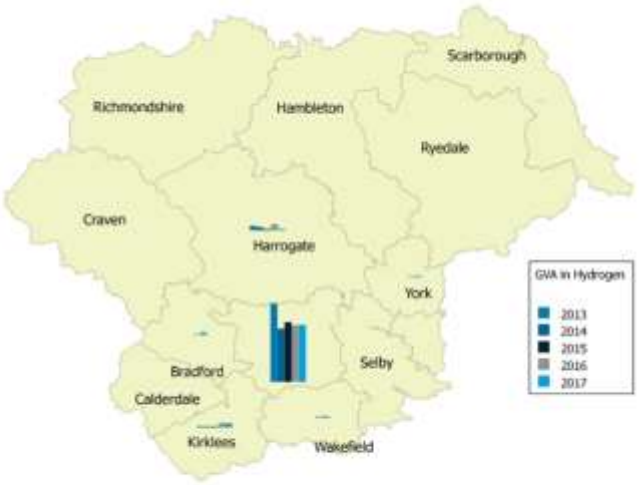
Recent changes in size of the sector

While the H21 research project recently started, currently the existing district network relies on natural gas as the primary fuel to provide heat to the residential, commercial and industrial sectors in the region, and activity related to this dominates the relevant sectors in W&NY.

The wider existing sector involved in the manufacture, transport and distribution of gas via pipeline did not experience significant economic growth in recent years, with both GVA and employment decreasing over 2013-2017 by 18% and 26% respectively. As clearly showed in Figure 3.6 and Figure 3.7, a great part of the value added accrued and employment generated by the sector is located in Leeds and, to a lesser extent, in the rest of West Yorkshire. The sector created approximately £508 m in value added in 2017 and employed around 2,400 people. Using estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), it is assumed that approximately 2.4% (~60 people) of current employment in the wider sector can be attributed to the hydrogen clean growth sector. Our approach to estimate the current size for the clean growth sectors is, of course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with the development of clean growth activities, employment and GVA associated with clean growth economic activities also grow. In reality, however, the figures can be higher or lower.

Figure 3.6: Gross Value Added for the wider hydrogen sector by district (2013 – 2017) (£2016 m)

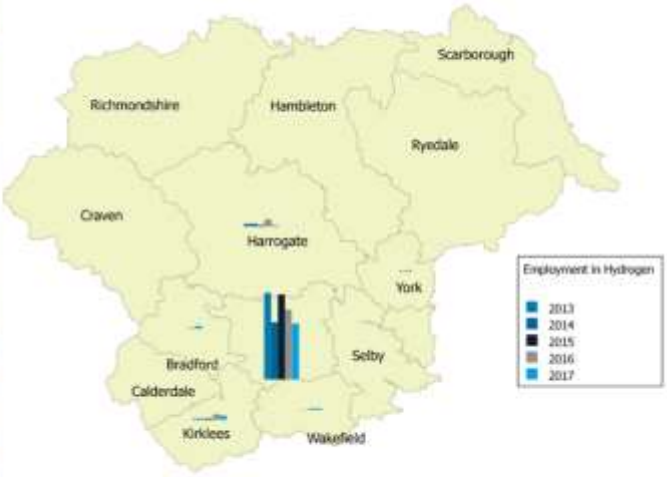
GVA (£2016m) in 2017	Wider Hydrogen sector	% of York, West & North Yorkshire
Bradford	21	4%
Calderdale	0	0%
Craven	0	0%
Hambleton	0	0%
Harrogate	11	2%
Kirklees	32	6%
Leeds	421	83%
Richmondshire	0	0%
Ryedale	0	0%
Scarborough	0	0%
Selby	0	0%
Wakefield	13	3%
York	11	2%
York, West & North Yorkshire	**508**	**100%**



Source: Cambridge Econometrics.

Figure 3.7: Employment in the wider hydrogen sector by district (2013 – 2017)

Employment in 2017	Wider Hydrogen sector	% of York, West & North Yorkshire
Bradford	100	4%
Calderdale	0	0%
Craven	0	0%
Hambleton	0	0%
Harrogate	50	2%
Kirklees	150	6%
Leeds	2,000	83%
Richmondshire	0	0%
Ryedale	0	0%
Scarborough	0	0%
Selby	0	0%
Wakefield	60	2%
York	50	2%
York, West & North Yorkshire	**2,410**	**100%**



Source: Cambridge Econometrics, based on BRES data.

Hydrogen business locations

Figure 3. shows the location of firms that have been identified as contributing to the hydrogen industry in W&NY. The only company identified corresponds to the gas distributer Northern Gas Networks Limited, which is directly involved into the H21 North of England hydrogen project. Other companies with headquarters outside the boundaries of W&NY will also work in partnership within the same engineering project, but our analysis has not identified any further businesses specifically engaged in hydrogen-related activities within the region.

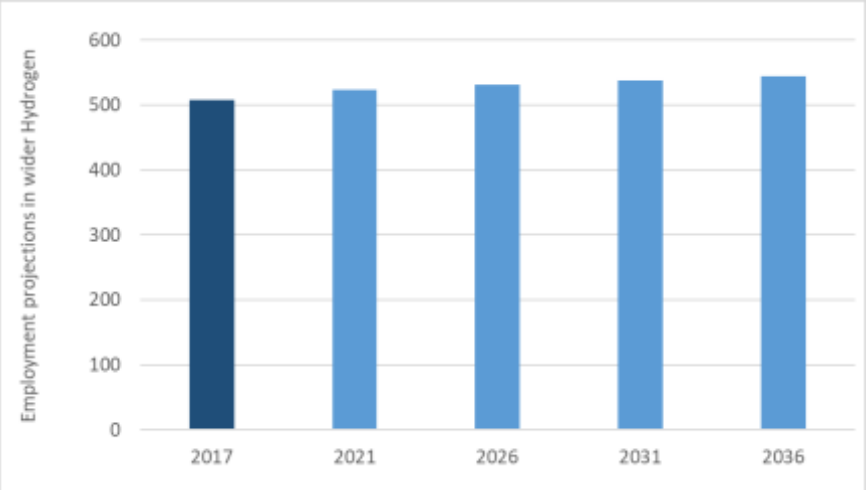
Figure 3.8: Location of companies involved in hydrogen in W&NY

Source: Cambridge Econometrics.

Future projections of the size of the sector

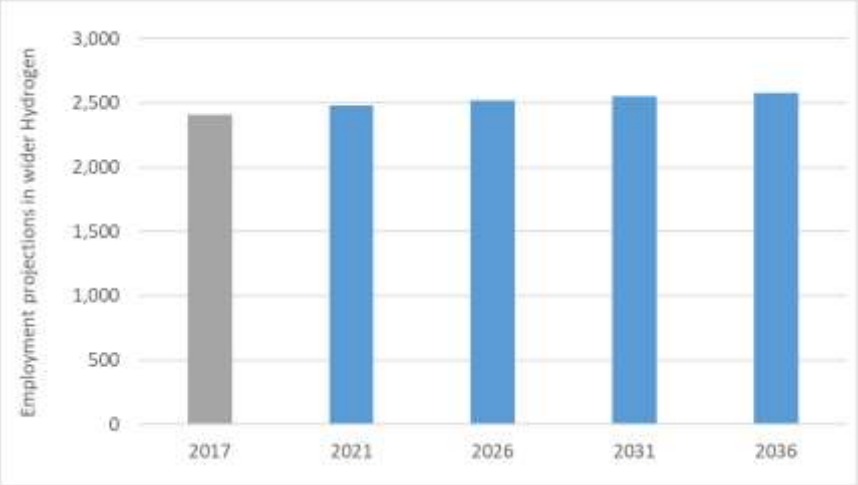
Projections for the future scale of the hydrogen industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall hydrogen industry and the ‘clean’ part of this industry. It is estimated that the level of employment in the hydrogen industry will increase by more than 10% compared to the 2017 level, to around 2,600 in total by 2036, while the GVA associated with the sector will reach £540 m.

Figure 3.9 GVA projection for the wider hydrogen industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.10 Employment projection for the wider hydrogen industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

Including further assumptions about the proportion of the hydrogen industry that is engaged in 'clean growth' activities[6], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. It is estimated that about 170 people will be engaged in clean hydrogen by 2036 (compared to ~60 as of 2017) and the GVA associated with the clean hydrogen sector would reach £12 m by 2025 and £23 m by 2036. This employment projection is in line with the economic impact assessment prepared in the H21 Leeds City Gate project[7], investigating the feasibility of converting the existing natural gas network in Leeds to 100% hydrogen.

[6] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time

[7] Internal document

SWOT analysis

Table 3.6 provides an overview of the strengths, weaknesses, opportunities and threats for the hydrogen sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.6: Summary of SWOT for the hydrogen subsector

Positive	Negative
Internal to the sector	
Strengths • Sector employs arounds 2,400 people and generates around £508 m in GVA across the study area • Research capacity in energy and in the production of high purity hydrogen with over 200 researchers and an annual research income of £50 m (University of Leeds, 2019 and 2019a) • The H21 Leeds City Gate project identified for converting the gas network to hydrogen would involve minimal new infrastructure compared to other alternatives (Northern Gas Networks, 2016) • The current demand for energy (from gas) in Leeds can be met for hydrogen by steam methane reforming and salt caverns using known technology (Northern Gas Networks, 2018) • Potential for a hydrogen fuel cell cluster location in the Leeds-Bradford area with the possibility of an innovation and manufacturing cluster (H2FC Supergen, 2017) • Potential for up to £30 m in government funding for Leeds-Tees Valley hydrogen corridor and up to £20 m funding for the Bulk Low Carbon Hydrogen Supply Competition (Leeds Tech CIC, 2019; BEIS, 2018) • The West Yorkshire low emissions strategy involves developing infrastructure for alternative fuels, including hydrogen (City of Bradford MDC et al, 2018)	Weaknesses • Cost of engineering and design. For example, the H21 project has stated £250 m is required to proceed between 2019-2023 (Northern Gas Networks, 2016) • Possible breakthrough of competing technologies such as from other energy storage and zero emission technologies (HyTrEc, 2015) • There can be a lack of supply chain visibility with research required to create a real supply chain (European Commission, 2013). There also needs to be engagement with the wider supply chain (Northern Gas Networks, 2016) • Lack of public awareness and limited public acceptability for using hydrogen for heating in homes (Madano, 2018) • Barrier for transforming research into commercial and competitive products on the market • There has been general reluctance from manufacturers to invest in R&D for hydrogen appliances (Kiwa, undated) • Hydrogen is more expensive than other low carbon technologies (Staffel I et al, 2019) • A key technical barrier is the limited number of designs for hydrogen fired appliances and the lack of commercial availability (Kiwa, 2016) (this may reflect current plans being transitional rather than aiming at truly zero carbon energy)

- TWI has received funding (along with Leeds and other universities) to further develop a bid on 'Establishing the UK Hydrogen Corridor' for the Strength in Places Fund (UK Research and Innovation, 2019)

External to the sector

Opportunities

- Government has set a target for the UK to reach net zero carbon emissions by 2050 (HM Government, 2019)
- Hydrogen could also be used for the storage of large amounts of intermittent electricity generation with benefits for rural areas (E4 Tech and Element Energy, 2016)
- Lack of a low cost and high performing battery technology could create opportunities for hydrogen
- Humberside benefits from being identified as one of six Industrial Clusters (BEIS, 2019), in which opportunities to decarbonise will be greater as the UK moves towards net-zero carbon emissions in 2050 (pers. comm) (note that the geographical area to be covered by the cluster is yet to be defined). This could include supply chain opportunities
- Potential supply chain opportunities for hydrogen appliances, hydrogen processes, pipeline assets, technical services and hydrogen storage services (Business Growth Hub, 2019)
- Hydrogen generation could be linked to offshore wind (i.e. produced from electrolysis) with hydrogen plants near ports; which would involve skilled jobs on the edge of Yorkshire (Leeds Climate Commission, 2019)
- The increased availability of hydrogen from the H21 project could be used for hydrogen powered vehicles (pers. comm)
- Brexit could enable government to provide more support to the hydrogen sector. The Institution of Mechanical Engineers called

Threats

- Lack of a competitive supply chain with an impact on the costs (HyTrEc, 2015)
- Potential loss of access to Horizon 2020 funding in the event of a "no-deal" Brexit (HM Government, 2019a)
- Reliance on local and national government policy (and subsidy) to deploy clean technology (pers. comm)
- Competition from other locations such as Birmingham (Hydrogen Europe, 2017)
- Reduced heat demand from improved energy efficiency (Energy Research Partnership, 2016)
- Requires a reallocation of spending and supply chain activity from fossil fuels (H2FC Supergen, 2017)

last year for greater support from government for hydrogen e.g. through funding programmes and demonstration sites (edie, 2018)
- H21 project could develop knowledge and technology that could then be applied in other UK cities (WYCA, 2019)

There are opportunities related to Humberside being named as one of the Grand Challenge industrial clusters (note that the geographical area covered by this cluster has not yet been defined, but stakeholders within the study area view the cluster as an opportunity). The study area has substantial demand for energy from industry, with the region suited for hydrogen use and potentially able to benefit from economies of scale (Committee on Climate Change, 2018). One of the aims of the Grand Challenge industrial clusters is that by 2030, one of the clusters will have the low carbon infrastructure in place for supporting industrial decarbonisation. It is also planned that these clusters will be areas for global inward investment, which would drive the demand for low carbon products and technologies by using a combination of communities, universities, the public sector and market power (HM Government, 2019b). This could provide opportunities for the supply chain for moving to hydrogen (appliance manufacturers, pipeline services, technical expertise and storage), skilled jobs in nearby regions and also opportunities for research and development (such as for the universities in the region). Drax, which is covered by both Leeds City Region and YNYER LEPs, has signed an MoU with National Grid Ventures and Equinox to work together to determine how a large-scale carbon-capture and storage (CCS) network and a hydrogen production facility could be constructed in the Humber region. Stakeholder engagement indicates that the intention is to develop CCS for the biomass units at the Drax site, with the aim of ultimately enabling industrial emitters to connect to the network and use the carbon storage facilities. This would provide opportunities for other businesses to connect.

There could also be opportunities in the supply chain; for example, opportunities have been identified for the region to be an innovation and manufacturing cluster for hydrogen fuel cell technologies. A report in 2017 highlighted that there is the potential for an innovation and manufacturing cluster in the Leeds area (amongst other possible locations) (H2FC Supergen, 2017). This cluster would aim to support the development of hydrogen fuel cell technologies, whilst also serving as a hub for deployment. This would involve implementing HFC technologies in densely populated areas, with the potential involvement of local manufacturers. This report highlighted a surplus of general manufacturing capability, supply of skilled labour and trainees from universities and craft level skills training in further education colleges (H2FC Supergen, 2017).

Northern England is also discussed as a potential location as their access to the financial markets in London is potentially difficult for obtaining venture funding. Investment by the government would then allow the drawing of attention from the financial markets. The introduction of low carbon produced hydrogen (such as blending in the gas supply) could also allow a hydrogen

supply chain to develop and developing hybrid heat pumps may also provide supply chain opportunities. Other opportunities relate to funding and investment in the sector. Energy research at the University of Leeds has attracted over £50 m in funding per year. One of the examples of research is in the sustainable production of hydrogen, including on the advanced steam reforming of carbonaceous sources (such as gas, biodiesel, cooking oil and waste products) for energy efficient production of hydrogen (University of Leeds, 2019). There is also the potential for government funding for the development of hydrogen in the Leeds-Tees Valley corridor. Another potential opportunity highlighted from stakeholder engagement is the use of hydrogen for heavy good vehicles and in manufacturing.

A distinctive feature to the region is the H21 Leeds City Gate project. Northern Gas Networks performed a study to investigate the potential for converting the low-pressure gas network in Leeds to hydrogen (Committee on Climate Change, 2018). For Leeds, this can be undertaken over three years and Northern Gas Networks have also examined the possibility of extending this across the North of England. Conversion is proposed to begin in 2028 across 3.7 m properties in Leeds, Bradford, Wakefield, York, Huddersfield, Hull, Liverpool, Manchester, Teesside and Newcastle (Northern Gas Networks, 2018). The H21 project therefore has the potential to facilitate movement towards decarbonisation in Leeds as well as developing knowledge and technology that could be applied in other cities across the country. This could provide the opportunity for skills (and supply chains) developed in the City Region to be exported to other locations. A study carried out by WYCA (WYCA, 2019) identifies this as a significant opportunity, with potential long-term benefits.

Export opportunities exist through encouraging the uptake of hydrogen for heat and transport applications as well as skills developed, for example, expertise gained from the H21 project. There may even be the potential for exporting the skills abroad, for example, to countries such as the Netherlands which has a large dependency on natural gas, especially for residential use (IHS Markit, 2018). Links could also be made to, for example, Australia and Canada, who have an MoU which covers the development of clean hydrogen technologies (Fuel Cell Works, 2019). There may also be opportunities through encouraging the uptake of hydrogen technologies for heat applications (H21 project).

Policy recommendation for the sector

Currently, employment within the hydrogen sector is focused in the City Region (83% of the study area's hydrogen jobs are located in Leeds itself) with relatively few jobs in YNYER. This suggests the sector is at an early stage in development, with competition from other areas, where the hydrogen industry is more established, potentially affecting growth. Whilst there are opportunities for the hydrogen sector to develop through building on existing strengths (e.g. the H21 Leeds City Gate Project), there are weaknesses surrounding public awareness and acceptability of the technologies as well as the potential loss of funding, for example, through Horizon 2020. There is, however, the possibility of government funding (e.g. TWI are leading on a bid to the Strength in Places fund for money to carry out a project to develop the Leeds-Tees Valley hydrogen corridor to encourage the use of hydrogen by transport, industry and domestic properties (for heating)).

City Region: for the City Region, increasing the level of communication and collaboration between those already involved (both industry stakeholders and researchers) could help ensure any replacement funding is allocated to where it is most needed to ensure existing employment is retained and create a basis for growth. Greater communication and awareness raising could also change public perceptions of hydrogen technologies, therefore increasing interest in and demand for hydrogen. This could be linked to the H21 project and could help enhance the industry outside of the Leeds local authority area into the wider City Region. Development of a communications strategy for hydrogen could encourage communications between those already in the sector, as well as with the wider public. Provided the City Region is taken forwards as an innovation and manufacturing cluster for hydrogen fuel cell technologies, there is also a recommendation relating to supporting this cluster through encouraging collaboration and development of the supply chain in the area, as well as information sharing on potential technologies. This would be in line with the aims of the cluster to additionally function as a deployment cluster, encouraging hydrogen technologies to be installed within the region.

Both LEP regions: working with those involved in the Humberside Industrial Cluster could also help define the geographical area covered by the cluster and ensure it incorporates and supports industry within the region (rather than becoming something external to the area). Collaboration with the cluster is relevant to both the City Region and YNYER, since the Drax site, which is expected to be part of the cluster, is covered by both regions. Development of the cluster could be key to bringing the oil and gas industry into the hydrogen sector, with the Drax, National Grid Ventures and Equinox MoU providing a starting point.

YNYER: Future policy for hydrogen within YNYER is likely to be dependent on the extent to which the Humberside cluster develops, since this could provide the catalyst for expanding the hydrogen sector through the provision of the required infrastructure and development of a supply chain. There is currently some employment in the sector in Harrogate and York, thus building on business and research in these areas is likely to be provide a starting point (in addition to the Humberside cluster).

3.6 Low carbon transport

Definition

As discussed and presented already in Chapter 2, the transport sector is one of the largest emitting sectors in the UK, accounting for 24% of all UK emissions, and only slightly lower (c1 percentage point) emissions than from business and industry (HM Government 2017). Decarbonising the transport sector is therefore an integral part of the pathway to achieving the emissions-reduction targets set by the 2008 Climate Change Act and its legally-binding carbon budgets.

A key set of policies and proposals in the Government's Clean Growth Strategy centre around accelerating the shift to low carbon transport, including initiatives such as ending the sale of new conventional petrol and diesel cars and vans by 2040, developing world-leading electric vehicle charging infrastructure, funding to accelerate the uptake of low emission taxis & buses and initiatives to enable cost-effective options for shifting more freight from road to rail.

In response to such Government policy, and also market forces, new technologies and fuels are being developed across the transport sector to improve fuel-efficiency and to improve the feasibility of low-carbon alternatives to conventional fuels. Economic activities related to these developments form the 'low carbon transport sector'.

Focusing specifically on the decarbonisation of road and rail transport, the low carbon transport sector can be classified as a low-carbon subset of the following 3-digit SIC sectors:

- 261: Manufacture of electronic components and boards
- 271: Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
- 272: Manufacture of batteries and accumulators
- 274: Manufacture of electric lighting equipment
- 279: Manufacture of other electrical equipment
- 291: Manufacture of motor vehicles
- 292: Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semitrailers
- 293: Manufacture of parts and accessories for motor vehicles
- 302: Manufacture of railway locomotives and rolling stock
- 309: Manufacture of transport equipment n.e.c.
- 451: Sale of motor vehicles
- 452: Maintenance and repair of motor vehicles
- 453: Sale of motor vehicle parts and accessories
- 491: Passenger rail transport, interurban
- 492: Freight rail transport

Relevant national policy and local policy context

As mentioned above, the Government's Clean Growth Strategy forms the national backdrop for low carbon transport policy. Focusing specifically on road and rail transport, the key national priorities and proposals are:

- To end the sale of new conventional petrol and diesel cars and vans by 2040
- To invest £1 bn to support the take-up of ultra-low emission vehicles (ULEV)
- To develop one of the best electric vehicles charging networks in the world
- To accelerate the uptake of low emission taxis and buses
- To work with industry to develop an Automotive Sector Deal to accelerate the transition to zero emission vehicles
- To announce plans for the public sector to lead the way in transitioning to zero emissions vehicles
- To invest £1.2 bn to make cycling and walking the natural choice for shorter journeys
- To enable cost-effective options for shifting more freight from road to rail

- To position the UK at the forefront of research, development and demonstration of Connected and Autonomous Vehicle technologies
- To invest around £841 m in innovation in low carbon transport technology and fuels.

In line with national policy, the local energy strategies of W&NY emphasise the importance of decarbonising the local transport sector while, at the same time, tackling air quality problems. On this respect, Leeds will introduce one of the first Clean Air Zones by 2020. With 185,000 new cars registered in 2018 in Yorkshire and the Humber, of which 8,623, or just over 4%, were ULEVs (compared to 2.5% of new registrations across the UK), there is great potential to decarbonise the sector through increased uptake of ULEVs. As such, both YNYER LEP and Leeds City Region LEP have identified electric and plug in hybrid vehicles as key low carbon technologies to support and develop in their local energy strategies, with a focus on creating a better local network of charging infrastructure to unlock the roll-out of this technology. Besides fostering the take-up of electric cars, local authorities in W&NY are aiming to decarbonise local public transport, and today the City of York has one of the biggest fleets of electric buses in the UK. The region also benefits from the presence of local vehicle manufacturers already developing electric models such as the British bus manufacturer Optare, based in North Yorkshire. Additional measures at the local authority level include the introduction of Clean Air Zones and the installation of charging points for taxis.

The W&NY region, and Leeds in particular, is increasingly positioning itself at the centre of the UK high speed rail industry and of the HS2 Yorkshire Hub. The HS2 project includes 345 miles of new high-speed track, part of which will connect London and Leeds. HS2 trains will also cross over onto existing railway track to also connect further towns and cities in the W&NY region such as Wakefield and York. Besides hosting the new HS2's Eastern Rail Supply Depot, Leeds and part of the W&NY region will continue to build up a strong competitive advantage following the opening of a new rail engineering training centre facilities in York, the forthcoming Institute for High Speed Rail and System Integration at the University of Leeds, which received government contributions of £11 m in addition to funding from the Leeds City Region LEP and other local partners, and the Institute of Railway Research at the University of Huddersfield.

Table 3.7 Low carbon transport

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• At least 30% of new car sales are expected to be ULEVs by 2030, and possibly as many as 70%[1], UK's automotive sector is ideally placed to be a world leader in the low emission vehicle market[2] • Accelerate the uptake of low carbon taxis and buses (Plug-in Taxi programme)	
Relative importance of the sector in W&NY region	• 8,623 ULEVs licensed within W&NY in 2018 Q4 (4.3% of UK total)[3] • 29 EV charging points in York (mostly standard) and 104 rapid charging events within W&NY in 2017[3] • York has one of the biggest fleets of electric buses outside London[4]	
Recognised in existing Local Energy Strategies	• Electric and plug-in hybrid vehicles are identified as key low carbon technologies in the strategies of YNYER, Leeds and the CA	

(and other local strategies and information)		
Future potential	• 185,000 new car registered in 2018 in Yorkshire and The Humber, UK Government funding ULEV uptake and EV charging • Expanding the charging network will involve local skilled labour (electricians and construction workers) • Leeds is at the centre of the HS2's Yorkshire Hub • Leeds will introduce a Clean Air Zone and is investing to install charging points for taxis[5]	↑
Competitive advantage	• British bus manufacturer Optare is based in North Yorkshire, with key focus on low carbon buses using alternative fuel options • The region benefits from outstanding research centres: the High Speed Rail and System Integration Institute at the University of Leeds and the Institute of Railway Research at the University of Huddersfield[6]	↑

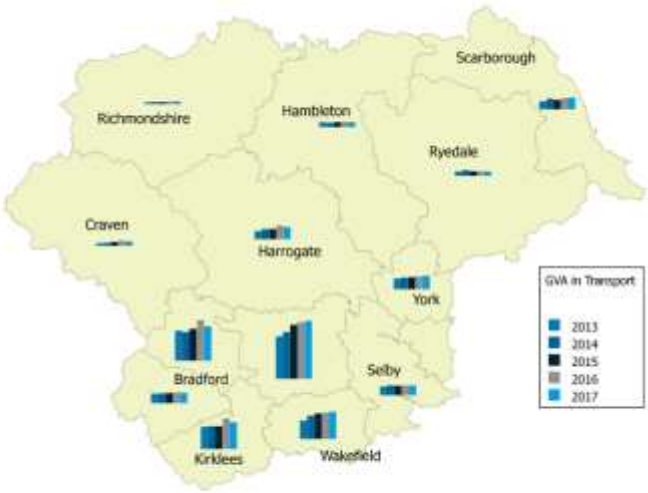
1,2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3: DfT 2018 & 2017 statistics
4: www.optare.com
5: https://airqualitynews.com
6: http://www.the-lep.com/news-and-blog/news/rail-revolution/

Recent changes in size of the sector

While the relative importance of low carbon vehicles is progressively increasing, the wider transport sector (as defined by the 3-digit SIC codes listed above) in W&NY has also expanded over the last 5 years. As depicted in Figure 3.11 and Figure 3.12, economic activity is taking place in all local authorities within W&NY, but West Yorkshire and Leeds in particular are the focal points. Since 2013, the sector has increased employment to around 34,600 jobs and increased value added by 27% to reach £1,556 m in 2017. Most of the economic activity was focussed in Leeds, Bradford, Wakefield and Kirklees.

Figure 3.11: Gross Value Added for the wider transport sector by district (2013 – 2017) (£2016 m)

GVA (£2016m) in 2017	Wider Transport sector	% of York, West & North Yorkshire
Bradford	242	16%
Calderdale	74	5%
Craven	33	2%
Hambleton	36	2%
Harrogate	85	5%
Kirklees	188	12%
Leeds	408	26%
Richmondshire	20	1%
Ryedale	31	2%
Scarborough	81	5%
Selby	69	4%
Wakefield	193	12%
York	96	6%
York, West & North Yorkshire	**1,556**	**100%**

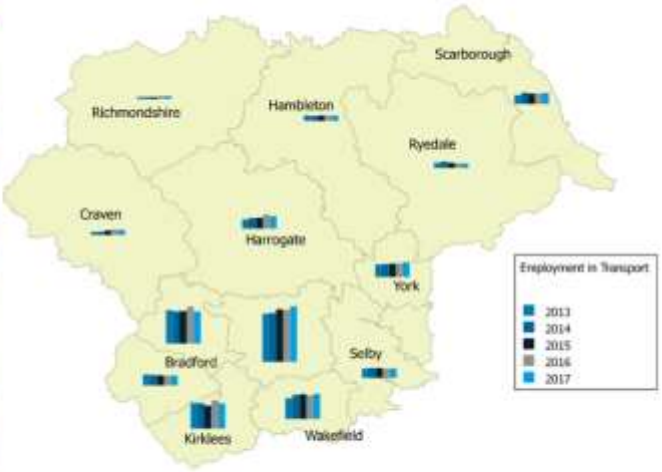


Source: Cambridge Econometrics.

Making use of the estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), we assume that approximately 2.8% (~970) of current employment in the wider transport sector can be attributed to the clean growth sector component. Our approach to estimate the current size for the clean growth sectors is, of course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with the development of clean growth activities, employment and GVA associated with clean growth economic activities also grow. In reality, however, the figures can be higher or lower.

Figure 3.12: Employment in the wider transport sector by district (2013 – 2017)

Employment in 2017	Wider Transport sector	% of York, West & North Yorkshire
Bradford	5,180	15%
Calderdale	1,595	5%
Craven	815	2%
Hambleton	870	3%
Harrogate	2,005	6%
Kirklees	4,120	12%
Leeds	8,950	26%
Richmondshire	495	1%
Ryedale	755	2%
Scarborough	1,795	5%
Selby	1,540	4%
Wakefield	4,080	12%
York	2,410	7%
York, West & North Yorkshire	**34,610**	**100%**

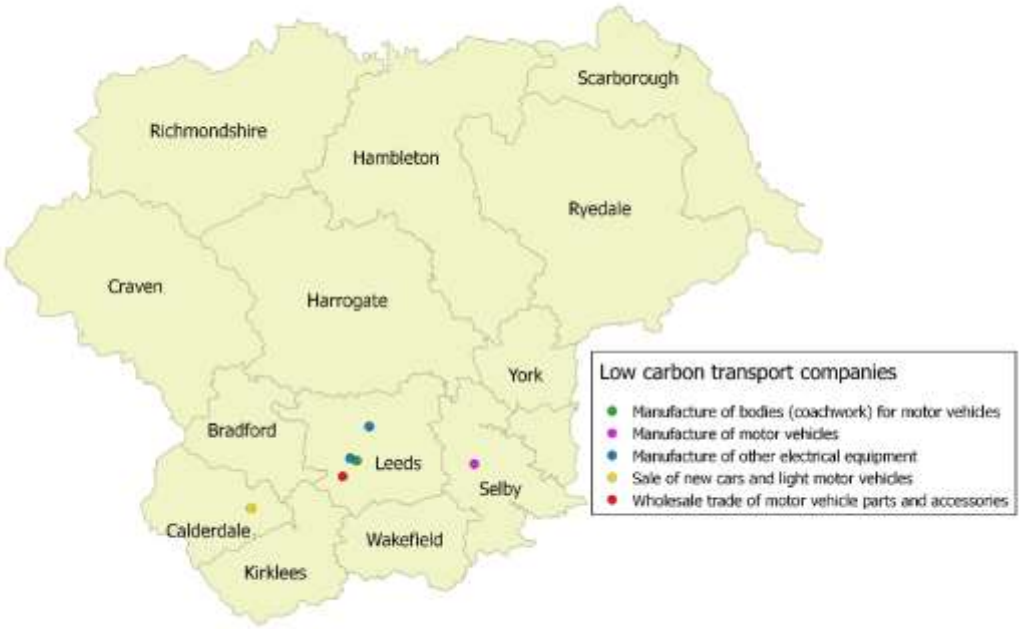


Source: Cambridge Econometrics.

Low carbon transport business locations

Figure 3.13 shows the location of firms that have been recognised as contributors to the low carbon transport industry in W&NY. All the depicted companies are located in West Yorkshire, and a small cluster of manufacturers of bodies for motor vehicles, electrical equipment and trader of motor vehicles parts and accessories can be identified near Leeds. The manufacturer identified in Selby is the British bus company Optare, producing a variety of electric models, while another large seller of electric cars, Nissan, is located in Calderdale.

Figure 3.13: Location of companies involved in low carbon transport in W&NY



Source: Cambridge Econometrics.

Future projections of the size of the sector

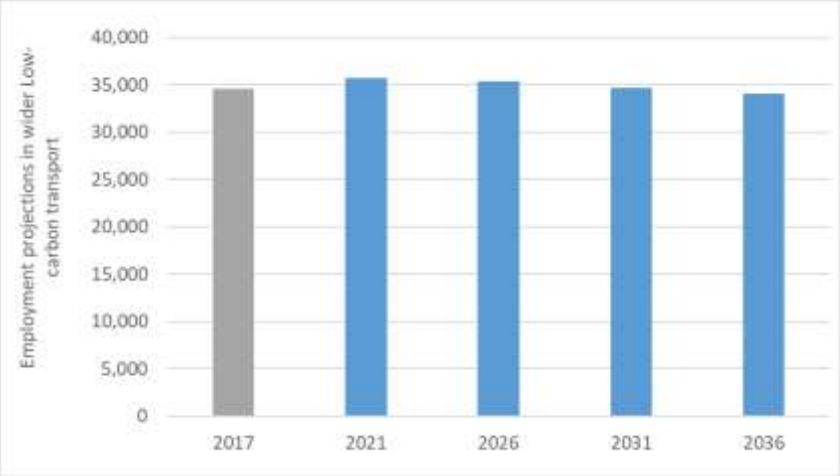
Projections for the future scale of the low-carbon transport industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall low-carbon transport industry and the 'clean' part of this industry. It is estimated that the level of employment in the low-carbon transport industry will largely stagnate compared to the 2017 level, at around 34,000 in total by 2036, while the GVA associated with the sector will reach £1,500 m.

Including further assumptions about the proportion of the low-carbon transport industry that is engaged in 'clean growth' activities[8], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. It is estimated that around 1,800 people will be engaged in 'clean Low-carbon transport' by 2036 (compared to about 1,000 as of 2017) and the GVA associated with the clean low-carbon transport sector would reach £75 m by 2025 and £114 m by 2036. Our approach to estimate the future size of the clean growth sector is, of course, subject to uncertainty, as we have made assumptions on two

[8] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time

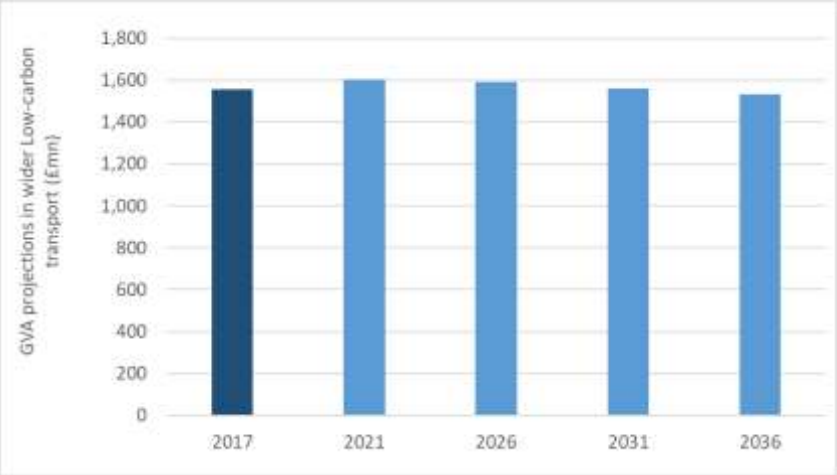
parameters (the percentage of the broader sector that is represented by low-carbon transport; and on the proportion of the identified low-carbon transport industry that is engaged in 'clean growth') - thus in reality this figure can be higher or lower.

Figure 3.14 Employment projection for the wider low-carbon transport industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

Figure 3.15 GVA projection for the wider low-carbon transport industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

SWOT analysis

Table 3.8 provides an overview of the strengths, weaknesses, opportunities and threats for the low carbon transport sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.8: Summary of SWOT for low carbon transport subsector

Positive	Negative
Internal to the sector	
Strengths	Weaknesses

• West Yorkshire Low Emissions Strategy includes introducing ULEV buses into Leeds with the long term aim of a zero emissions bus fleet (West Yorkshire Combined Authority, 2017)[1] • Supportive local authorities (pers. comm.) • Experience in transport infrastructure in the region which has been highlighted e.g. consultancies based in Leeds (Quantum, 2012) • Investment in low carbon transport e.g. FirstBus have invested £71 m in 284 low emission buses and Transdev have invested in electric buses in Harrogate • Presence of key supply chain players for low carbon transport e.g. Optare who manufacture electric buses and low carbon buses (Optare Group Ltd, 2019) • The Centre for Innovation in Rail at Huddersfield supports the supply chain for bringing new technologies into the rail market (University of Huddersfield, 2019) • West Yorkshire is a major location for transport and distribution employing 50,000 people in 2015 (National Careers Service, 2017) • Presence of a green energy supply chain nearby to the region (pers. comm.)	• Lack of infrastructure (e.g. charging points) for electric vehicles and a shortage of skilled technicians to repair/maintain electric vehicles (Institute of the Motor Industry, 2019) • Lack of investment in road and rail which has not kept up with both economic and population growth (West Yorkshire Combined Authority, 2019) • Lack of a current low cost, high performance battery technology (pers. comm.) • Investment can be difficult to obtain for low emission vehicles as the return periods are long and the infrastructure requirements are high (Ricardo Energy and Environment, 2017) • Small businesses recognise the need to move to zero carbon, but information gathering is difficult for them (pers. comm.) • Competition from West Midlands automotive manufacturing cluster. The West Midlands produces around a third of the vehicles produced in the UK. The automotive supply chain in the West Midlands also accounts for 21.2% of the motor vehicle parts and accessories manufacturing companies in the UK. Low carbon (energy) is also part of the West Midlands Local Industrial Strategy (West Midlands Combined Authority, 2019) • Competition from North East manufacturing cluster. In this cluster, there are 240 automotive companies and 30,000 employees. The region also produces 20% of the electric vehicles manufactured in Europe (North East Automotive Alliance, 2019
External to the sector	
Opportunities	Threats
• Sales of new conventional diesel and petrol cars and vans will be ended by 2040 with the aim of nearly all cars/vans to be zero emission by 2050 (Department for Transport, 2018)	• Investment in transport has been focussed on London such as HS2 and Crossrail (University of York, 2019) • Government policy may be the key driver in the transition to

- Northern Powerhouse Rail have proposed a new line from Leeds to Manchester via Bradford, upgrading existing lines and HS2 (Transport for the North, 2019)
- Potential TransPennine route upgrade between Manchester and York/Selby via Leeds (Network Rail, 2019)
- A number of local measures are potentially available: city design and integrated planning; travel demand management; registration restrictions; provision of public transport, walking and cycling infrastructure and services; and public awareness campaigns (Lah, 0., 2015)
- Plans for a High Speed Rail Institute at the University of Leeds with a £13 m investment from the Local Growth Fund and £11 m in Government funding (University of Leeds, 2019)
- Potential opportunities in electric vehicle battery manufacturing which will be significant as the market increases (Ricardo Energy and Environment, 2017)
- Growing market for cleaner transport options with an increase of 158.1% between July 2018 and July 2019 for new registrations of battery electric vehicles and a 34.2% increase for mild hybrid electric vehicles (SMMT, 2019)
- Introduction of a clean air zone to Leeds city centre from 6 January 2020 (BBC News, 2019) could increase the market for electric/alternative fuel vehicles
- City of Bradford Metropolitan District Council has recently run a consultation on air quality and transport (City of Bradford Metropolitan District Council, 2019); this could lead to a clean air zone and hence increase the market for electric/alternative fuel vehicles
- electric vehicles (University of York, 2019) and there is also the need to clarify the future policies of the low carbon transport policy (Electricity North West, 2019)
- Transition to low carbon requires significant funding (Matikainen S, 2017)

Opportunities exist with the ban on conventional petrol and diesel vehicles by 2040 and the planned clean air zone in Leeds (and potentially Bradford). This will result in an increased demand for the manufacture of low-emission

vehicles (such as electric vehicles) which could provide opportunities for companies involved in the supply chain. However, the region faces competition from both the West Midlands and North East automotive manufacturing clusters which are major players in UK automotive manufacturing.

There are opportunities in promoting low carbon transport in the region, such as for public awareness campaigns on low carbon transport, providing walking and cycling infrastructure and the provision of low carbon public transport. Opportunities also exist through providing further infrastructure for charging infrastructure, which will further increase the uptake of ultra-low emission electric vehicles.

Opportunities are present for the railways; the region has the potential for substantial investment and research relating to low carbon transport. This includes Northern Powerhouse Rail (£39 bn business case) which proposes a new railway line in the region, upgrading lines and upgrading to HS2. The Strategic Transport Plan (STP) and the Investment Programme (in which Northern Powerhouse Rail is part of) will also promote low carbon transport (Transport for the North, 2019a). There are additionally opportunities for research and collaboration (in Leeds and Huddersfield) with the Centre for Innovation in Rail at Huddersfield and also the High Speed Rail Institute at the University of Leeds which is under development.

Products and services within the sector include vehicle manufacturing. Optare (based in North Yorkshire) manufactures both low carbon and electric buses. The presence of green supply chains nearby may also encourage uptake of alternative technologies for transport. Other features of the region are in Leeds and Harrogate with the move of bus companies (First and Transdev) to low emission and electric vehicles. The region also has a significant transport and distribution sector.

Export opportunities exist through promoting the uptake of low carbon transport (e.g. public transport) as well as the skills developed in this area. This could potentially include the knowledge of manufacturing low carbon transport vehicles and expertise in the region, such as the rail expertise at the University of Huddersfield and the centre at the University of Leeds.

Policy recommendation for the sector

Going forwards, building on existing strengths is likely to be key. Based on 2017 figures, 27% of the study area's jobs in low carbon transport are located in Leeds, with 15% in Bradford and 12% in each of Wakefield and Kirklees. GVA shows a similar pattern. These figures are assumed to reflect population centres. Whilst there could be opportunities related to private transport as a result of clean air zone and movement towards electric/hybrid vehicles, the main opportunity is thought to relate to public transport (e.g. bus manufacture).

City Region: for the City Region specifically, focusing on the opportunities presented by the potential High Speed Rail Institute at the University of Leeds and the proposed new line to Manchester could bring long term benefits for low carbon transport. However, in the short term, there is a need to implement local measures related to planning and travel demand management. These more localised options are expected to be lower cost, which is an important consideration given the identified threats (e.g. transport investment typically being focused on London). Policy therefore needs to take account of expected long term investments that are likely to be taken by external organisations, but

also work to encourage behaviour change through creating an environment where low carbon transport at the local level (such as cycling) is actively chosen by individuals. This may result in some benefits for local businesses in the supply chain (e.g. cycling accessories). Greater use of public transport could also bring benefits for local manufacturers e.g. Optare.

YNYER: within YNYER, as per the City Region, there are local measures relating to planning and public awareness that could be implemented to promote and enhance low carbon transport, also actions such as encouraging the installation of more charging points for electric vehicles. This could result in short term benefits for the supply chain, with potential longer term benefits where maintenance and updating of structures and installations may be required.

Both LEP regions: across the study area, stakeholders have indicated that local authorities are currently supportive of the low carbon transport sector; any new policy should ensure this support continues in both the City Region and YNYER. Such support could extend to working with small businesses to provide them with information to decrease their emissions or transition to zero carbon. This would help deal with one of the identified weaknesses, which noted that small businesses acknowledge the need to move to zero carbon but find it difficult to know what actions to take.

A further policy recommendation across both regions relates to the need for there to be collaboration between Leeds and York in relation to low carbon transport operating between the two cities. This partnership working could also be extended to Bradford. Sharing knowledge and best practice (e.g. in relation to the clean air zone planned for Leeds in January 2020) could help ensure cities across the study area are able to learn from each other in terms of moving towards low carbon transport. This could include collaborating on public transport solutions (where there is expected to be less competition from other regions) including both rail (building on local research) and buses (manufactured in the study area).

3.7 Smart city

Definition

The Smart city sector includes all those companies in W&NY developing and fostering the introduction of new IT and other technological innovations that can be applied to monitoring and managing existing infrastructure, assets and resources more efficiently. The application of a wide range of electronics and digital technologies to communities and cities, connecting citizens and establishing a direct interaction with them, allows to better supervise urban flows and introduces the possibility for real-time responses to changing circumstances across all city functions. Devices such as electronic sensors, smart meters and other forms of hardware connected to the internet of things (IoT) can be remotely controlled to monitor transport systems, waste management activities, water supply and many more flows and economic activities. The use of information and communication technologies (ICT) therefore has the potential to radically transform people's lives and working environments in the region.

The Smart city clean growth sector was classified as a subset of the following 3-digit SIC codes:

- 261: Manufacture of electronic components and boards

- 262: Manufacture of computers and peripheral equipment
- 265: Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
- 279: Manufacture of other electrical equipment
- 422: Construction of utility projects
- 620: Computer programming, consultancy and related activities
- 631: Data processing, hosting and related activities; web portals
- 711: Architectural and engineering activities and related technical consultancy.

Relevant national policy and local policy context

Smart systems and the IoT are relatively new innovations, but nonetheless they have already received significant attention in national and local plans. The national Clean Growth Strategy introduced specific policies and proposals aimed at delivering a clean, smart and flexible power system to significantly reduce UK's carbon emissions, including the implementation of the smart systems plan and investing £265m in smart technologies for energy storage, demand side response and grid balancing. Besides, the UK Government clearly acknowledged the potential for smart and flexible energy systems to deliver significant benefits to consumers and the economy (HM Government and Ofgem 2017). In their report to Parliament in 2017[9], the Committee on Climate Change (CCC) estimated that the benefits from realising a smart energy system could be between £17 and £40bn to 2050, arising mostly from deferred networks reinforcements, avoided new generation build and curtailment of generation from renewables. While large cost reductions to operate the electricity grid could be achieved, final consumers also have the potential to realise substantial savings on their energy bills through the rollout of smart meters and the introduction of smart tariff schemes. These innovative services give households and businesses more control over how they use energy and help them to better manage their daily consumption patterns. Monitoring devices can communicate data via internet and offer the possibility for real-time control over electricity use, inducing consumers to make more informed decisions and buy energy when it is cheaper. So far, monitoring research on people who already installed smart meters in the UK shows that more than 80% of them are now more aware of their energy costs and have, as a consequence, taken steps to reduce their energy use (Department for Business, Energy & Industrial Strategy 2018).

Local energy plans within W&NY also emphasised the key role that smart technologies and smart cities will play in reducing energy demand and emissions. An example is given by the identified priority to create an energy smart City of York, with a focus on introducing a smart transport system centred on EVs, improving the energy efficiency of the existing housing stock and exploring opportunities for smart street lighting and traffic light sensors. Similarly, the project 'Smart Leeds' is aimed at introducing several pilot and demonstration applications of smart technologies in the Leeds City Region, covering innovative opportunities such as vehicle-to-grid (V2G), domestic batteries and smart kinetic roads. The Leeds City Region identified smart grid

[9] Committee on Climate Change (2017), 2017 Report to Parliament – Meeting Carbon Budgets: Closing the policy gap.

systems integration as one among five strategic priority areas to promote the transition to a smarter and less costly grid system and to foster the rollout of smart meters and other technologies across the domestic, commercial and industrial sectors.

Table 3.9 Smart city

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• Target of offering a smart meter to every household in the UK by end of 2020[1] • Smart systems plan to help consumers to use energy more flexibly	↑
Relative importance of the sector in W&NY region	• ADI in Shipley selected to run a low-power wide-area network (LPWAN) project in Yorkshire, also providing advice to SMEs for their digital transformation and developing environmental sensors to improve food production[2] • Chameleon Technology in Harrogate developing home displays for households to manage their smart meters and better manage energy consumption[2]	↑
Recognised in existing Local Energy Strategies (and other local strategies and information)	• Bradford Council and University already installed flood sensors to monitor River Aire levels and provide early warnings of flood risk[3] • WY UTMC Common Database System – joint centre for traffic, congestion and air quality monitoring[4]	↑
Future potential	• Leeds City Region could potentially become an innovation hub and a testbed for smart technologies, with digital sector already contributing £6.5 bn and employing 102,000 people[5] • Public willingness to attract tech companies in the region and explore numerous applications of smart technologies	↑
Competitive advantage	• Numerous companies within W&NY developing and implementing smart technologies • University research hubs (Leeds Institute for Data Analytics)	↑

1: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
2: https://www.insidermedia.com
3: https://odileeds.org/blog/2017-02-17-bradford-flood-network
4: https://democracy.leeds.gov.uk/ieDecisionDetails.aspx?Id=48198
5: https://www.westyorks-ca.gov.uk/news/how-leeds-city-region-is-leading-smart-city-tech/

Recent changes in size of the sector

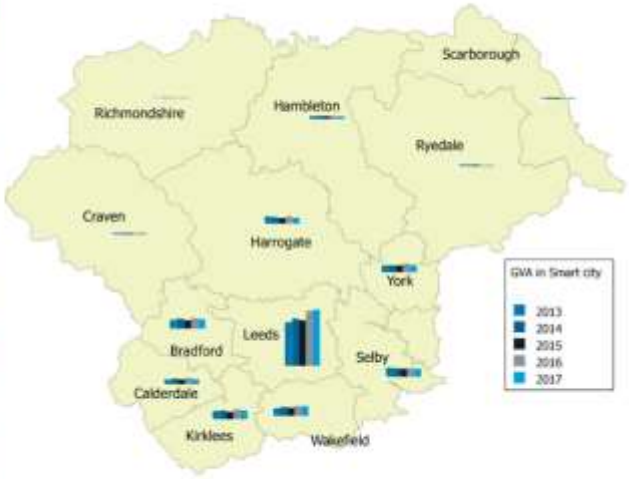
The IT and digital sector is well-developed in W&NY and represents the most important one, in terms of GVA and employment, across the seven wider clean growth sectors considered. Between 2013 and 2017 the sector experienced a 12% increase in accrued GVA to reach a maximum of £3,500 m in 2016 and, over the same period, increased its workforce by 19% with 53,425 people employed in 2016. Figure 3.21 and Figure 3.22 confirm the presence of a strong IT sector in the region mostly centred around Leeds, the rest of West Yorkshire and York.

Making use of the estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), we assumed that approximately 20.6% (~10,600) of current employment in the wider smart city sector can be attributed to the clean growth sector component. Our approach to estimate the current size for the clean growth sectors is, of course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with

the development of clean growth activities, employment and GVA associated with clean growth economic activities also grow. In reality, however, the figures can be higher or lower.

Figure 3.21: Gross Value Added for the wider Smart city sector by district (2013 – 2017) (£2016 m)

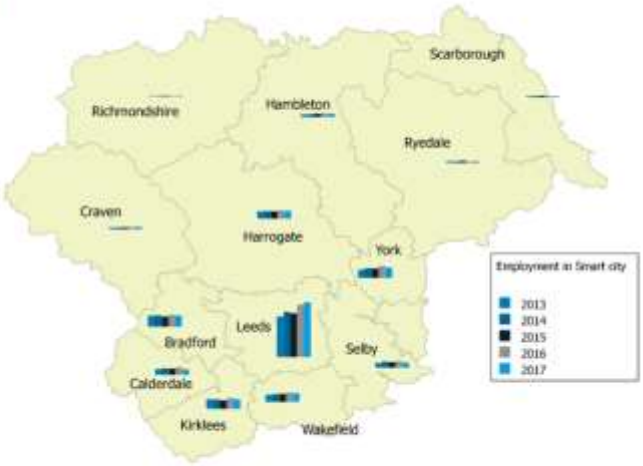
GVA (£2016m) in 2017	Wider Smart city sector	% of York, West & North Yorkshire
Bradford	272	8%
Calderdale	134	4%
Craven	43	1%
Hambleton	78	2%
Harrogate	165	5%
Kirklees	250	8%
Leeds	1586	48%
Richmondshire	21	1%
Ryedale	31	1%
Scarborough	35	1%
Selby	232	7%
Wakefield	281	8%
York	203	6%
York, West & North Yorkshire	**3,329**	**100%**



Source: Cambridge Econometrics.

Figure 3.22: Employment in the wider Smart city sector by district (2013 – 2017)

Employment in 2017	Wider Smart city sector	% of York, West & North Yorkshire
Bradford	4,625	9%
Calderdale	2,320	5%
Craven	1,000	2%
Hambleton	1,440	3%
Harrogate	3,290	6%
Kirklees	4,050	8%
Leeds	22,665	44%
Richmondshire	475	1%
Ryedale	620	1%
Scarborough	575	1%
Selby	2,205	4%
Wakefield	3,585	7%
York	4,385	9%
York, West & North Yorkshire	**51,235**	**100%**



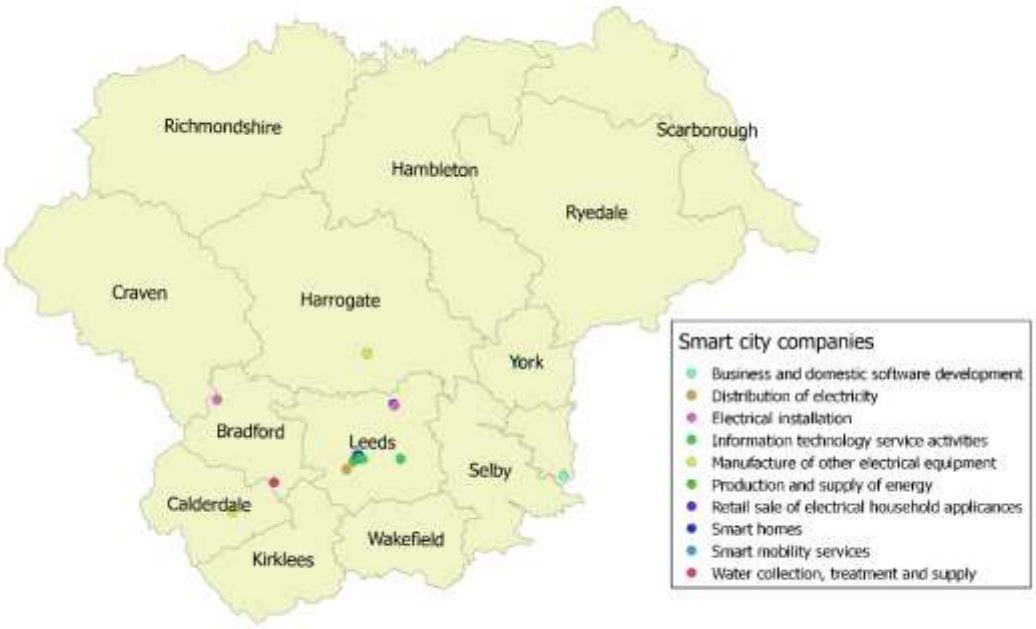
Source: Cambridge Econometrics.

Smart city business locations

When considering the location of companies involved in the development of smart technologies, it is possible to notice how the Leeds City Region represents a focal centre of research and innovation due to the noticeable presence of companies offering IT, smart homes and smart mobility services. The remaining companies in the region are involved in the manufacturing of

electronic and electrical equipment, water meters, retail sale of electrical household appliances and development of business and domestic software.

Figure 3.23: Location of companies working on smart technologies in W&NY



Source: Cambridge Econometrics.

Future projections of the size of the sector

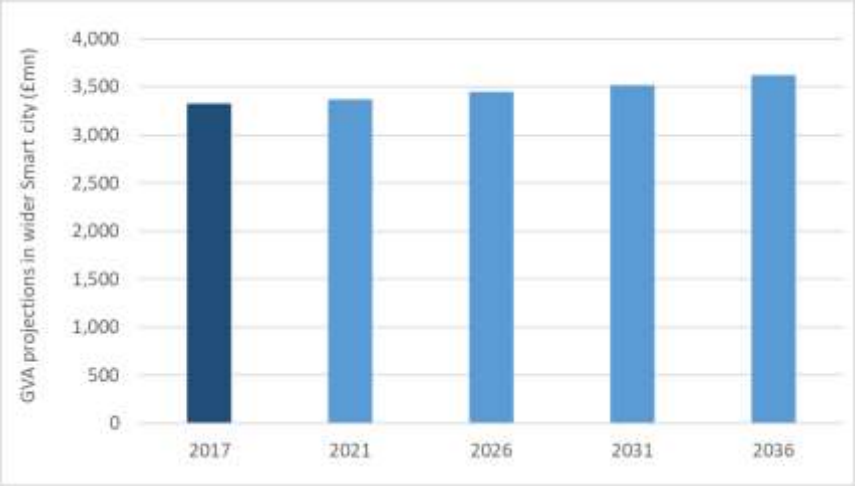
Projections for the future scale of the smart city industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall smart city industry and the 'clean' part of this industry. It is estimated that the level of employment in the smart city industry will increase substantially compared to the 2017 level, to reach around 56,000 in total by 2036 (compared to 51,000 in 2017), while the GVA associated with the sector is estimated to reach £3,600 m.

Including further assumptions about the proportion of the smart city industry that is engaged in 'clean growth' activities[10], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. We estimate that 19,000 people will be engaged in clean smart city by 2036 (compared to 10,500 as of 2017) and the GVA associated with the clean smart city sector would reach £800 m by 2025 and £1,350 m by 2036. Our approach to estimate the future size for the clean growth sectors is, of course, subject to uncertainty, as we have made

[10] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time

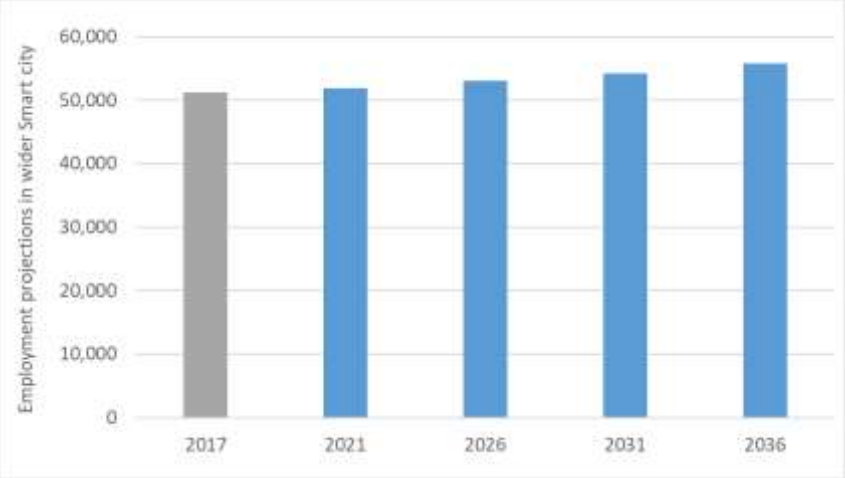
assumptions on two parameters (the percentage of the broader 'computer, electronics and electrical equipment' sector that is represented by smart city industry; and on the proportion of the identified smart city industry that is engaged in 'clean growth') - thus in reality this figure can be higher or lower.

Figure 3.24 GVA projection for the wider Smart city industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.25 Employment projection for the wider Smart city industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

SWOT analysis

The following table provides an overview of the strengths, weaknesses, opportunities and threats for the smart communities sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.10: Summary of SWOT for smart communities subsector

Positive	Negative
Internal to the sector	

Strengths

- Leeds city council programme “smart Leeds” aims to identify and deliver new technologies and innovative solutions as well as educate through the 100% digital Leeds (Leeds County Council 2019)
- Lucy Zodian- working towards a smart street lighting infrastructure to improve efficiencies and control (Lucy Zodian, undated)
- Northern Powergrid is investing £15m into the development and installation of next-generation substation controllers, boosting smart grid capabilities in 860 substations (Northern Powergrid 2018)
- Yorkshire Water is embarking on a data-led “internet of things” approach to obtain real-time information on water and sewage operations (Yorkshire water, undated)
- Smart Buildings ltd (Engie) are developing Smart Buildings using the internet of things manage building functionality (Smart buildings, undated)
- Numerous research projects and institutions are working on smart technology including 3m Buckley innovation centre, Virtuocity, Self Repairing Cities and York Global Initiative for Safe Autonomy
- Leeds institute for data analytics (LIDA) is a council run initiative to capture, analyse and process data to maintain position at the forefront of the smart communities revolution
- The Superfast West Yorkshire and York project has provided 100% of premises with >2 mb of broadband
- 102,000 people already employed in digital roles (WYCA, undated)
- Leeds City Region Enterprise Partnership (LEP) has commenced to develop the Leeds City Region Digital

Weaknesses

- Consumer awareness of smart communities is low, which may have an impact on widespread adoption - 68% of people do not know what a ‘smart city’ is and 26% find the concept of a ‘smart city’ worrying due to lack of available information (ATG Access, 2018)
- 34% of the current roles in the WYCA labour market could disappear in Leeds City Region over the next 20 years as a result of automation (WYCA, undated)
- Employment in WYCA within the clean growth sector has seen little growth (as per previous numbers)[)]
- Rural areas have been neglected in the transition towards a smart community technology, particularly in areas with poor broadband speeds. Rural broadband speeds are 15% slower than urban areas (Community First Yorkshire, undated)
- Lack of data are barriers to development and investment into the smart communities sector
- An ageing infrastructure requires improvement and investment (Department for Business Innovation and Skills, 2013)
- The smart community infrastructure should be GDPR compliant, which may pose limitations on the potential of technologies
- Smart communities require cross-sectoral cooperation which needs further encouragement

Framework, based on which it will develop a Digital Strategy for the whole of the City Region • Leeds City Region Enterprise Partnership (LEP) has launched the Discover Digital initiative which aims to encourage people to consider switching to a career in digital (Discover Digital, 2019) • University of Leeds has received funding under the Strength in Places Fund to develop a full bid for their proposal (Medical Technologies in the Leeds City Region: Driving economic growth, improving health and care) which is expected to include digital healthcare and ensuring technology is taken up by industry (UK Research and Innovation, 2019)	
External to the sector	
Opportunities • Advanced Digital Innovation (ADI) is working alongside Arqiva and the University of Leeds to provide testing facilities, training, mentoring and commercial advice to entrepreneurs and SMEs with an early-stage Internet of Things product or service (University of Leeds 2016) • £75 m is available for local authorities to bid for in order to improve broadband speeds of over 30 Mbps (HM Government 2018) • £1 bn Leeds City Region Enterprise Partnership (LEP) growth Deal funding will be used to drive growth and job creation (WYCA undated[b]) • Leeds City Region Enterprise Partnership has committed to connect 5,277 properties to superfast broadband (WYCA and LEP 2019) • The number of digital jobs in the region set to grow 10 times faster than non-digital roles (WYCA, undated[a])	Threats • Cyberattacks have the potential to access data and disrupt technology with potentially serious impacts (Braun et al, 2018) • There are no standardised frameworks for the development of smart communities • Data privacy issues surrounding data storage, transfer and processing • Economic uncertainty • Lack of policy contexts • Real time decision mechanisms need to be developed

- WYEP research suggests improving the City Region's productivity rate through automation could add 10 bn to the economy and create thousands of new jobs (WYCA, undated[a])
- Trapeze Group UK and Ito World have won contracts to deliver an 'Open Data Hub' to improve data collation and dissemination on transport (Intelligent transport 2019)
- Brexit could result in it being easier to source skilled workers for the digital economy from outside the EU (Hatch Regeneris, 2019)

Automation presents opportunities for the City Region in terms of improved productivity rates and job creation, although widespread automation will inevitably result in job losses in some industries. The City Region has existing strength in the digital sector, supported by initiatives such as Discover Digital, and the number of digital jobs in the region being set to grow 10 times faster than non-digital roles (WYCA, undated[a]). Opportunities include improved superfast broadband connectivity and mentoring and commercial advice for entrepreneurs and SMEs regarding Internet of Things products or services. The focus on digital inclusion by 'Smart Leeds' aims to bring about financial savings, reduced isolation, better employment prospects and improved health and wellbeing to residents across the city by working collaboratively across all sectors to create and deliver new and improved services such as improved broadband, water, electricity and transport services.

There are numerous companies within W&NY developing and implementing smart technologies, including Yorkshire Water's data-led "internet of things" approach to obtain real-time information on water and sewage operations. This has the potential to impact consumers across the City Region and YNYER, however weaknesses include the risk of rural areas being left behind, with restricted access to superfast broadband and the focus of smart technology testing being rolled out in more populated urban areas.

Case study: Yorkshire Water's Internet of Things

Yorkshire Water's innovation work spans over 70 live projects covering a broad cross-section of topics, from incremental service provisions, to large-scale transformations. One such project is its data-led 'internet of things' (IOT) approach, which focuses on expansion of remote telemetry to enable real-time data streams from across its infrastructure. This project aims to transform operational performance by installing 15,000 monitoring devices across the water network to identify leaks and assess the condition of pipes, allowing for more efficient despatching of response teams to incidents and a greater understanding of water and sewerage trends. It is anticipated that the IOT approach will result in reductions in leakage, significantly fewer pollution incidents and reduced supply outages during planned or unplanned interruptions. Implementation of this

project has required the company to invest in both smart technology and its staff, in particular the employment of a new team of data scientists to analyse these real-time data. An additional element to this innovative approach is the company's decision to publish the data, partnering with the Open Data Institute (ODI Leeds) to become the first UK water company to be open by default. It is hoped that this decision will help foster innovation and assist in the roll out of smart technology across the sector.

Policy recommendation for the sector

Jobs in the smart communities sector within the study area are mainly based in the City Region, with Leeds itself supporting 44% (and generating 48% of GVA allocated to smart communities in 2017). Employment in the sector in YNYER is relatively low, with Craven, Richmondshire, Ryedale and Scarborough each having around 1% of total jobs. This is assumed to reflect issues around smart community technologies tending to be trialled and put into use in more densely populated areas.

Both LEP regions: given 68% of people do not know what a 'smart city' is and 26% find the concept of a 'smart city' worrying due to lack of available information (ATG Access, 2018), policy should address better information provision for consumers to ensure that there is an understanding and buy-in to the smart community concept. This could be through the development of an awareness raising strategy, to share information on existing available technologies, as well as potential developments in the pipeline. Increasing awareness of digital capabilities amongst both consumers and businesses enables the supply chain to better connect with those utilising products. Improving understanding of digital technologies would also help mitigate some of the threats, for example, relating to data privacy and policy context since consumers would be better informed. Policy additionally needs to promote cross sectoral cooperation, an issue which has been highlighted as an existing weakness. This could help deal with the current imbalance in the distribution of jobs and employment across the study area (with both currently concentrated in Leeds). Greater partnership working could help facilitate jobs growth in other areas, in particular those where smart community jobs are currently relatively few in number (e.g. Richmondshire and Ryedale).

A focus on digital security, alongside digital innovation is essential to manage the risk of potential cyberattack. Information from stakeholder engagement suggests that specialist support for SMEs is needed to ensure that small and medium sized businesses can also benefit from reduced resource consumption, wastage and overall costs as a result of the internet of things approach. Similarly, rural areas require targeted investment (e.g. improved rural broadband speeds) to ensure they are not left behind in terms of technological innovation. Ensuring digital infrastructure is in place to enable economic growth is part of the Leeds City Region Strategic Economic Plan (2016-2036), however, it is an issue that is relevant across the study area.

YNYER: given the large geographical area covered by YNYER, which includes several mainly rural districts (e.g. Ryedale, Craven), policy for this region should focus on ensuring that 'smart community technologies are deployed beyond the population centres to avoid them being left behind.

City Region: within the City Region, policies should build on existing strengths (e.g. smart street lighting) to ensure that technologies continue to be

developed and tested in areas where trials are viable. In 2017, 44% of the study area's employment in smart communities was in Leeds itself. Policy needs to ensure that the benefits of smart technologies (and hence employment and GVA generated) are extended beyond the population centres and into more spread out settlements, for example, in Calderdale, which had a much lower percentage of the study area's smart community jobs (5% in 2017).

3.8 Circular economy

Definition

The circular economy sector consists of all the companies involved in at least one stage of the circular and regenerative approach to the life cycle of products (make, use, reuse, remake, recycle) which offers an alternative to the traditional linear economy and mode of production (make, use, dispose). It is an industrial system replacing the concept of end-of-life with restoration and regeneration and focusing on extending the permanence of products into the economic system for as long as possible without deteriorating their economic value and technical properties (European Commission 2017). In practice, this requires the repair and maintenance, sharing and remanufacturing with recycled materials of products to increase their durability and their reallocation to the same or to a different purpose. Businesses in this sector are typically involved in waste and resource recovery activities, promoting the recycling, repair and maintenance of materials and products such as plastics, glass, paper, textiles and clothing, computers and other electrical, electronic and mechanical devices.

The Circular economy clean growth sector was classified as a subset of the following 3-digit SIC codes:

- 360: Water collection, treatment and supply
- 370: Sewerage
- 383: Materials recovery
- 390: Remediation activities and other waste management services
- 452: Maintenance and repair of motor vehicles
- 951: Repair of computers and communication equipment
- 952: Repair of personal and household goods.

Relevant national policy and local policy context

Principles of the circular economy can be identified across the policies proposed by the UK Government in the Clean Growth Strategy to enhance the benefits and value of natural resources. The country is now working towards the ambitious target of reducing avoidable waste in the coming decades, with the final goal of reaching zero avoidable waste by 2050. In practice, this means enhancing the productivity and the value of extracted resources as well as extending their lifetime before being recycled where it is technologically, environmentally and economically feasible. The negative environmental impacts associated with the extraction, use and disposal of resources will be drastically reduced as a result. With the aim of setting out a waste policy framework in line with the 25 Year Environment Plan, the UK Government published the Resources and Waste Strategy in 2018 guided by the two overarching objectives of maximising the value of resource use and minimise waste and its negative impacts on the environment. Besides reinstating the

target of eliminating avoidable waste by 2050, the Strategy also introduced the following ambitions:

- To make all plastic packaging on the market recyclable, reusable or compostable by 2025
- To eliminate food waste to landfill by 2030
- To eliminate avoidable plastic waste over the 25 Year Environment Plan
- To double resource productivity by 2050.

Besides national targets, local strategies within W&NY emphasise the importance of developing a strong economy grounded on circular economy principles to achieve substantial reductions in carbon emissions in addition to those realised with technological change. In this perspective, one of the strategic priorities for YNYER is to create a circular agri-food sector harnessing significant opportunities for costs savings and emission reductions by, for example, powering agricultural vehicles using bio-fuels and agri-waste. Among the projects that are underway in the region. the Circular Economy & Resource Efficiency Support (CERES) Programme will fund small and medium enterprises to engage into environmentally friendly and efficient resource management, with the final goal of ensuring that small and medium businesses adopt circular economy principles.

Table 3.11 Circular economy

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• UK as a Zero Avoidable Waste economy by 2050, also exploiting opportunities with industry for repair and manufacturing; a new Resource and Waste Strategy will be published[1] • £162 m investment in research and innovation in energy, resource and process efficiency plus £99 m investment covering waste and resource efficiency[2]	↑
Relative importance of the sector in W&NY region	• Repair of motor vehicles and motorcycles among the sectors generating most GVA in the Leeds City Region[3] • Resource Efficiency Fund adopted to help SMEs purchasing energy, water or waste saving capital improvements[4] • Dalton Industrial site as pilot experiment in Hambleton[5] • New collection services are being promoted in Leeds (i.e. Vegware) with waste packaging being collected and converted into compost[6]	↔
Recognised in existing Local Energy Strategies (and other local strategies and information)	• Circular Economy & Resource Efficiency Support (CERES) Programme to promote circular economy practices within SMEs[7] • Ensuring the circularity principles become embedded in the economy of SMEs within the Leeds City Region[8] • Leeds City Council adopted the Natural Resource and Waste Local Plan to improve resource use efficiency and management • YNYER aims at establishing resource efficiency clusters as a strategic priority	↑
Future potential	• Extensive development of the circular economy involving remanufacturing and repair has the potential to create employment near existing manufacturing sites where unemployment tends to be higher[9] • In November 2018 the Association of Electrical and Mechanical Trades (AEMT) organised a conference on the circular economy and the opportunities for the repair and service sector[10]	↑

	• Yorkshire and The Humber has the highest concentration of food and drink businesses in the UK[11], one of the sectors with most significant opportunities for resource efficiency (reduced food waste)[12] • Large possibilities for industrial symbiosis in W&NY, and the RES programmes could be extended to cover a larger share of resource-intensive firms	
Competitive advantage	• AEMT, representing engineering companies in the service and repair industry in the UK, has its headquarters in York • AEMT has been working to include circular economy principles through the service and repair of electrical and mechanical equipment, especially in the Motor Repair industry[13] • The close proximity of industrial sites in YNYER creates opportunities for sharing of resources and waste, high concentration of production business in Bradford and rest of Leeds City Region[14] • Willingness of LAs to fund resource and waste efficiency programmes	↑

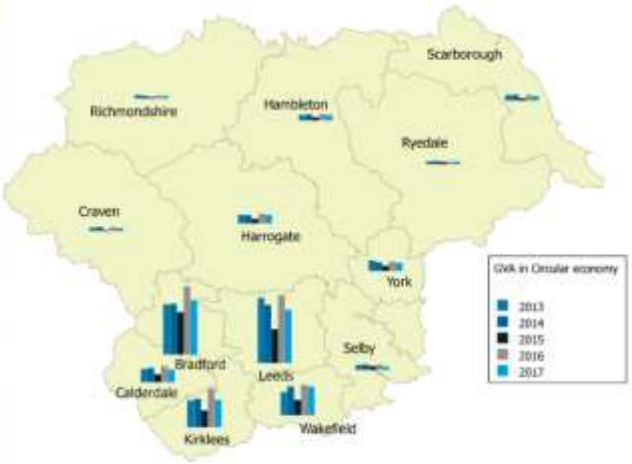
1,2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3,8: Carbon Trust (2018), An Energy Strategy and Delivery Plan for the Leeds City Region
4,5,12,14: Carbon Trust (2017), LCR and YNYER LEP Energy Strategy – Energy Technology Appraisal
6,10: https://www.theaemt.com/DB/news-webpage/aemt-conference-examines-the-circular-economy-and-the-opportunities-for-the
7,11: YNYER Local Energy Strategy
9: WRAP and Green Alliance (2015), Employment and the circular economy – Job creation in a more resource efficient Britain
13: AEMT Journal (2017), Volume 17 Issue 3.

Recent changes in size of the sector

The existing sector involved in the repair, maintenance and recovery of products such as textiles, electronics and other personal and household goods is present in all local authorities within W&NY but mostly concentrates in West Yorkshire across Bradford, Leeds, Wakefield and Kirklees. Sectoral GVA and employment have increased up to 2016 to reach levels of about £800 m and more than 19,900 people employed, but decreased suddenly in 2017. Volatility in employment across years is largely driven by Repair of computers and household equipment jobs and Maintenance and repair of motor vehicles types of jobs[11].

Figure 3.26: Gross Value Added for the wider Circular economy sector by district (2013 – 2017) (£2016 m)

GVA (£2016m) in 2017	Wider Circular economy sector	% of York, West & North Yorkshire
Bradford	166	25%
Calderdale	38	6%
Craven	10	2%
Hambleton	17	3%
Harrogate	26	4%
Kirklees	83	13%
Leeds	162	25%
Richmondshire	8	1%
Ryedale	9	1%
Scarborough	14	2%
Selby	11	2%
Wakefield	87	13%
York	25	4%
York, West & North Yorkshire	655	100%

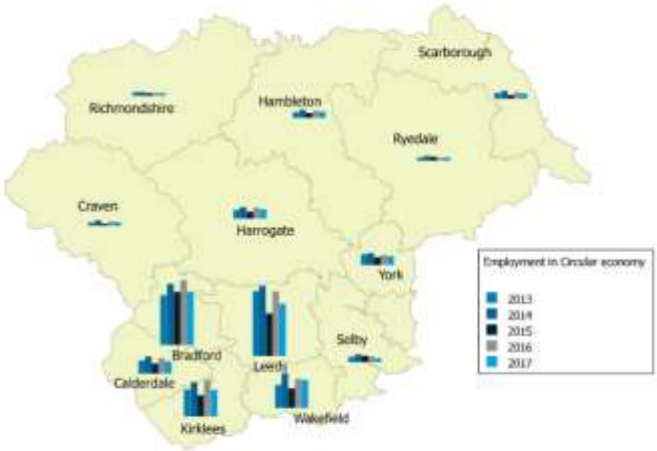


[11] Note: yearly Employment and GVA figures for some of the subsectors may appear to be highly volatile due to sector reclassification at statistical authorities.

Making use of the estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), we assumed that approximately 32.7% (~5,400) of current employment in the wider circular economy sector can be attributed to the clean growth sector component. Our approach to estimate the current size for the clean growth sectors is, of course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with the development of clean growth activities, employment and GVA associated with clean growth economic activities also grow. In reality, however, the figures can be higher or lower.

Figure 3.27: Employment in the wider Circular economy sector by district (2013 – 2017)

Employment in 2017	Wider Circular economy sector	% of York, West & North Yorkshire
Bradford	4,035	25%
Calderdale	930	6%
Craven	275	2%
Hambleton	465	3%
Harrogate	730	4%
Kirklees	2,030	12%
Leeds	3,950	24%
Richmondshire	220	1%
Ryedale	240	1%
Scarborough	385	2%
Selby	305	2%
Wakefield	2,120	13%
York	690	4%
York, West & North Yorkshire	**16,375**	**100%**

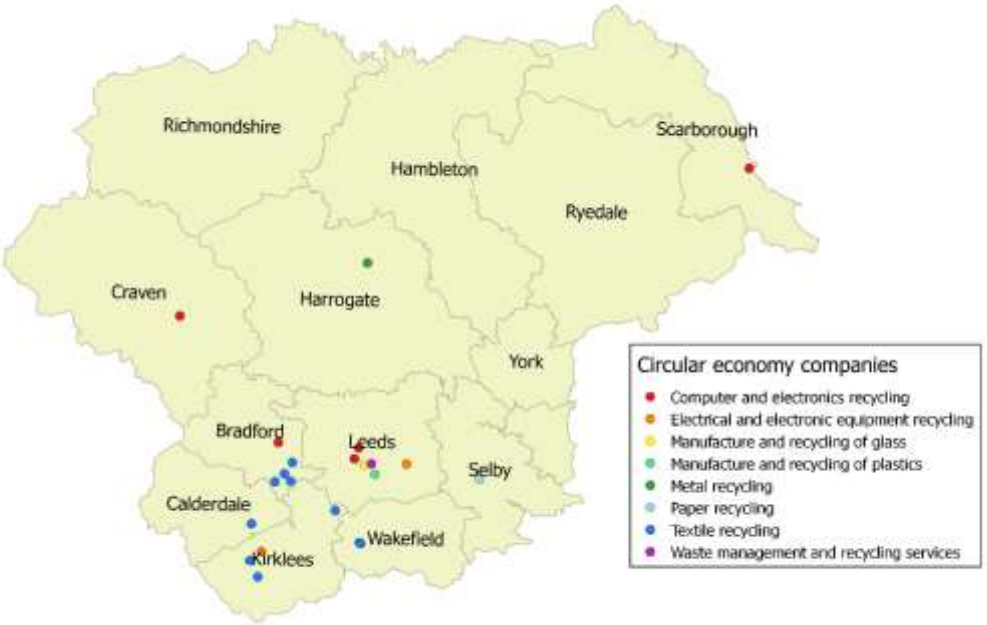


Source: Cambridge Econometrics.

Circular economy business locations

Figure 3.28 shows the location of identified companies involved in at least one stage of the circular economy cycle. W&NY sees a concentration of businesses centred around recycling and recovering of textile and clothing, with a particular concentration across Bradford, Kirklees, Calderdale and Wakefield. The number of companies recycling electronics, computer and other electrical equipment is also significant, with three of them located around Leeds and the remaining ones across Bradford, Craven and Scarborough. Leeds also hosts a number of businesses manufacturing and recycling glass and plastics and one large company (Veolia UK) offering waste management and recycling services, while paper and metal recycling activities are concentrated in Selby and Harrogate.

Figure 3.28: Location of companies involved in the circular economy in W&NY



Source: Cambridge Econometrics.

Future projections of the size of the sector

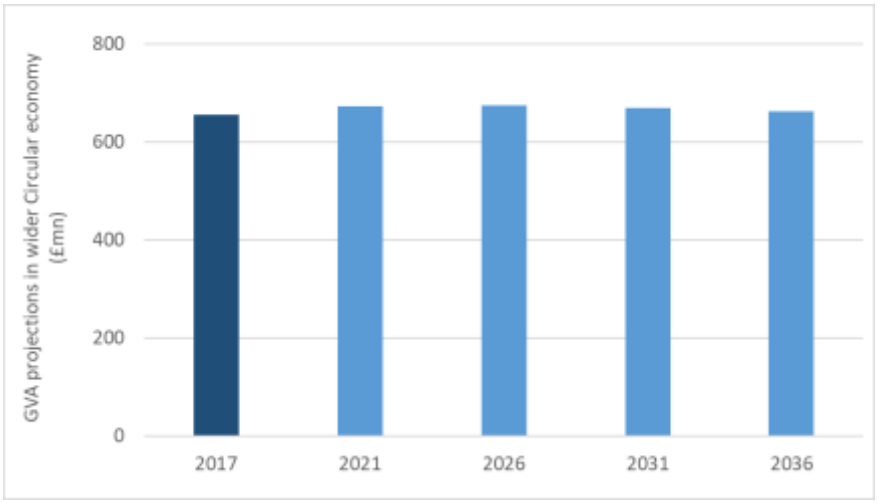
Projections for the future scale of the circular economy industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall circular economy industry and the 'clean' part of this industry. It is estimated that the level of employment in the circular economy industry will largely stagnate compared to the 2017 level at around 16,000 in total by 2036, and the GVA associated with the sector will also remain at around £660 m.

Including further assumptions about the proportion of the whole identified circular economy industry that is engaged in 'clean growth' activities[12], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. We estimate that about 14,000 people will be engaged in clean circular economy by 2036 (compared to 5,300 as of 2017) and the GVA associated with the clean circular economy sector would reach £750 m by 2025 and £1,300 m by 2036. Our approach to estimate the future size for the clean growth sectors is, of course, subject to uncertainty, as we have made assumptions on two parameters (the percentage of the broader 'repair and maintenance, water collection, sewerage and materials recovery' sectors that is represented by

[12] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time

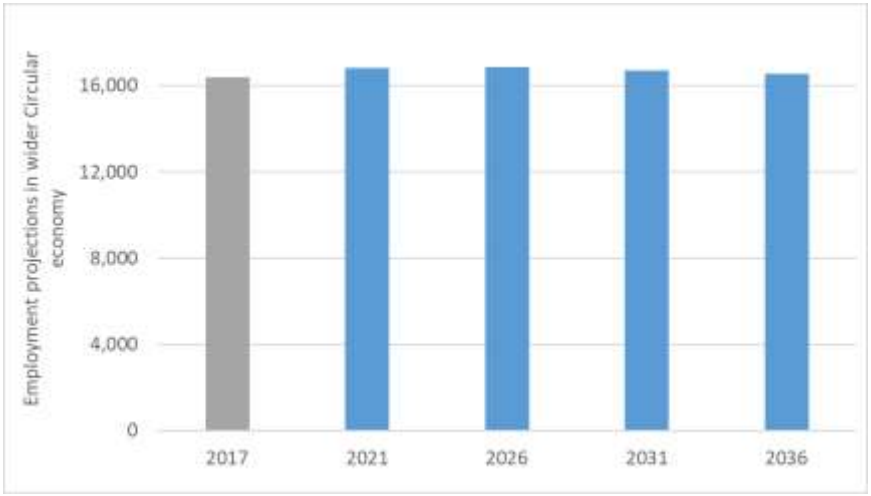
'circular economy'; and on the proportion of the broader sector that is engaged in 'clean growth') - thus in reality these figures can be higher or lower.

Figure 3.29 GVA projection for the wider circular economy industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.30 Employment projection for the wider circular economy industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

SWOT analysis

The following table provides an overview of the strengths, weaknesses, opportunities and threats for the circular economy sector within the region. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.12: Summary of SWOT for the circular economy subsector

Positive	Negative
Internal to the sector	
Strengths • The Circular Economy Club (CEC) York Circular Economy Mapping week (2018) gathered	Weaknesses • Requires collaboration through the value chain (World Economic Forum 2018)

together the initiatives from across the Yorkshire region detailing the organisations designing and implementing circular local strategies (CECYork, undated) • Veolia Recycling and Energy Recovery and Paper Pulp facilities in Leeds transform unwanted materials into important resources (electricity to power 22,000 homes via the National Grid and production of Pro-Fibre product (Leeds Climate Commission, undated) • Leeds By Example collaboration with Hubbub and Zero Waste Leeds, inspiring people to recycle more food and drink packaging consumed on the go in Leeds has doubled city centre recycling rates (Leeds by Example, undated) • Yorkshire Water's innovation project has established 'product' status for redundant filter bed media: it can be recovered and processed into construction grade aggregate for sale or re-use, a principle which can be established across the whole Yorkshire Water region (Yorkshire Water, undated). • East Riding of Yorkshire unitary authority has the highest recycling, reuse and composing rate in England (64.5%) (Let's Recycle, 2018) • Presence of several community interest companies (CICs) working to deal with issues such as food waste • CREDS (Centre for Research into Energy Demand Solutions), which includes academics from Leeds and York Universities, aims to support the transition to a low carbon energy system • Motor repair industry is a working example of how the circular economy can succeed in industrial practice (Falkner, 2017)	• Transition to a circular economy requires new skills (Faulkner, 2017) • Rural areas have been neglected in the transition towards the circular economy, with the focus being on circular cities • Lack of waste data and inconsistencies in existing waste data are barriers to development and investment in the UK's resource recovery from waste sector (Purnell, 2017) • Cultural barrier of negative perception of used products • Lack of carbon transport and storage infrastructure in place currently hinders deployment of clean growth technologies (industry stakeholder; pers. comm.). This means there are limited opportunities for energy intensive operations to move towards the circular economy
External to the sector	
Opportunities	Threats

- Leeds City Region Enterprise Partnership £0.25m funding to Texfelt enabling investment in new facility to produce Springbond (eco-engineered carpet underlay made from upcycled plastic bottles) (Texfelt, 2019)
- Relocation of a plastic waste recycling company (OSO Polymers) to Stourton (Leeds) (Bdaily news, 2019). This could encourage other related businesses to move to the area
- ERDF funded SME pilot scheme December 2019 – 2022 to address knowledge and information gaps within SMEs to make the case for energy and resource efficiency investments (Resource Efficiency Fund 2, undated)
- Glass Futures' Strength in Places seedcorn grant by UKRI to develop 'The Glass Corridor', catalysing the development of new technologies across the glass manufacturing supply chain, including recycling and zero-carbon manufacturing of 'carbon reducing products' (Glass Futures, 2019)
- Provision of regulatory and fiscal framework that incentivises organisations to remanufacture and reuse while disincentivising the use of raw/virgin materials (IEMA, 2018)
- Brexit: waste regulation in the UK is currently confused and post EU-exit there is potential for better regulation to meet national need (pers. comm. 2019)
- Frictions between existing linear economy and circular economy
- Brexit: potential for greater divergence in waste management practice between the UK nations will increase if the EU framework guidance is lost (Purnell, 2017)
- Climate change will force an increase in wastewater arisings, requiring investment which needs to be balanced with affordability of customers' water bills (Purnell, 2017)

Research has found that employment in the circular economy is distributed across Britain, broadly in line with the overall distribution of employment (Morgan and Mitchell, 2015). However, there is substantial scope for net job creation in a growing circular economy particularly in high unemployment regions, or for those occupations with higher unemployment rates: at the current growth rate, net job creation in circular economy activity to 2030, as a percentage of the labour force is 0.54% in the North East (6,948 jobs) and 0.30% in Yorkshire and the Humber (7,978 jobs) (Green Alliance/WRAP (2015). In the Leeds City Region, data and governance are needed for city-scale circular economies (Owen, A and Liddell, J 2016). Yorkshire Water's

industrial development at Esholt is estimated to generate GVA in the region of £100 m annually, with a large part of this being high value jobs (pers. Comm. 2019). Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage, accommodation and food service activities make significant contribution to the City Region's GVA. The motor repair industry is a working example of how the circular economy can succeed in industrial practice, embracing circular product design, product re-use, repair and remanufacturing and effective supply chain and cross-sectoral collaboration.

There is emerging support for SMEs through the ERDF pilot project, to develop circular economy business models. Support and clean growth information provision for SMEs was identified through stakeholder engagement as being of importance given the greater focus often afforded to larger or more industrial organisations in terms of clean growth potential. There is good research and innovation capacity in the field of circular economies, for example, CREDS (Centre for Research into Energy Demand Solutions), whose academic partners include the Universities of York and Leeds. Yorkshire Water's Esholt project is exemplar of how the water industry can adapt towards a systemic approach, expanding product provision from treating wastewater alone, into integrated systems enabling resource recovery from the whole environment; this offers the opportunity to deliver significant value alongside making use of resources which are currently wasted (e.g. heat recovery from sewage works, carbon capture from engines etc).

Opportunities exist in the form of innovating products such as Veolia's Pro-Fibre products (e.g. biodegradable functional packaging), and Yorkshire Water's repurposing of redundant water filter media to construction grade aggregate. Yorkshire Water's innovation scheme currently encompasses over 70 live projects spanning circular economy and wider clean growth sectors. These emerging technologies and others, such as in glass manufacturing, could also represent export opportunities.

Policy recommendation for the sector

Employment in the circular economy sector is currently split relatively evenly between the City Region and YNYER, with the City Region generating 57% of the sector's GVA for 2017 and YNYER 43%. Considering individual local authority districts, the highest numbers of jobs are located in Bradford and Leeds (with each having 25% of the study area's circular economy jobs) and Wakefield (13%). This reflects the apparent clustering of the sector in the south of the study area, although as noted above, there are example circular economy projects in many areas.

Both LEP regions: development of the circular economy sector requires collaboration across the value chain and an integrated response to challenges. Bringing together stakeholders at different levels in a forum in which knowledge-sharing and creation of linkages between organisations can develop may help ease frictions between existing linear and circular economies. This action can be taken forwards across both the City Region and YNYER, with the potential for collaborative events and policies where the regions overlap and where existing organisations (e.g. CREDS) bring together partners from across the study area.

City Region: Yorkshire Economy's circular economy principles being demonstrated at Esholt provide potential for GVA growth in the region of £100 m annually for the City Region, although the principle as a whole, or in part

can be applied to any of the company's 630 works across Yorkshire. Future policy should encourage such actions by all organisations (public and private) building on opportunities and encouraging collaborations to enable innovative products (such as the springboard) to become commercially viable. The region already has many examples that can be showcased including, for instance, the Leeds By Example collaboration with Hubbub and Zero Waste Leeds. Leeds also has a zero-waste shop (The Jar Tree), where consumers can bring along their own containers in order to buy loose produce. Building on these existing ideas and specialisms should enable the sector to develop across the region including in more rural districts (e.g. Calderdale).

YNYER: for YNYER specifically, circular economy principles are being applied via multi-stakeholder implementation in Circular Malton. This provides an example for other locations within the region to learn from and build on. Policy for the region should focus on facilitating knowledge and information sharing about such examples, enabling other communities to benefit and develop their own circular economy groups. The provision of a regulatory and fiscal framework that incentivises organisations to remanufacture and reuse while disincentivising the use of raw materials is also required to enable circular economy principles to be taken up more widely and to foster collaboration between public and private organisations and between local authority districts in the region.

3.9 Construction

Definition

The clean growth construction sector represents the sustainable part of the wider construction industry which is involved in the development of new solutions to reduce the burden on the environment of the construction value chain. The construction sector is currently the largest user of raw materials in the world, and between 25 and 40 percent of global carbon emissions derive from the existing building stock (World Economic Forum 2016).

Typical examples of clean growth construction include all the activities oriented towards improving the energy efficiency of the existing buildings stock and the manufacturing and installation of modular buildings. Contrary to conventional on-site project construction, modular units are built in an off-site highly controlled factory environment, with each part crafted in an assembly line. This determines lower production and assembly times compared to on-site development. The production process also results to be less energy and waste intensive, with a drastic reduction in wasted materials since every single part of building is integrated and planned from the start. Companies manufacturing modular buildings are increasingly relying on eco-friendly materials such as sustainably sourced wood and recycled steel and glass, further limiting the overall environmental impact of prefabricated builds. These builds are easy to disassemble and 'portable' as they can be relocated from one place to another without any required demolition, generating opportunities for reusability and recyclability of parts and materials.

The Construction clean growth sector was classified as a subset of the following 3-digit SIC codes:

- 411: Development of building projects
- 412: Construction of residential and non-residential buildings.

Relevant national policy and local policy context

At the national level, the Clean Growth Strategy sets clear targets to improve efficiency levels of new and existing buildings across the residential, commercial and industrial sectors. By 2030, energy efficiency should improve by at least 20% for businesses and industry, and as many homes as possible should be upgraded to at least an EPC Band C by 2035, with all fuel poor homes upgraded by 2030. Currently existing schemes to support home energy efficiency improvements have also been extended until 2028 (Energy Company Obligation – ECO). Besides fostering energy efficiency, the Strategy opens to the opportunity of building lower cost and lower carbon homes using innovative construction methods including factory off-site manufacturing, and £1.4 m were invested to identify the drivers, barriers and challenges for new low carbon homes.

Local authorities in W&NY recognise the existing large potential for improving resource and energy efficiency in the construction industry and are willing to follow the national legislative framework to promote enhanced housing standards for new builds and the current stock. They are also aiming at enhancing the skills base of the current workforce employed in the construction sector, particularly for the installation of energy efficiency measures, and also to incentivise the knowledge sharing of best construction practices across firms.

Table 3.13 Construction

Criteria	Comments/evidence	Score
Sector identified as a priority within the Government's Clean Growth Strategy	• £184 m Government investments for innovation in Homes, improve as many homes as possible to EPC Band C by 2035[1] • Government's goal of improving energy efficiency by at least 20% by 2030 for businesses and industry[2]	↑
Relative importance of the sector in W&NY region	• 124,094 households (9.9% of households in W&NY) were in receipt of ECO measures at the end of 2018[3] • About 182,000 ECO (of which 16,760 ECO Affordable Warmth) measures installed at the end of 2018[4]	↔
Recognised in existing Local Energy Strategies (and other local strategies and information)	• Energy efficiency improvements are identified as key drivers to carbon dioxide reductions in the strategies of YNYER, Leeds and WYCA	↑
Future potential	• 2.75 million homes are suitable for cavity wall or solid wall insulation in the north of England, and 140,000 fuel poor households in the LCR[5] • Energy efficiency of industrial processes could be cost effectively improved by 10 to 20% in the next 20 years6	↑
Competitive advantage	• Energy efficiency programmes and funds are already in place to support households and industries in W&NY • Major opportunity for local insulation manufacturers and installers[7] dwellings each year (i.e. Legal & General in Leeds, Ilke Homes in North Yorkshire)[8]	↑

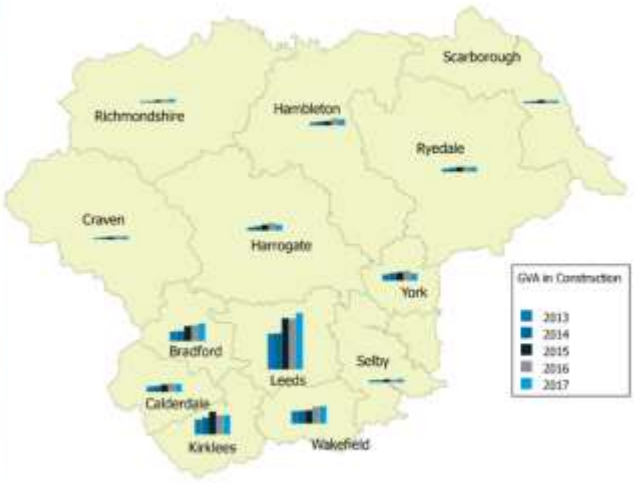
1,2: HM Government (2017), The Clean Growth Strategy – Leading the way to a low carbon future
3,4: BEIS 2019 Household Energy Efficiency Statistics
5,6: Carbon Trust (2017), LCR and YNYER LEP Energy Strategy – Energy Technology Appraisal
7: YNYER Local Energy Strategy
8: https://www.peelports.com

Recent changes in size of the sector

The construction sector in W&NY expanded substantially between 2013 and 2017. While sectoral GVA increased by 53% reaching £926 in 2017, the number of people employed in the construction sector rose by 38%, with 21,455 units in 2017. As showed by Figure 3.31 and Figure 3.32, most of the sectoral economic and employment value is generated in Leeds and, in a smaller scale, in the rest of W&NY.

Figure 3.31: Gross Value Added for the wider Construction sector by district (2013 – 2017) (£2016 m)

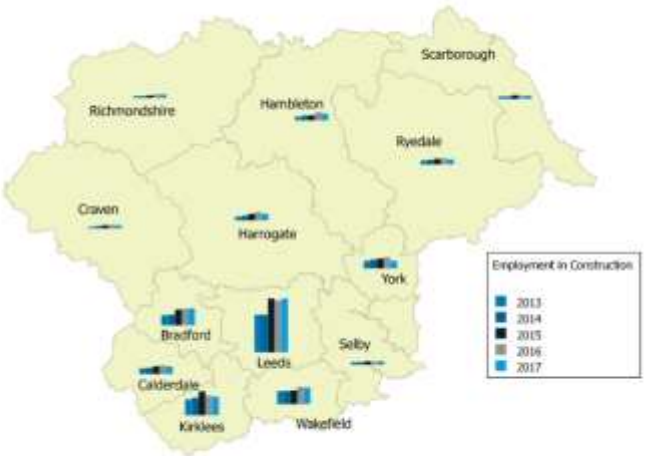
GVA (£2016m) in 2017	Wider Construction sector	% of York, West & North Yorkshire
Bradford	106	11%
Calderdale	48	5%
Craven	17	2%
Hambleton	37	4%
Harrogate	37	4%
Kirklees	116	13%
Leeds	333	36%
Richmondshire	20	2%
Ryedale	29	3%
Scarborough	18	2%
Selby	21	2%
Wakefield	102	11%
York	44	5%
York, West & North Yorkshire	**926**	**100%**



Source: Cambridge Econometrics.

Figure 3.32: Employment in the wider Construction sector by district (2013 – 2017)

Employment in 2017	Wider Construction sector	% of York, West & North Yorkshire
Bradford	2,375	11%
Calderdale	1,075	5%
Craven	435	2%
Hambleton	945	4%
Harrogate	925	4%
Kirklees	2,600	12%
Leeds	7,500	35%
Richmondshire	515	2%
Ryedale	720	3%
Scarborough	445	2%
Selby	520	2%
Wakefield	2,300	11%
York	1,100	5%
York, West & North Yorkshire	**21,455**	**100%**



Source: Cambridge Econometrics.

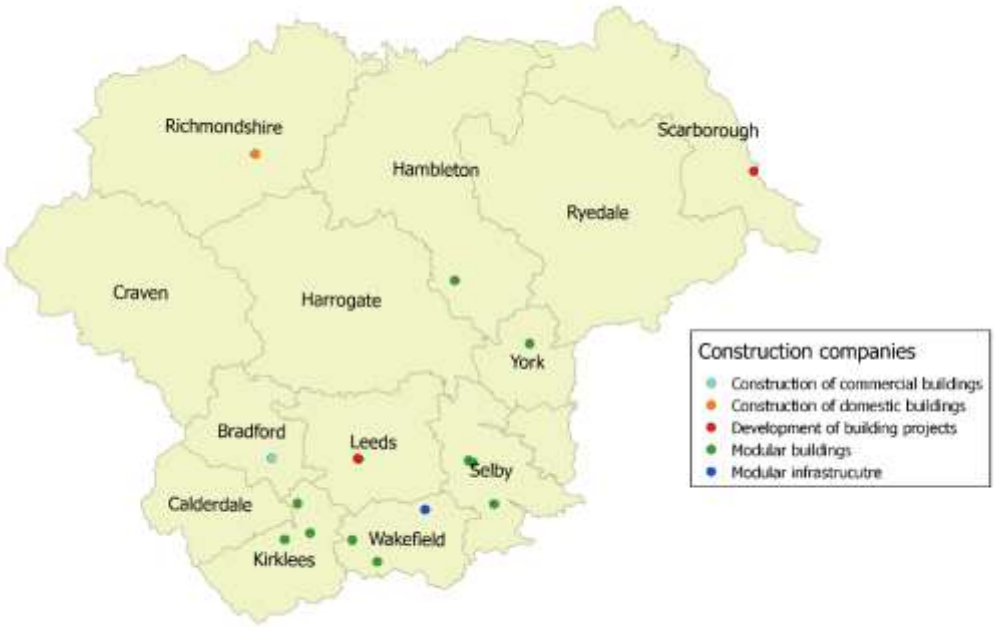
Making use of the estimates from the Department for Business, Innovation & Skills (BIS) on the size and performance of the UK low-carbon economy (Department for Business, Innovation & Skills 2015), we assumed that approximately 0.8% (~170 people) of current employment in the wider construction sector can be attributed to the clean growth sector component. Our approach to estimate the current size for the clean growth sectors is, of

course, subject to uncertainty and has its limitations. Since the publication of the BIS report the sector has naturally evolved, but a rational assumption is that in line with the development of clean growth activities, employment and GVA associated with clean growth economic activities also grow. In reality, however, the figures can be higher or lower.

Construction business locations

The region hosts a significant number of businesses building and installing modular homes together with companies performing groundworks and related civil engineering infrastructure services for modular companies. The great majority of them is located across the local authorities of Kirklees, Wakefield and Selby, but two companies are also present in York and Hambleton. Figure 3.33 also depicts a few additional companies specialised in residential and non-residential new construction and improving the energy efficiency of existing buildings through retrofitting, modernization and façade upgrade. These are located across Leeds, Bradford, Richmondshire and Scarborough.

Figure 3.33: Location of companies involved in construction in W&NY

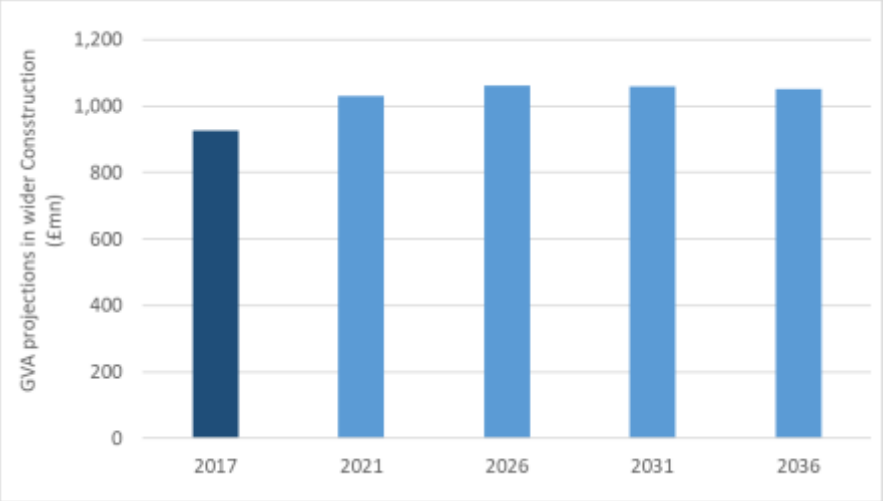


Source: Cambridge Econometrics.

Future projections of the size of the sector

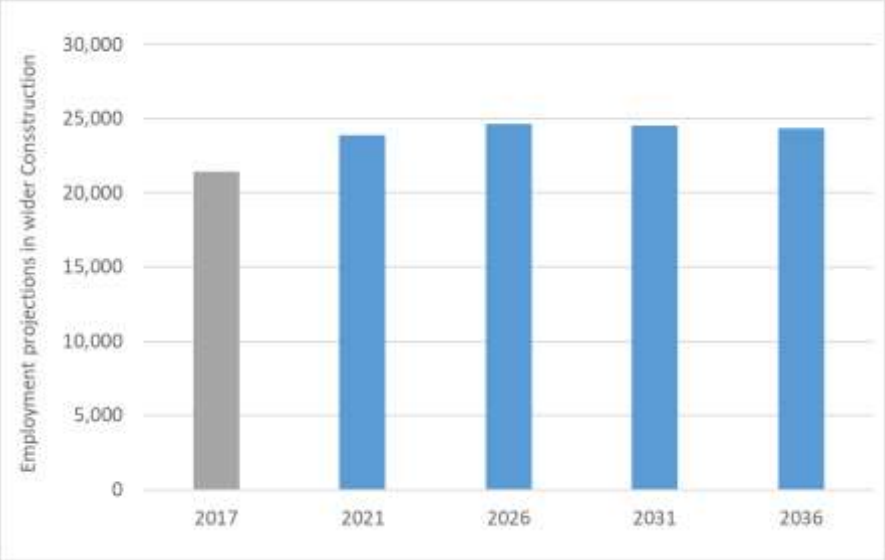
Projections for the future scale of the construction industry have been developed, based upon historical data outlining the size of the sector, and assumptions of future growth based upon existing economic projections for West & North Yorkshire, and an assumption regarding the future development of both the overall construction industry and the ‘clean’ part of this industry. It is estimated that the level of employment in the construction industry will increase by more than 10% compared to the 2017 level, to around 24,000 in total by 2036 (compared to 21,500 in 2017), while the GVA associated with the sector will reach £1050 m.

Figure 3.34 GVA projection for the construction industry in W&NY (£mn)



Source: Cambridge Econometrics, based on BRES employment data and productivity assumptions calculated from MDM model.

Figure 3.35 Employment projection for the construction industry in W&NY (total count)



Source: Cambridge Econometrics, based on BRES employment data

Including further assumptions about the proportion of the identified construction industry that is engaged in 'clean growth' activities[13], it is possible to determine the level of GVA and employment that might exist in the clean growth aspect of the industry in future. Our approach for making assumptions is further detailed at the beginning of Chapter 3.1, under *Our methodology for the analysis and forecasting of the clean growth sectors*. We estimate that approximately 400 people will be engaged in clean construction by 2036 (compared to about 170 as of 2017) and the GVA associated with the clean construction sector would reach £23 m by 2025 and £37 m by 2036. Our approach to estimate the future size for the clean growth sectors is, of course,

[13] Starting from the values proposed in (Department for Business, Innovation & Skills & Department of Energy & Climate Change 2015) and (Capital Economics, TBR and E4tech 2016), gradually increasing these values, with an aim to reflect the increasingly 'clean' nature of these industries over time

subject to uncertainty, as we have made assumption on a parameter (the proportion of the construction industry that is engaged in 'clean growth') which is in this case considerably low (0.8% of total industry) and gives a relatively conservative estimation regarding employment and GVA. In reality this figure may be higher driven by increasing efforts towards zero-carbon buildings.

SWOT analysis

Table 3.14 provides an overview of the strengths, weaknesses, opportunities and threats for the construction sector within the study area. Information has been drawn from the literature and stakeholder engagement. The strengths and weaknesses relate to existing factors that are internal to the sector, whilst the opportunities and threats are outside influences that could affect the sector's performance.

Table 3.14 Summary of SWOT for the construction subsector

Positive	Negative
Internal to the sector	
Strengths • Scarborough Construction Skills Village is exemplar in construction training; this model is being duplicated at the regional and national level as an effective way of addressing the construction skills gap (Scarborough Borough Council, 2018) • Considering all the districts in the study area, Leeds has the highest number of jobs in the wider construction sector followed by Kirklees and Bradford. The City Region currently has more wider construction sector jobs than YNYER. • There are 5,605 construction companies in YNYER (CITB, 2016). • The UK is currently exceeding the minimum target for recovery of non-hazardous construction and demolition waste (ONS, 2019) • £250,000 invested by Biffa to help improve the Yorkshire construction industry's waste compliance (Biffa, 2017) • Dynamo Build's digital construction cluster and the thinkBIM network (Leeds Beckett University) bring together specialists to establish a hub for skills development and retention in	Weaknesses • Ageing workforce (CITB, 2018) • Construction training fell by 33% in YNYER over a four-year period (from 1,166 trainees in 2012 to 782 in 2016) (CITB, 2018) • Particular skilled professions (such as architects and surveyors) within the construction industry require a high level of education and professional accreditation which can require a significant amount of time to acquire • There is demand for, and risk of a shortfall in, priority occupations including specialist building operatives, construction process managers, etc. (CITB, 2016) • The construction sector is responsible for 10% GHG emissions from UK industry (Cooper & Hammond, 2018) • Slow uptake of new technologies in the construction sector (KPMG, 2016)

BIM (Building Information Modelling) and digital construction technologies (thinkBIM ,2019; Dynamo Build 2019) • Green building store (Huddersfield) supplies sustainable building products and has developed expertise in Passivhaus (green building store, nd) • Leeds College of Building is the only further education college in the UK that is focused on construction and the built environment • Zero Carbon Yorkshire Buildings, a working group formed of those involved in construction (including academics) has identified several areas of focus including the promotion of Passivhaus low energy building standard and low carbon building (Zero Carbon Yorkshire, nd)	
External to the sector	
Opportunities • Industrial Strategy White Paper sets out plans for investment within the construction industry including £34m to expand innovative construction training programmes across the country and the launch and roll-out Sector Deals (Department for Business, Energy & Industrial Strategy, 2017) • The National Infrastructure and Construction Pipeline is worth approximately £600bn (Department for Business, Energy & Industrial Strategy, 2017) • UKRI Transforming Construction Industrial Strategy Challenge Fund's investment of up to £170 m, matched by £250 m from industry, to create new construction processes and techniques, such as the development of standardised	Threats • Uncertainty caused by EU-exit: Brexit stockpiling by manufacturing companies is causing raw materials shortages and a shortage of haulage capacity (HIS Markit, 2019) • Potential challenges associated with attracting talent from the EU after Brexit (Hatch Regeneris, 2019)

modular components from which buildings can be manufactured (UKRI, 2019)
- EU exit could lead to decreased costs associated with bureaucracy (LABC Warranty, 2019)

The construction sector offers opportunities both in terms of the traditional building industry and innovative digital techniques. The Construction Skills Village brings education and industry closer together and was designed by the construction industry to address the construction skills gap. It offers new entrants to the construction industry opportunities to develop skills alongside qualified trades people as well as work experience on large-scale construction developments. Owing to its unique approach, enabling trainees to learn both practical skills and soft skills, this format is being reproduced at the regional and national level. It is hoped that this approach will encourage more women to enter the industry, responding to skills shortages and marketplace needs.

Alongside the development of traditional skills, the City Region has existing strengths in innovative digital construction technologies via the thinkBIM network at Leeds Beckett University. This initiative supports sector-wide adoption of Building Information Modelling to promote the digitisation of the construction industry, supporting delivery of the Digital Built Britain Strategy (2016). The nearby north east region is a leader in digital construction, with future plans to build a hub for the global construction sector via the IC3 initiative at Northumbria University, to drive productivity and performance through digital technologies and smarter working processes. This represents an opportunity for the City Region to link up with this developing capability and build on its existing strengths in the sector, capitalising on the existing levels of construction sector jobs and GVA.

Policy recommendation for the sector

The existing construction sector appears to be concentrated in the City Region (which had 74% of the study area's construction jobs in 2017), with fewer jobs in YNYER (26%). GVA shows a similar pattern, with 36% of the sector's GVA allocated to construction being generated in Leeds (2017 figures).

City Region: jobs and GVA are currently concentrated in Leeds so encouraging collaboration across the region could help develop skills in other local authority districts. This will require the involvement of construction firms across the region as well as institutions outside it to enable new skills and techniques to be learnt. There may also be a need for interaction with other organisations who have links to the construction industry (e.g. Biffa, who provided funding to reduce waste) to ensure the sector learns from other industries. This could help deal with existing weaknesses (e.g. the construction sector being slow to adopt new technologies).

YNYER: addressing skills gaps in priority construction jobs through the development of a YNYER construction skills strategy and action plan could help grow the sector within YNYER. The strategy could be combined with a local focus on improving the image of construction to attract younger entrants to the industry, by demonstrating that construction offers well paid, skilled jobs, with reference drawn to planned Government investments such as the intention to improve as many homes as possible to EPC Band C by 2035. The

strategy will require consultation with construction companies as well as training facilities e.g. Scarborough Construction Skills Village to ensure it is joined up and relevant to the needs of the industry.

Study area: across the study area, uptake of new technologies is slow as a result of conservatism in the industry, meaning opportunities to foster new expertise in the area of digital construction have been limited to date. The North East's reputation for Building Information Modelling (BIM) could be used as a lever to promote digital career opportunities in the construction industry in both the City Region and YNYER, by building on existing strengths (such as the thinkBIM network) and creating links with the Dynamo North East cluster, to raise the profile of digital construction, improve links between business and education, upskill the workforce and retain existing talent in the construction industry.

4 Synthesis

4.1 Overview of this chapter

Table 4.1 provides an overview of the reasons why the seven clean growth sectors featured were selected as priority sectors to investigate further in this report.

Table 4.1 Ranking of clean growth sectors

Criteria	Circular economy	Bioenergy	Agri-tech	Hydrogen	Low carbon transport	Smart City	Construction
Sector identified as a priority within the Government's Clean Growth Strategy	↑	↓	↑	↓	↑	↑	↑
Relative importance of the sector in W&NY region	↔	↔	↑	↓	↔	↑	↔
Recognised in existing Local Energy Strategies (and other local strategies and information)	↑	↑	↑	↔	↑	↑	↑
Future potential	↑	↔	↑	↑	↑	↑	↑
Competitive advantage	↑	↑	↑	↑	↑	↑	↑

In this chapter the findings from earlier chapters of this report are brought together to recommend opportunities that have the greatest potential for the City Region and York, North Yorkshire Region to explore. Firstly, it reviews the seven clean growth sectors considered above. Through comparisons, it identifies which of the sectors have the greatest opportunities for growth and development. It then considers the sectors in light of the ESDP and LIS, still to be fully produced, determining where sectoral opportunities could link to priorities and objectives.

4.2 Opportunities with the greatest potential for the region

Table 4.2 summarises the strengths and opportunities from the different sectors that have been the focus of this report. The table covers areas such as levels of employment and research capacity, among the strengths, and levels of funding and investment among the weaknesses.

Table 4.2 Strengths and weaknesses for the different sectors

Sector	Strength	Weakness
Circular economy	Good research networks Existing high recycling and reuse rates	Rural areas neglected New skills required

	CE projects from across industry (e.g. water, motor trade, food & drink, plastics recycling)	Data inconsistencies hampering development Lack of infrastructure (e.g. carbon storage)
Bioenergy	Research capacity (e.g. BioVale, BDC) Commercial bio-energy facilities in region Good level of bio economy related jobs and turnover	Lack of bio-energy investment Financial constraints Land availability constraints Difficulties in securing commercial partners
Clean agri-tech	Good level of employment in bio-economy related jobs with specialisation in agri-food Good research capacity (e.g. BDC) W&NY cluster Grow Yorkshire network	Cessation of funding (e.g., Agri-Tech Catalyst) Low rate of entry into farming Insufficient investment Lack of advisory services
Hydrogen	Minimal new infrastructure needed to convert gas network to hydrogen (Leeds) Research capacity Known tech could meet demand (Leeds) Hydrogen fuel cell cluster potential Potential for funding Funding for TWI to develop a hydrogen corridor bid under the Strength in Places Fund	Reluctance to invest in hydrogen R&D Lack of commercial availability Lack of supply chain visibility Cost of engineering and design Competing technologies
Low carbon transport	Plans for ULEC buses in Leeds Supportive local authorities Sectoral experience Investment (e.g. First Bus) Presence of key supply chain players e.g. Optare, Centre for Innovation in Rail Employment in transport and distribution in W Yorkshire	Lack of infrastructure Lack of technicians Lack of investment in road and rail Insufficient battery technology Lack of support for SMEs Competition (West Midlands automotive manufacturing cluster) Competition from NE manufacturing cluster
Smart communities	Leeds Smart City Investment (e.g. Northern Powergrid) Industry innovation (e.g. Yorkshire Water) Research capacity (e.g. LIDA, Virtuocity) Discover Digital Initiative Funding for University of Leeds to develop a medical technologies bid under the Strength in Places Fund	Poor consumer awareness Neglect of rural areas Job losses resulting from automation Little growth in clean growth sector employment Lack of data Ageing infrastructure Requires cross-sectoral cooperation
Construction	Strengths in digital construction Initiatives to address skills gap (e.g. presence of Leeds	Ageing workforce

	College of Building in the City Region) Construction waste compliance initiatives Expertise being developed in Passivhaus (green building store, Zero Carbon Yorkshire Buildings group)	Skills gap (with potential issues sourcing EU workers after Brexit) Slow uptake of new technology Emission-heavy industry

The circular economy sector is the sector with the largest comparative share of GVA and employment; although the GVA per employee is smaller than for bioenergy. A number of weaknesses however have been identified for this sector which will need addressing in order to maximise the full potential, which may increase the productivity of the sector (in terms of GVA per person). The weaknesses for this sector include, inter alia:

- Need for new skills
- Rural areas have been neglected in the transition towards the circular economy, with the focus being on cities
- Lack of waste data and inconsistencies in existing waste data are barriers to development and investment in the UK's resource recovery from waste sector
- Negative perception of used products
- Lack of carbon transport and storage infrastructure for energy intensive operations to move towards the circular economy.

Moreover, there are threats related to the regulatory and fiscal framework after Brexit [14]and climate change requiring further investment (which may be reflected in higher water bills). Development of the circular economy sector will require collaboration across the value chain and an integrated and coordinated response to challenges across both the City Region and YNYER. Pending further information on the ESDP and the LIIS, current opportunities to build on this collaboration include the SME pilot scheme and CREDS (the opportunities are set out in Table 4.3 below).

Other sectors that perform relatively well compared to the circular economy sector include the bio-energy sector and clean agri-tech. The SWOT analysis for these sectors is summarised in Table 4.2 and Table 4.3 (with the individual assessment provided separately).

Table 4.3 Opportunities and threats for the different sectors

Sector	Opportunity	Threat
Circular economy	SME pilot scheme Good level of investment (e.g. UKRI, Leeds City Region Enterprise Partnership)	Requires provision of regulatory and fiscal framework
Bioenergy	Investment (e.g. Renewable Heat Incentive) SME support	Constant policy changes affect investor confidence (e.g. biomass subsidies)

[14] But note that Brexit could also present an opportunity in terms of developing better regulation to meet

	Significant industrial bio-energy potential Supply chain growth opportunities Humberside Industrial Cluster	Lack of policy framework Risk of supply chain and expertise loss
Clean agri-tech	Industry-academia collaboration Humberside industrial cluster Investment Plans for circular agri-food sector Changes in agricultural policies following Brexit could provide opportunities for agri-tech to be utilised to manage land in different ways	Climate change Threat of 'no-deal' Brexit Reliance on policy and subsidy to deploy clean technology
Hydrogen	Humberside industrial cluster Potential to link hydrogen generation to offshore wind Potential supply chain opportunities Opportunities linked to battery development Potential for government to provide more support for hydrogen post Brexit Potential for skills/knowledge developed during H21 project to be exported to other regions	Lack of competitive supply chain Loss of Horizon 2020 funding access in event of no-deal Brexit Reliance on policy and subsidy to deploy clean technology Requires reallocation of spending and supply chain activity Reduced heat demand (improved energy efficiency)
Low carbon transport	Growing market for cleaner transport options 2040 ban on sales of diesel and petrol cars/vans Proposals to upgrade existing rail lines High Speed Rail Institute Electric vehicle battery manufacturing potential	Requires significant funding London-focused investments to date Reliant on government policy
Smart communities	Support for SMEs (ADI) Funding for broadband speed improvements Strong growth predicted in digital jobs Open Data Hub Automation can improve productivity and jobs Growth Deal funding Brexit may mean it is easier to attract digitally skilled workers from outside the EU	Risk of cyberattack Lack of standardised frameworks Economic uncertainty Data privacy issues
Construction	National Infrastructure and Construction Pipeline Investment (e.g. UKRI Transforming Construction)	Uncertainty caused by EU exit

The bio-energy sector is remarkably productive in the region (with large GVA per person) but is not a large employer. There is an identified risk of constant

policy changes affecting investor confidence (e.g. biomass subsidies). The lack of large-scale projects is also a threat to the development of effective supply chains and the activity is currently concentrated in Leeds and part of West Yorkshire, perhaps due to the location of the power and gas plants thereabouts. The SWOT analysis has however identified a number of opportunities, including, inter alia:

- Funding opportunities for bio-energy through the domestic/non-domestic Renewable Heat Incentive and the Renewables Transport Fuel Obligation
- UK Government spending through the RHI scheme (West Yorkshire Combined Authority, 2018)

It has also been suggested by the trade association that the sector is estimated to quadruple in the next twenty years due to the potential for new products and markets (e.g. new digesters and fertilisers).

The clean agri-tech sector includes activities related to the production of food and animal feed and the manufacture of innovative bio-based materials using the by-products from agriculture, aquaculture and forestry. It is the third largest employer of all seven sectors, building on the strong linkages between clean agri-tech and laboratories/research centres (e.g. National Agri-Food Innovation Campus, NAFIC). The City of York is indeed home to an important innovation cluster for the bio-economy industry (BioVale). Moreover, the sector has rapidly expanded in the W&NY region. This is evidenced by the innovation audit (RSM, 2019), which identifies agri-food (and bio-science) as one of the sectors in the region that has the most growth potential. Thus, the impacts from any loss of subsidies or new competition from non-EU producers in the event of a “no-deal” Brexit need urgent priority.

Against the above, the hydrogen sector is, for now, of little economic relevance to the study area (representing 5% of total GVA generated in 2017 by the seven clean growth sectors considered here). However, it can achieve high productivity levels (per person employed). The sector suffers from a shortage of investment due to what is appears to be a lack of commercial availability. There is an opportunity for companies currently in the oil and gas supply chain that could move into a hydrogen economy and this possibility needs to be explored in further detail prior to prioritisation.

The transport sector is one of the largest emitting sectors in the UK and its decarbonation is an integral part of the pathway to achieving the emissions-reduction targets. Opportunities exist with the ban on conventional petrol and diesel vehicles by 2040. This will result in an increased demand for the manufacture of low-emission vehicles (such as electric vehicles) which could provide opportunities for companies involved in the supply chain. However, the region faces competition from both the West Midlands and North East automotive manufacturing clusters which are major players in UK automotive manufacturing. The focus thus needs to be shifted to public transport. Focusing on the opportunities presented by the potential High Speed Rail Institute at the University of Leeds and the proposed new line to Manchester could bring long term benefits for low carbon transport.

The remaining sectors, i.e. smart communities and construction are considered to be of moderate priority. Although the former has potential to support digital innovation, rural areas have been particularly neglected in the

transition towards smart communities technology. At the time of writing there are no standardised frameworks for the development of smart cities but a number of programmes are in place that can lead to further automation and improved productivity (e.g. Smart Leeds, Smart Buildings ltd and Growth Deal funding) as part of the sector being identified as a priority within the Government's Clean Growth Strategy. Thus, there is potential for growth. As for construction, this has also been identified as a priority sector but is of relative importance in the W&NY region. The sector appears to be concentrated in the City Region, with fewer jobs in YNYER. Addressing skills gaps in priority construction jobs through the development of a YNYER construction skills strategy and action plan could help grow the sector within YNYER. This will entail supporting existing programmes such as the Construction Skills Village, thinkBIM network and creating links with the Dynamo North East cluster.

Stakeholder feedback indicates that the presence of high-value jobs and a knowledgeable and skilled workforce, access to 'green' supply chains, funding from LEPs, alongside wider trends towards energy efficiency and decarbonisation, may encourage the decision of clean growth sector businesses to locate in the City and YNYE regions. However, stakeholder engagement also indicates that 'clean growth' as a concept is not yet clearly defined. For example, the key sectors identified in one local authority Economic Growth Strategy – creative and digital, logistics, financial and professional services and scientific research and development – all contain business that have a clean growth remit to some extent although there is no specific strategy for attracting clean growth sector businesses as a stand-alone sector.

The following table summarises the scores for the different sectors. Based on all the evidence gathered and consultation, the sectors featuring higher in the priority list are circular economy and clean agri-tech. There are however significant linkages between the sectors themselves that need consideration. Our analysis has shown that the circular economy subsector has the largest comparative share of GVA and employment, however, as with 'clean growth', stakeholder engagement has indicated that the circular economy is a principle which can be applied across existing sectors, rather than being a silo. For example, Yorkshire Water's innovation initiative span 70 separate projects, taking a systemic approach which applies circular economy principles to a host of clean growth subsectors including agri-tech (e.g. high intensity vertical farms), smart community (e.g. data centres, digital expansion), bio-energy (heat recovery from sewage works) to name a few. Additionally, the construction sector is embracing the principles of the circular economy with clear objectives set for material recovery and sustainable construction which are unlikely to be abandoned post-Brexit. Another trend that is unlikely to weaken is digitalisation but there is an uneven spread that needs addressing with urgency. Information from stakeholder engagement suggests that specialist support for SMEs is needed to ensure that small and medium sized businesses can also benefit from the internet of things. Similarly, rural areas require targeted investment (e.g. improved rural broadband speeds) to ensure they are not left behind in terms of technological innovation. Given the large geographical area covered by YNYER, which includes several mainly rural districts (e.g. Ryedale, Craven), policy for this region should focus on ensuring that smart community technologies are deployed beyond the population

centres to avoid them being left behind. Within the City Region, policies should build on existing strengths (e.g. smart street lighting) to ensure that technologies continue to be developed and tested in areas where trials are viable.

4.3 Sectoral opportunities and ESDP and LIS priorities

The Leeds City Region Energy Strategy and Delivery Plan (ESDP) was adopted by the West Yorkshire Combined Authority in December 2018. It sets out how the ambition of the Strategic Economic Plan (SEP) for the City Region to become a resilient, zero carbon economy underpinned by high-quality green and blue infrastructure.

Among the sectors offering more opportunities to deliver its targets, but the nature of the sector alone, are low carbon transport. Specific actions within the sector include the provision of hydrogen vehicles (including refuelling stations) and electric vehicle charging infrastructure. The opportunities from the hydrogen sector include the following:

- potential for hydrogen generation through electrolysis from Humberside wind farms Humberside industrial cluster
- potential supply chain opportunities through the inclusion of new movers into the region (e.g. in South Yorkshire).

The National Hydrogen Summit at the University of Leeds (June 2019) brought together stakeholders from across the sector to develop a cohesive voice for hydrogen. Although the findings from the Summit are not yet available, they are likely to provide valuable expert input, with the intention of leading to a coherent policy position that can be widely supported (UK Energy Research Centre 2019).

The Local Inclusive Industrial Strategy (LIS) is currently being developed (and is currently in the consultation phase). The evidence gathering exercise has however concluded that although the Leeds City Region is a leader in education with an internationally significant concentration of universities producing high quality research, the region's businesses are among the UK's lowest investors in R&D. There is thus potential to increase both the level of innovation and the number of businesses innovating. Such opportunities are particularly prominent for the agri-food sector. The agri-tech sector has many potential opportunities involving both research and industry stakeholders. There are opportunities for the region in terms of Humberside being named as one of the Grand Challenge industrial clusters (although the geographical area covered by the cluster has not been defined).

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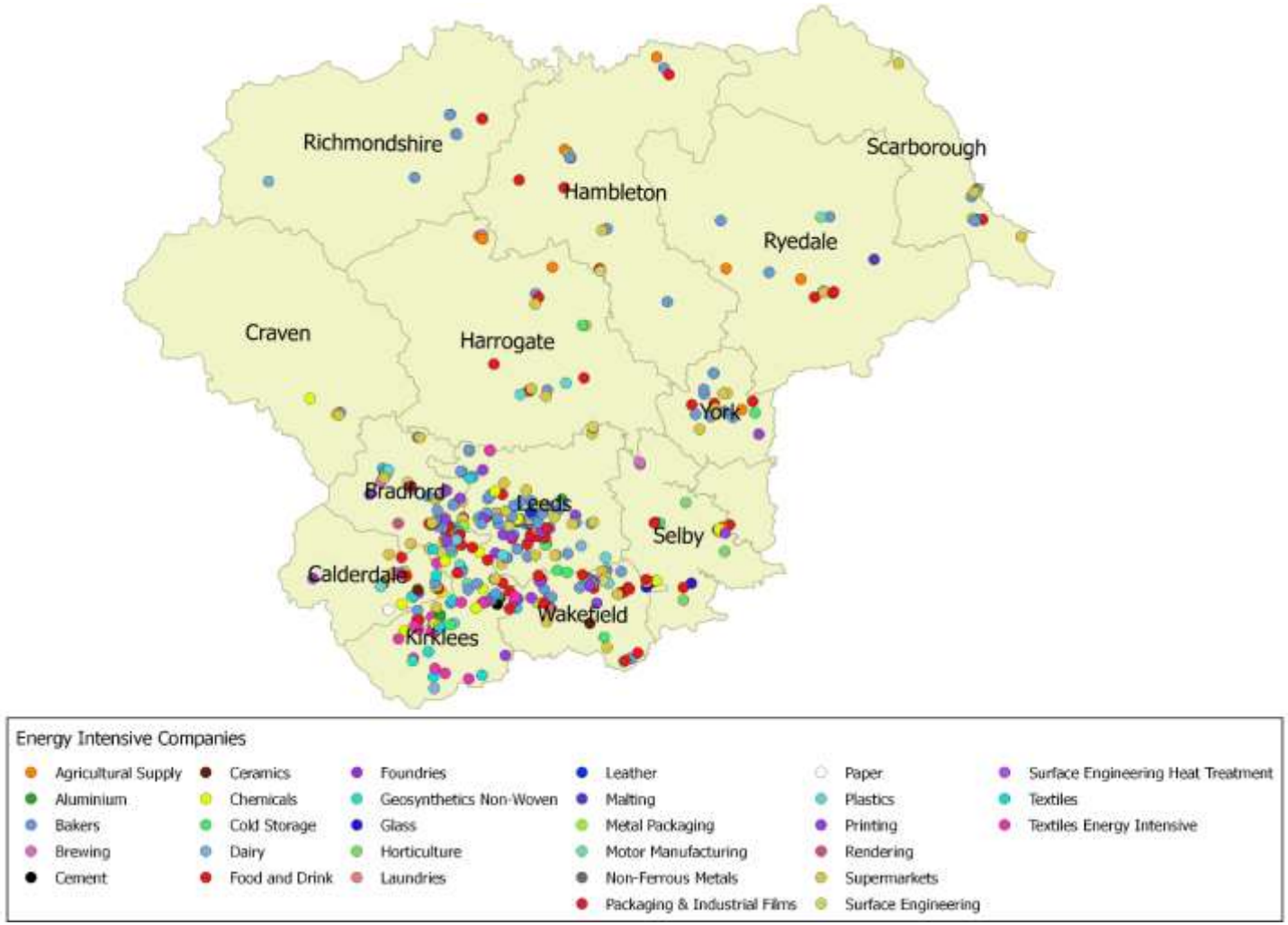
Appendices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Hambleton
Scarborough
Ryedale
Craven
Harrogate
York
Bradford
Leeds
Selby
Calderdale
Wakefield
Kirklees
Energy Intensive Companies
Agricultural Supply
Aluminium
Bakers
Brewing
Cement
Ceramics
Chemicals
Cold Storage
Dairy
Food and Drink
Foundries
Geosynthetics Non-Woven
Glass
Horticulture
Laundries
Leather
Malting
Metal Packaging
Motor Manufacturing
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Supermarkets
Surface Engineering
Surface Engineering Heat Treatment
Textiles
Textiles Energy Intensive