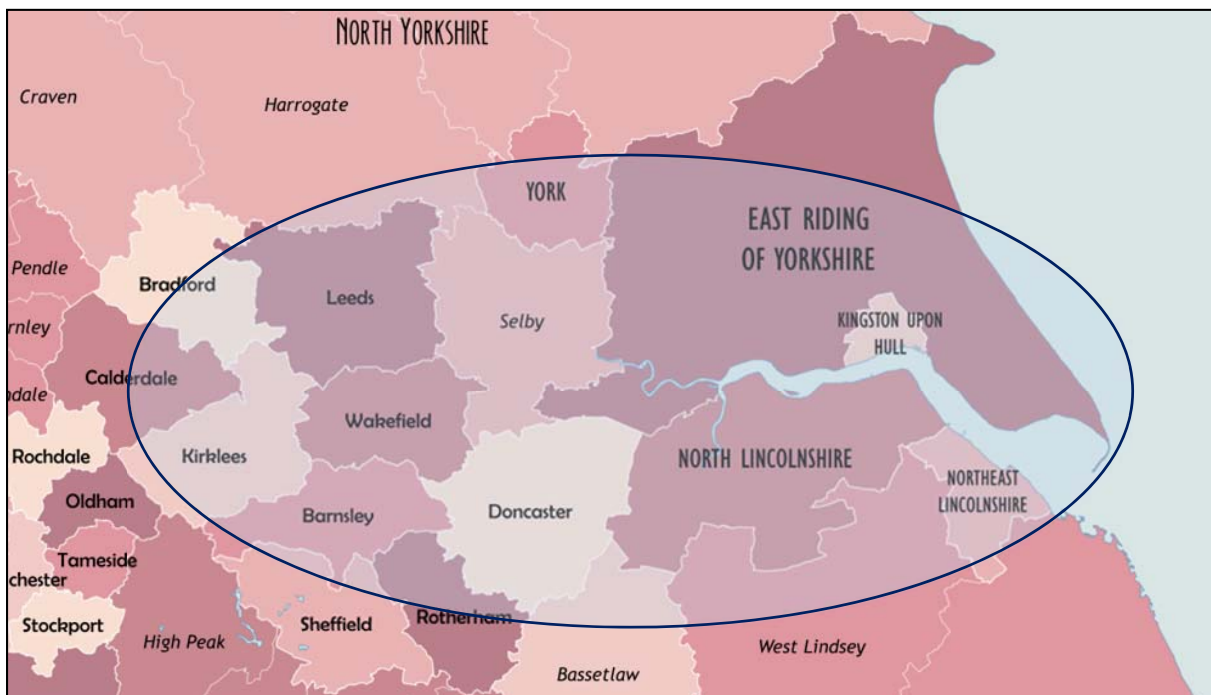


**CONFIDENTIAL**

**Industrial regions and climate change policies**

**YORKSHIRE AND THE HUMBER REGIONAL REPORT**



Prepared for:  
**ETUC**

Prepared by:  
**UK Trades Union Congress and Orion Innovations (UK) Ltd**

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## **Glossary**

BAU	Business as usual
BIS	Department for Business, Innovation and Skills
CCS	Carbon Capture and Storage
CCSA	Carbon Capture and Storage Association
CPS	Carbon Price Support
DECC	Department for Energy and Climate Change
EAF	Electric arc furnace
EIIs	Energy Intensive Industries
EIUG	Energy Intensive Users Group
EU ETS	European Union Emissions Trading System
FIT	Feed in Tariff
GMB	Britain's General Union
GVA	Gross Value Added
Ktoe	Thousand tonnes of oil equivalent
LEP	Local Enterprise Partnership
MtCO <sub>2</sub>	Million tonnes of carbon dioxide
NUTS	Nomenclature of Territorial Units for Statistics
ONS	Office for National Statistics
RDA	Regional Development Agency
RO	Renewables Obligation

## **Foreword**

This project was devised by the European TUC and is funded with support from the European Commission. The project has set out to explore low carbon industrial strategies and the relationship between the de-carbonisation and re-industrialisation agendas by examining progress in seven leading industrial regions across the EU.

This report examines Yorkshire and the Humber region in the UK, and together with the six other regional reports, North Rhein-Westphalia, Upper Silesia, Antwerp, Asturias, Lulea, North Sweden and one further location to be confirmed, will be submitted to the European Commission at a conference in Brussels in Spring 2016. It is also intended to present the interim findings of this and the six other regional studies at a high level event at the United Nations Framework Convention on Climate Change in Paris in December 2015.

This report has been prepared by Orion Innovations in partnership with the TUC and is based on a literature review, analysis of publicly available data, and engagement with more 30 organisations from across industry, the public sector, trade unions and academia, through questionnaires, interviews and a workshop. The TUC and Orion Innovations would like to thank all those who have contributed their advice and experience in the course of this study. We trust that their views are fairly reflected in this report.

## **1 Executive Summary**

### **1.1 Introduction**

The EU has made a commitment to cut greenhouse gas emissions to at least 40 per cent below 1990 levels by 2030<sup>1</sup>, confirming that this will be Europe's contribution to the UN's climate treaty talks in Paris in December 2015, and is proposing an 80 per cent to 95 per cent emissions reduction by 2050<sup>2</sup>. The required transformation of our industry and power sectors has far reaching implications for jobs, skills, productivity and investment; especially in Europe's industrial heartlands. At the same time the EU is also seeking to reindustrialise Europe and has set an objective that 20 per cent of the European economy should come from industry by 2020, up from 16 per cent today.

Similar commitments to tackling both climate change and regional reindustrialisation can be seen in the UK and have most recently been reflected in the manifesto pledges of the government elected in May 2015, including to rebalance the UK economy and devolve far-reaching powers over economic development and transport to English regions, notably through the Northern Powerhouse.

This project aims to explore low carbon industrial strategies and the interrelationship between the decarbonisation and reindustrialisation agendas by examining seven leading industrial regions across the EU, including Yorkshire and the Humber in the UK.

Evidence from this study suggests that we are only just beginning to address the huge industrial challenges involved in meeting the two objectives of emissions abatement and the re-growth of UK manufacturing industries.

### **1.2 Region general description**

The geographic focus for this study is Yorkshire and the Humber in the north east of England, which spans 90 miles from Bradford to the Humber Estuary. The region is home to the full range of the UK's foundation industries: the UK currently has six major oil refineries, two of which are located in Humberside; the region houses one of the UK's four key chemical industry clusters and four of the seven steel manufacturing sites; nine out of eighteen large glass industry sites; one of the UK's four cement manufacturing companies has a plant on Humberside; and there is significant representation of most other energy intensive industries (EIIs) including 17 ceramics and several paper industry manufacturing sites.

Yorkshire and the Humber also hosts a large number of the UK's gas and coal-fired power stations. One of the largest natural gas-fired power generating facilities in England is based at the Saltend Chemicals Park north of the Humber, and there are four gas fired power stations and a combined heat and power station south of the Humber. Three of the UK's largest coal-fired power stations are located in the Selby area.

The biggest of these power stations, Drax, emits more than 20 million tonnes of carbon dioxide (MtCO<sub>2</sub>) into the atmosphere each year, making it the largest single emitter in the UK.<sup>3</sup> It is also the anchor site for the White Rose Carbon Capture and Storage (CCS) Project, which gained acceptance from the Planning Inspectorate in December 2014 and may see the construction of the UK and Europe's first CCS regional network.<sup>4</sup>

In addition, progress in the region's decarbonisation and renewable energy agenda is underway at Alexandra Dock at Green Port Hull, where Siemens and its partner Associated British Ports are

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<sup>1</sup> 2030 framework for climate and energy policies, EU 2014: [www.ec.europa.eu/clima/policies/2030](http://www.ec.europa.eu/clima/policies/2030)

<sup>2</sup> European Commission, "A Roadmap for moving to a competitive low carbon economy in 2050", [http://eur-lex.europa.eu/resource.html?uri=cellar:5db26ecc-ba4e-4de2-ae08-dba649109d18.0002.03/DOC\\_1&format=PDF](http://eur-lex.europa.eu/resource.html?uri=cellar:5db26ecc-ba4e-4de2-ae08-dba649109d18.0002.03/DOC_1&format=PDF)

<sup>3</sup> According to the EU ETS Registry.

<sup>4</sup> [www.whiteroseccs.co.uk/](http://www.whiteroseccs.co.uk/)

investing £310m in the construction of a new wind turbine manufacturing facility.<sup>5</sup> It is estimated that 1,000 jobs will be directly created, and many more indirectly through the supply chain.

Due to be completed in 2015 is the Dong Energy construction of an off-shore wind farm at Westermost Rough, 35 kilometres from the Humber Estuary, where 35 turbines of 6MW capacity will provide enough electricity to power around 150,000 homes. As part of this project £11m of the government's Regional Growth Fund has been invested into the Grimsby Royal Dock.

Together the White Rose CCS, Siemens and Dong Energy projects have put Yorkshire and the Humber at the forefront of Europe's regional decarbonisation and renewable energy agenda. Nevertheless, emissions emanating from the energy intensive industries (EIIs) and power stations in Yorkshire and the Humber pose a challenge to the UK's carbon abatement strategy.

Industry has historically played a significant part in the economy of Yorkshire and the Humber, and remains the biggest contributor to the region's Gross Value Added (GVA). According to the latest data,<sup>6</sup> manufacturing as a whole contributes 15 per cent of GVA for Yorkshire and the Humber, making it the most industry-intensive region in the UK.

Since the new millennium Yorkshire and the Humber has experienced a significant decline in manufacturing employment. Manufacturing employment fell from more than 380,000 in 2000 (~16 per cent of the regional total) to less than 260,000 (~10 per cent of the regional total) a decade later. In line with the national uptick in employment levels, there has been a slight increase over the last eighteen months to 283,000 or 11 per cent of the regional total. Manufacturing continues to account for a substantially larger share of the Yorkshire and the Humber workforce than the national average of 7.8 per cent.<sup>7</sup>

There is no single unitary authority with responsibility for economic development in the Yorkshire and the Humber region. From the public authority perspective, a multitude of different organisations are actively involved in economic development, but no one entity encompasses the entire area covered by this study. Yorkshire and the Humber is now served by five Local Enterprise Partnerships (LEPs), two of which participated in this study, and 14 local authorities.

There are also a number of non-governmental forums that foster discussion with and help to influence the decision makers. These include both national bodies with a regional focus and exclusively regional organisations.

### **1.3 Region and the low carbon transition**

The dominance of foundation industries and power generation in Yorkshire and the Humber is reflected in energy consumption and associated emissions.

Yorkshire and the Humber is the second biggest energy consuming region in the UK. It has historically emitted roughly 10 per cent of the UK's CO<sub>2</sub> emissions, with industrial activity accounting for half of these emissions.<sup>8</sup>

Energy use and emissions can be measured at source or use. Industrial emissions within Yorkshire and the Humber are estimated at 21 MtCO<sub>2</sub> per annum. If however emissions from power generation are included irrespective of location of use, then industrial emissions within the region more than double to well in excess of 50 MtCO<sub>2</sub> per annum.<sup>9</sup>

The 27 largest carbon dioxide emitting sites in Yorkshire and the Humber include 18 industrial sites and 9 power generation sites. Together they emit in excess of 44 MtCO<sub>2</sub> every year<sup>10</sup>. The

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<sup>5</sup> [http://www.siemens.co.uk/en/news\\_press/index/news\\_archive/2014/major-uk-offshore-wind-manufacturing-site-to-be-built-by-siemens.htm](http://www.siemens.co.uk/en/news_press/index/news_archive/2014/major-uk-offshore-wind-manufacturing-site-to-be-built-by-siemens.htm); [http://www.siemens.co.uk/en/news\\_press/index/news\\_archive/2014/siemens-announces-green-port-hull-wind-manufacturing-site-improvements.htm](http://www.siemens.co.uk/en/news_press/index/news_archive/2014/siemens-announces-green-port-hull-wind-manufacturing-site-improvements.htm)

<sup>6</sup> Published in February 2015, referring to 2012. There is a lag in the collection and scrutiny of official data in this level of detail. Source: [www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts1-data-tables.xls](http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts1-data-tables.xls)

<sup>7</sup> ONS, March 2015: see JOBS05

<sup>8</sup> Local and Regional CO<sub>2</sub> Emissions Estimates for 2005-2012, Ricardo-AEA, September 2014

<sup>9</sup> Based on EU ETS Registry data, 2014

<sup>10</sup> Ibid.

TUC estimates there are at least 20,000 people directly employed at these 27 sites and thousands more contractors and employees in supply chains.

The UK, along with EU competitors in Germany, Belgium, Denmark, Norway, the Republic of Ireland and Sweden, have secured EU approval to provide transitional financial compensation ('State Aid') to energy intensive industries to help offset the direct and indirect costs of national and EU energy and climate change policies. These policy costs have added significantly to the energy prices paid by EIIs and eroded their ability to invest in low carbon technologies. Support measures vary widely across the EU but the cost burden of government policies appears to be much heavier in the UK than among EU competitors, and its relief measures appear to be less generous in scope and duration.

Government figures<sup>11</sup> reveal that in 2014 national policies added a fifth (18 per cent) to the electricity prices of foundation industries benefitting in full from government support, such as steel, chemicals and cement. But in wholly excluded sectors, such as glass and ceramics, a gas-intensive sector ineligible for support, government policies have pushed up energy prices by 26 per cent, and are heading to a 59 per cent increase by 2020.

In 2015, the Budget announced further reforms to reduce energy costs among EIIs, expected to save them an additional £25m in 2015-16. The TUC welcomed this further support, but nevertheless remains concerned over the scale and scope of the overall package of measures, which, for example, is considerably less generous than the government's £4.3bn in tax breaks for the oil and gas industry announced over the past three years.<sup>12</sup>

The TUC estimates just 53 UK companies have received compensation from the various government support packages, representing about one per cent of the UK's 5,100 foundation industry enterprises. Nine firms in receipt of government support are in the Yorkshire and the Humber region.

Vital though transitional support programmes are, the future of our intensive industries lies in an ambitious investment programme in "innovative low carbon technology solutions."<sup>13</sup> In spring 2015, the government published a series of national low carbon technology roadmaps for eight of the energy intensive industries. Many of these industries within our study region contributed to these studies, and the conclusions will undoubtedly impact on their future.

These roadmaps identify the technology solutions needed to deliver target emissions abatement, and highlight the importance of the successful development of CCS, including the region's White Rose CCS project. Decarbonisation of the grid is also an essential contributor across all sectors to indirect emissions reduction. White Rose is funded both by the UK's carbon capture and storage demonstration fund and a €300m European Union grant<sup>14</sup>, offering a unique opportunity in Europe to develop a CCS network for both power and industrial decarbonisation.

The reports contain the primary drivers and barriers associated with the uptake of the required technologies and a set of strategic conclusions for driving forward decarbonisation. However, these have yet to be reflected in a programme of actions. The value of the investment required ranges from £6bn to £16bn.

In order to avoid carbon leakage, all of the above investment needs to be implemented without undermining industry competitiveness relative to international competition, but mechanisms for achieving this are yet to be defined.

In Europe, low carbon roadmaps "elaborated by industrial sectors show a clear need for the development and large scale demonstration of innovative low carbon industrial processes, as well as new high added value low carbon products", according to the EU's *Policy framework for climate*

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<sup>11</sup> DECC: *Energy Prices and Bills*, 2014

<sup>12</sup> <http://touchstoneblog.org.uk/2015/03/no-budget-for-a-sustainable-industrial-future/>

<sup>13</sup> *Technology Innovation for Energy Intensive Industry in the UK*, Centre for Low carbon Futures for the Energy Intensives Users Group (EIUG) and TUC, July 2011

<sup>14</sup> [www.whiteroseccs.co.uk/white-rose-ccs-project-secures-award-decision-on-european-ner300-funding](http://www.whiteroseccs.co.uk/white-rose-ccs-project-secures-award-decision-on-european-ner300-funding)



*and energy in the period from 2020 to 2030. The EU has made the significant proposal to increase funding for industrial innovation through an expanded use of funds drawn from the EU ETS scheme. The ETS directs revenues towards “the demonstration of innovative low carbon technologies in the industry and power generation sectors.”*

#### **1.4 Local stakeholder views**

Orion Innovations and the TUC engaged with more than 40 individuals from 30 organisations across industry, the public sector, LEPs, trade unions, and academia in order to explore their perspectives on regional low carbon industrial strategy and Yorkshire and the Humber in particular. Insights were gathered through questionnaires, interviews and a workshop.

Although participants expressed a broad range of views, in part reflective of the organisations and the sectors in which they operate, there was an enormous amount of common ground with regard to existing governance structures within Yorkshire and the Humber, the need for regional low carbon strategy, and the challenges and opportunities associated with effective delivery.

There is consensus that it is not possible to look at energy, environment and industrial policy separately from one another. The three need to be woven together nationally and regionally, and must recognise the realities and constraints of globalisation.

There is widespread concern that current UK energy and environmental policies are having a serious and detrimental impact on the energy costs, competitiveness, and ability and willingness of EIs to make long term investment in the UK.

There is also a broader issue, yet to be resolved, regarding who bears the cost of industrial decarbonisation. In the power sector there is broad acceptance that society should pay through energy bills. The question of who will finance the technological innovation required for those industries that operate in globally competitive markets is particularly challenging and in the absence of suitable policies, runs the risk of causing “carbon leakage” – the loss of jobs, plant and investment to countries with weaker or no climate change policies.

Yorkshire and the Humber is seen as having substantial strategic advantages in terms of access to energy resources (oil, gas, power and offshore wind), infrastructure (port facilities), and the breadth and strengths of foundation industries (oil refining, chemicals, steel, cement etc.).

Ensuring that these foundation industries develop and invest in the most technically advanced and energy efficient processes and technologies will ensure that Yorkshire and the Humber continues to make a significant contribution to all that we produce and consume in the UK.

For this to happen there is a need for:

- A clearly defined low carbon industrial strategy and leadership for its implementation, whether at a regional or national level.
- Policies that deliver decarbonisation and energy security without undermining the competitiveness of UK industry;
- Long term energy, environmental and industrial policy certainty, reflective of the long lifetime of EII capital investment decisions;
- Investment in the innovation needed to deliver the technologies that underlie the government’s 2050 industrial energy efficiency roadmaps;
- Investment in the accompanying skills and training needed to develop, deliver and deploy these technologies;
- Ready access to substantial investment finance and implementation of business policies that address the cost of capital, competition for capital, and the business case for investment in low carbon solutions.
- Support to encourage and facilitate the cross-sector collaboration needed to deliver solutions such as CCS or heat networks;

- Consultation and engagement between working people, trade unions and employers in order to ensure a just transition that builds high value jobs, and enhances productivity.

For many foundation industries, notably, steel, chemicals and cement manufacture, delivery of the government's 2050 industrial energy efficiency roadmaps is highly dependent on access to CCS infrastructure.

The White Rose CCS Project has the potential to deliver a long term competitive advantage both for energy generation and the steel, chemical and cement industries in Yorkshire and the Humber region. However there is concern about the pace of development and a belief that there is a small window of opportunity that needs to be grasped. Specific recommendations for government related to CCS include the following:

- Enable final investment decisions on the two CCS competition projects by early 2016;
- Retain the £1bn capital funding for the CCS competition;
- Allow the CCS competition projects access to Contracts for Difference in the current Levy Control Framework;
- Support the development of further CCS projects in parallel with the first two, not in sequence;
- Urgently develop an incentive to invest in industrial CCS similar to the Contract for Differences for energy projects.

No single organisation has currently assumed overall responsibility for facilitating the Yorkshire and the Humber region's drive for energy and resource productivity. LEPs are believed to offer a useful platform and to have the potential to provide an appropriate regional governance structure for effective development and deployment of regional low carbon industrial strategy. However, there is a need for stakeholders, including trade unions, business and others, to take a proactive approach to exploiting these governance structures. A number of stakeholders recommended the creation of regional forum to work with the LEPs, and low carbon working groups focused on mutually beneficial projects.

There is considerable appetite amongst local and national government, businesses, and trade unions to ensure a just transition to a low carbon economy, the retention and creation of high quality sustainable employment, and delivery of enhanced productivity and value added. It is widely recognised that this timely transition would make a significant contribution to the development and success of the Northern Powerhouse agenda. The deployment of the 2050 industrial decarbonisation roadmaps are considered to be a key determinant of the sustainable future for the industries assessed in this report, and there is broad recognition amongst participants in this project that all parties, including trade unions, have a leadership role to play in ensuring the necessary collaboration between government, business, local agencies, academia, and society as a whole.

## **2 Introduction**

### **2.1 Context**

Mounting scientific evidence of potentially damaging anthropogenic climate change has resulted in both national and international efforts to stem the growth in greenhouse gas emissions. The EU has made a commitment to cut greenhouse gas emissions to at least 40 per cent below 1990 levels by 2030<sup>15</sup>, confirming Europe's contribution to the UN's climate treaty talks in Paris, December 2015.

At the same time there is growing concern about industrial performance and the resulting imbalance in European economies. In recent years European companies have moved production to cheaper, less regulated countries, or have lost competitiveness to imports.

The European Commission has outlined plans to reindustrialise Europe, boosting growth and employment. It has set an objective that 20 per cent of the European economy should come from industry by 2020, up from 16 per cent today. Similar drivers and objectives can be seen in the UK, and have most recently been reflected in the manifesto commitments of the government elected in May 2015, including support for modern industrial strategies to rebalance the UK economy and to devolve far-reaching powers over economic development and transport.

The government continues to support the Climate Change Act of 2008, which commits the UK to carbon emission reduction targets of at least 34 per cent on 1990 emissions by 2020, and 80 per cent by 2050. At the same time the government has committed itself to 'rebalancing the economy' (a term used to describe the equitable spread of economic growth across all UK regions) and to supporting modern industrial strategies; and in this spirit has emphasised the key role of the north of England in driving economic growth. The government has coined the term 'Northern Powerhouse' as a vision for a thriving part of the UK economy to which energy intensive (and productive) industries will be a significant contributor.

Nevertheless the scale and pace of effort needed to achieve these environmental and industrial objectives poses major challenges, in particular for energy intensive industrial regions. The UK government's 2011 Carbon Budget Order suggests that decarbonising the UK economy could reduce overall industry emissions of up to 70 per cent by 2050. Currently two thirds of these emissions come from eight energy intensive industry sectors: cement, chemicals, food and drink, glass, iron and steel, oil refining, and pulp and paper. Between them, these sectors employ around 2 per cent of the UK's workforce and contribute an annual £50bn to the UK economy.

A recent DECC/BIS study examined potential low carbon pathways to 2050 for these industries<sup>16</sup>, and estimated that the net present value (NPV) capital costs associated with delivery will be between £6bn and £16bn.

### **2.2 Objectives**

This project aims to explore low carbon industrial strategies, and the interrelationship between the de-carbonisation and re-industrialisation agendas, by examining seven leading industrial regions across the EU: Yorkshire and the Humber (UK); North Rhein-Westphalia (DE); Silesia (PL); Flemish region, Antwerp area (BE); Asturias (ES); Lulea, North Sweden (SW); and one further location to be confirmed.

The project will aim to take stock as to what business, government and trade union stakeholders think and contribute at a regional level towards realising the transition to a low carbon economy and European re-industrialisation.

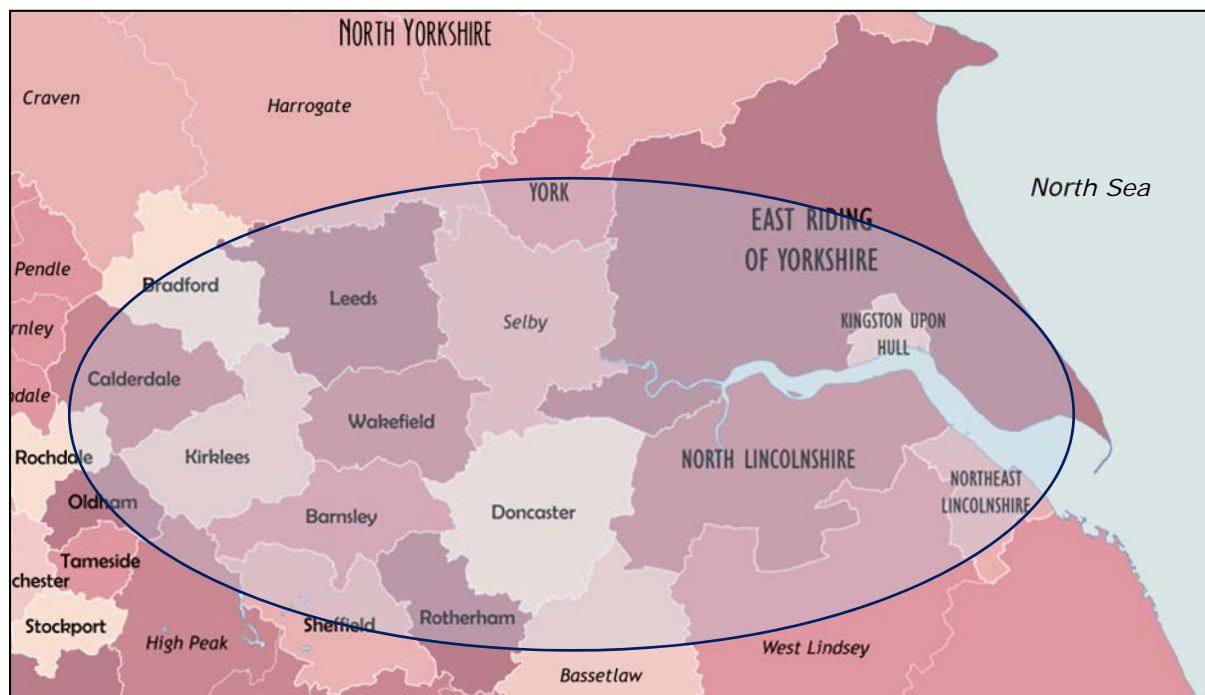
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<sup>15</sup> 2030 framework for climate and energy policies, EU 2014: [www.ec.europa.eu/clima/policies/2030/](http://www.ec.europa.eu/clima/policies/2030/)

<sup>16</sup> Industrial decarbonisation and energy efficiency roadmaps to 2050, March 2015. Prepared for DECC and BIS by WSP, Parsons Brinckerhoff and DNV GL.

### 3 Region general description

#### 3.1 Overview



**Figure 1: Administrative regions of Yorkshire and the Humber and geographic focus of this study**

The geographic focus for this study is Yorkshire and the Humber, a region in the north east of England (Figure 1), which spans 90 miles from Bradford to the Humber Estuary. It encompasses most of the Leeds City and Humber Local Enterprise Partnership zones (LEPs)<sup>17</sup>, and part of the Sheffield, York and North Yorkshire, and Greater Lincolnshire LEPS. Much of the analysis outlined below through necessity makes use of data available for Yorkshire and the Humber (NUTS1<sup>18</sup>) and the Leeds City and Humber LEPS (NUTS 3).

#### 3.2 Main industrial activities and trends

Yorkshire and the Humber is home to the full range of the UK's 'foundation industries' which have been established here since the beginning of the first Industrial Revolution.

The UK currently has six major oil refineries of which two, Total Lindsey and Phillips 66, are located in the study region.

The region is home to one of the UK's four key chemical industry clusters. The Saltend Chemicals Park, a major chemicals manufacturing site, lies north of the Humber estuary on the outskirts of Hull. It was founded by BP in 2009 and is now home to a range of energy intensive chemical manufacturers including BP Chemicals, Ineos, Yara, Nippon Gohsei, and Air Products. The site shares an established infrastructure and the provision of services, feedstocks and utilities.

The Saltend Cogeneration Company, one of the largest natural gas-fired power generating facilities in England is based at the Saltend Chemicals Park and satisfies the electricity and steam requirements of the site. The balance of the plant's output is sold into the UK power market.

Chemicals operations exist elsewhere in Yorkshire and the Humber including notably BASF in Bradford (formerly Allied Colloids), which is in the process of expanding operations.

<sup>17</sup> LEPS are partnerships between local authorities and businesses that decide investment priorities for roads, buildings and facilities.

<sup>18</sup> Nomenclature of Territorial Units for Statistics. Due to UK official data definition parameters, data pertaining to manufacturing provide the best proxy to assess the economic contributions of industrial and power industries to regional GVA.

The UK iron and steel industry is dominated by five large international companies, TataSteel Europe Limited, SSI, Outokumpu, Sheffield Forgemasters and Celsa Steel UK Ltd. Together they have seven manufacturing sites in the UK (three integrated steel manufacturing sites and four electric arc furnace (EAF) sites. Four of these seven sites are in Yorkshire and the Humber: Tata Steel's integrated manufacturing site in Scunthorpe and EAF site in Rotherham, and the Outokumpu and Sheffield Forgemasters EAF sites in Sheffield.

Two of the three flat glass companies in the UK have their sites located in the Humber area and four out of six large UK container glass companies have at least one site in Yorkshire. The area is ideally placed for energy, raw materials and logistics.

Cemex, one of the UK's four cement manufacturing companies has a manufacturing plant at South Ferriby on Humberside, and there is representation in Yorkshire and the Humber of most other energy intensive industries including 17 ceramics and several paper industry sites.

Yorkshire and the Humber is also home to a large number of the UK's gas and coal-fired power stations. In addition to the Saltend Cogeneration Company, there are four gas fired power stations and a combined heat and power station south of the Humber at Keadby, Glandford Brigg, Killingholme (2 plants) and Immingham. Three of the UK's largest coal-fired power stations are located in the Selby area and were built to exploit the Selby coalfields.

Together, these plants directly employ at least 20,000 people and have high levels of representation from Community, Prospect, GMB, Unite and UNISON.

The biggest of these power stations, Drax, emits more than 20 MtCO<sub>2</sub> into the atmosphere each year, making it the largest emitter in the UK and the 6<sup>th</sup> biggest coal-fired CO<sub>2</sub> polluter in Europe.<sup>19</sup> It is the anchor site for the White Rose Carbon Capture and Storage (CCS) Project, which gained acceptance from the Planning Inspectorate in December 2014 and will see the construction of the UK's first CCS facility.<sup>20</sup> White Rose is funded both by the UK's carbon capture and storage demonstration fund and a €300m grant<sup>21</sup>, offering a unique opportunity in Europe to develop a CCS network for both power and industrial decarbonisation.

Additional decarbonisation progress in Yorkshire and the Humber is in process at Alexandra Dock at Green Port Hull, where Siemens and its partner Associated British Ports are investing £310m in the construction of a new wind turbine manufacturing facility.<sup>22</sup> Set to manufacture 600 blades for exportation per year, it is estimated that 1,000 jobs will be directly created, and many more indirectly through the supply chain.

Dong Energy is also constructing an off-shore wind farm at Westermost Rough, 35 kilometres from the Humber Estuary, where 35 turbines of 6MW capacity covering a total area of 35km<sup>2</sup> will provide enough electricity to power around 150,000 UK homes. Dong has invested £11.5m into the Grimsby and Royal Dock, of which £11m was granted from the government's Regional Growth Fund. Construction is expected to be completed in mid-2015.

Together the White Rose CCS, Siemens and Dong Energy projects have firmly put Yorkshire and the Humber at the forefront of Europe's regional decarbonisation agenda and demonstrate enthusiasm and momentum behind the low carbon agenda in the region, driven by investors and regional and national authorities.

Industry has historically played a significant part in the economy of Yorkshire and the Humber, and remains the biggest contributor to the region's Gross Value Added (GVA). According to the latest data,<sup>23</sup> manufacturing contributes 15 per cent of GVA for Yorkshire and the Humber, making it the

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<sup>19</sup> According to the EU ETS registry.

<sup>20</sup> [www.whiteroseccs.co.uk/](http://www.whiteroseccs.co.uk/)

<sup>21</sup> [www.whiteroseccs.co.uk/white-rose-ccs-project-secures-award-decision-on-european-ner300-funding](http://www.whiteroseccs.co.uk/white-rose-ccs-project-secures-award-decision-on-european-ner300-funding)

<sup>22</sup> [www.siemens.co.uk/en/news\\_press/index/news\\_archive/2014/major-uk-offshore-wind-manufacturing-site-to-be-built-by-siemens.htm](http://www.siemens.co.uk/en/news_press/index/news_archive/2014/major-uk-offshore-wind-manufacturing-site-to-be-built-by-siemens.htm); [www.siemens.co.uk/en/news\\_press/index/news\\_archive/2014/siemens-announces-green-port-hull-wind-manufacturing-site-improvements.htm](http://www.siemens.co.uk/en/news_press/index/news_archive/2014/siemens-announces-green-port-hull-wind-manufacturing-site-improvements.htm)

<sup>23</sup> Published in February 2015, referring to 2012. There is a lag in the collection and scrutiny of official data in this level of detail. Source: [www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts1-data-tables.xls](http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts1-data-tables.xls)

most industry-intensive region in the UK. The GVA in this region in 2012 was £96.3bn, of which £14.2bn was generated by manufacturing industries.

Manufacturing contribution to GVA is higher than the national average in each of the three primary LEP regions. This is particularly true of the Humber region where manufacturing contribution as a proportion of total GVA is more than twice the national average (see Figure 2).<sup>24</sup> However, in line with the rest of the UK, manufacturing contribution to GVA has been in decline since 1998.

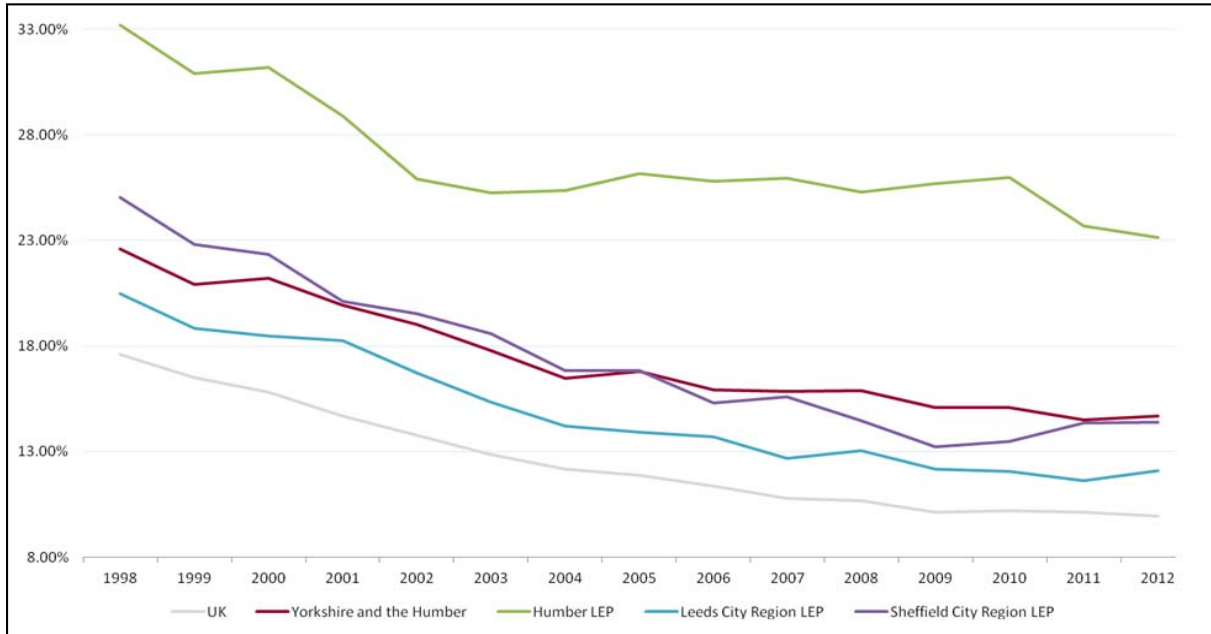


Figure 2: Manufacturing contribution to GVA, 1998 - 2012

Manufacturing GVA in Yorkshire and the Humber contributed an increasing proportion of the national manufacturing GVA throughout the decade leading up to the economic downturn. Since 2011 it has made a slight recovery, but remains well below its pre-crisis peak (Figure 3).<sup>25</sup>

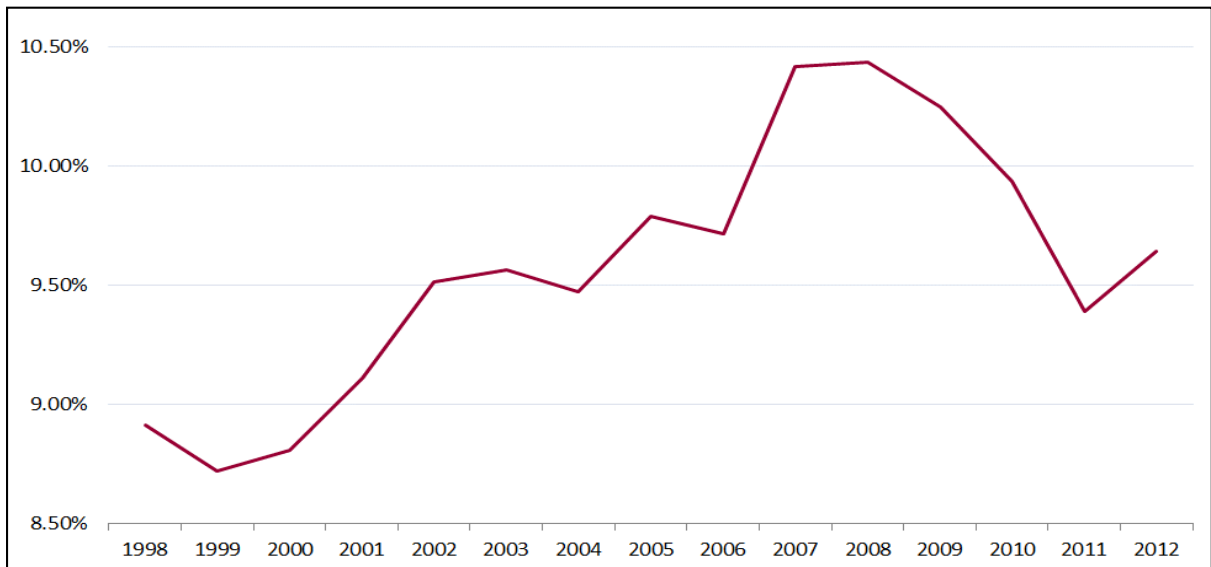


Figure 3: Yorkshire and the Humber contribution to national manufacturing GVA

<sup>24</sup> GVA for Local Enterprise Partnerships - Reference Tables (published 19/02/2015) [www.ons.gov.uk/ons/rel/regional-trends/regional-economic-analysis/gva-for-local-enterprise-partnerships--1997-2013/ref-gva-leps.xls](http://www.ons.gov.uk/ons/rel/regional-trends/regional-economic-analysis/gva-for-local-enterprise-partnerships--1997-2013/ref-gva-leps.xls); The UK GVA source is taken from the Blue Book time series.

<sup>25</sup> Calculations based on February 2015 prices (Yorkshire and the Humber) and October 2014 prices (UK)

The manufacturing GVA in Yorkshire and the Humber of £14.2bn in 2012 is profiled in Figure 4. The largest manufacturing sector by GVA is food and drink (£2.7bn), followed by basic metals such as steel (£2.3bn), and rubber, plastic, and non-metallic mineral products (£1.5bn). The energy intensive industry sectors of iron and steel, chemicals (including rubber plastic and non-metallic mineral products), and oil refining together account for 38 per cent of GVA (£5.5bn). The inclusion of other energy intensive industry sectors such as ceramics, glass and paper, is likely to increase the contribution to GVA to nearer 50 per cent in Yorkshire and the Humber.

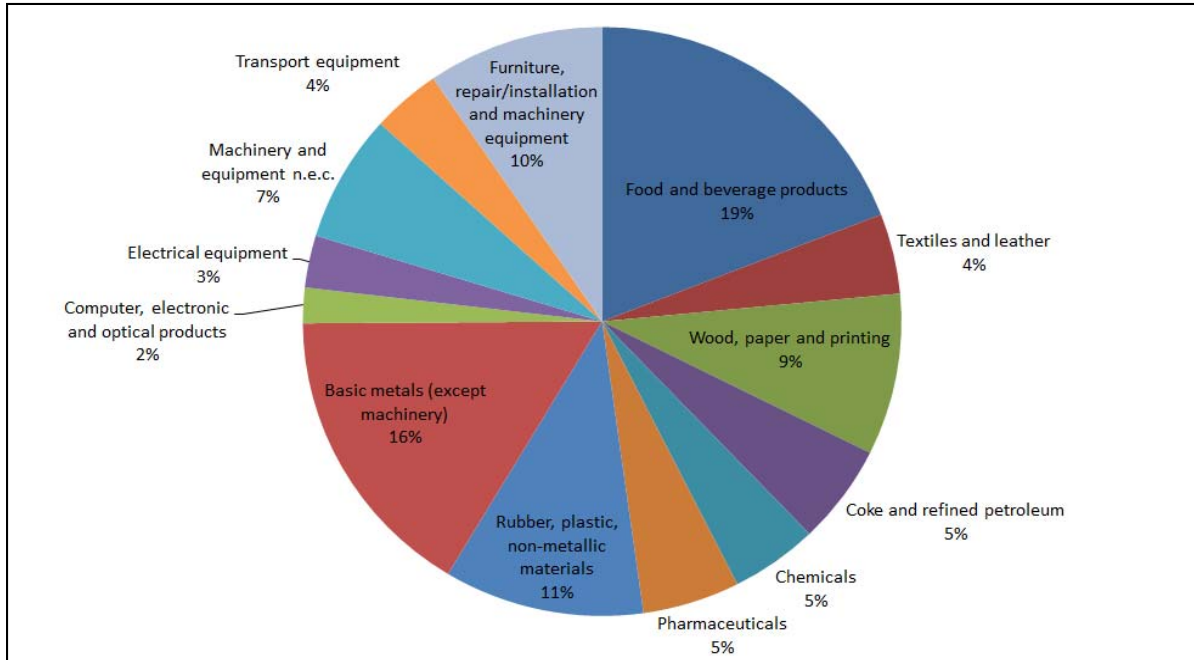


Figure 4: Profile of Yorkshire and the Humber manufacturing GVA, 2012<sup>26</sup>

Closer analysis of four manufacturing classes most obviously linked to high energy use and emissions show that chemicals GVA is significantly lower in 2012 than in 1998; metal and metal products has regained significant ground since 2008 but is also still below 1998 levels; rubber and plastics have fared slightly better, while coke and refined products have reflected the significant rise and recent fall in the value of crude oil (see Figure 5).

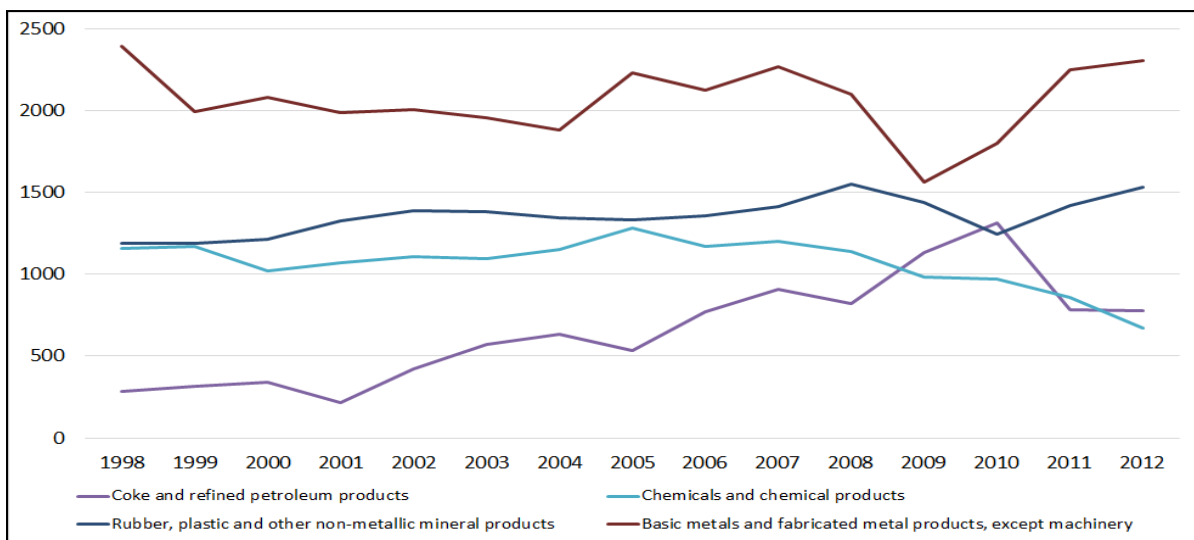


Figure 5: Yorkshire and the Humber EII sector GVA 1998-2012 (2012 £M)

<sup>26</sup> ONS, 18 December 2014: Regional GVA (Production Approach) [www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts2-data-tables.xls](http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--production-approach-/december-2014/rft-nuts2-data-tables.xls)

### 3.3 Employment trends

Unemployment within Yorkshire and the Humber has remained stubbornly above the national average since the recession in 2008. As shown in Figure 6 (where ‘November’ relates to the previous year), the rise in unemployment in the aftermath of the recession was more pronounced in the region than for the UK as a whole. At 6 per cent it remains 0.3 percentage points above the national average<sup>27</sup>, although unemployment in the region has fallen considerably faster than the national average over the past year.

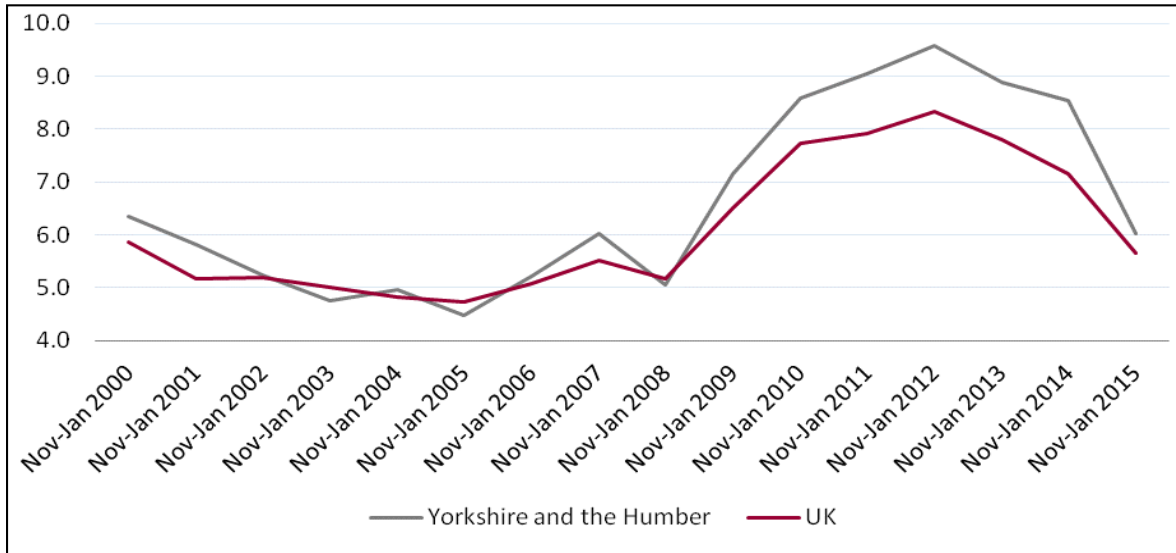


Figure 6: Comparative unemployment rates (per cent)

Since the new millennium Yorkshire and the Humber has experienced a significant decline in manufacturing employment. Manufacturing employment fell from more than 380,000 in 2000 (~17 per cent of the regional total) to less than 260,000 (~10 per cent per cent of the regional total) a decade later. In line with the national uptick in employment levels, there has been a slight increase over the last eighteen months to 283,000 or 11.5 per cent of the regional total (See Figure 7). Manufacturing continues to account for a substantially larger share of the Yorkshire and the Humber workforce than the national average of 7.8 per cent.<sup>28</sup>

<sup>27</sup> ONS, Labour Market Statistics, April 2015

<sup>28</sup> ONS, March 2015: see JOBS05



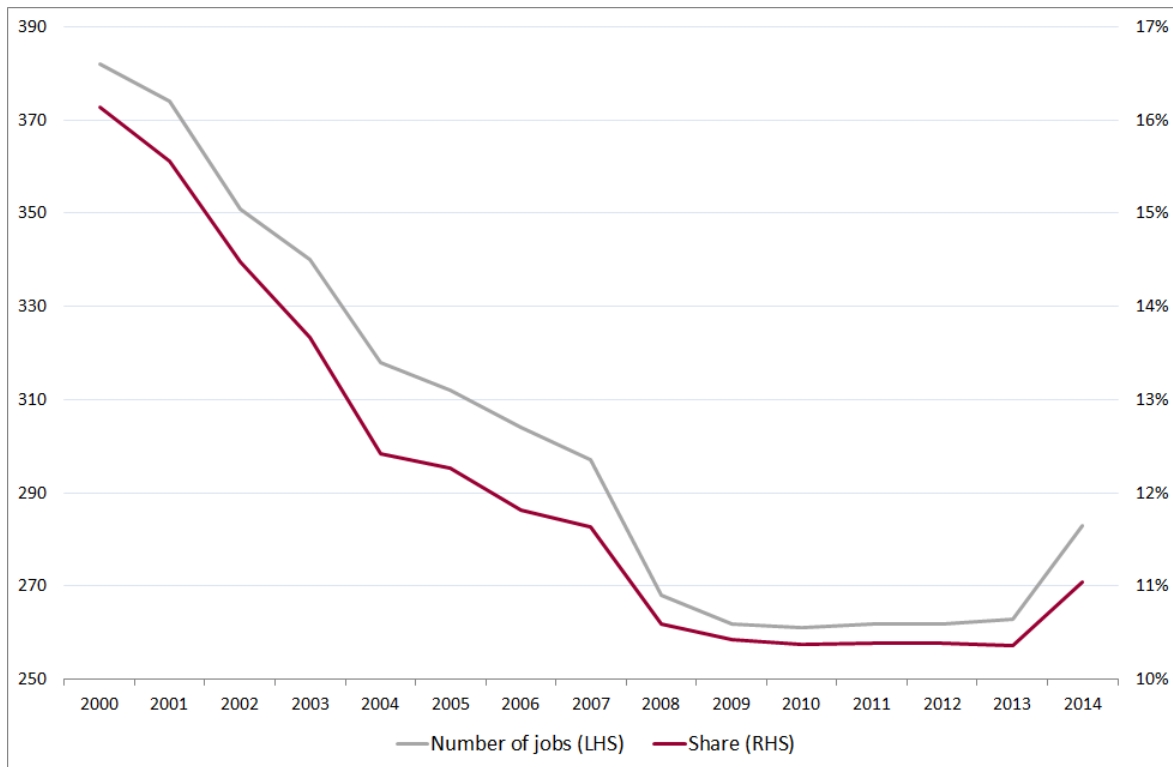


Figure 7: Jobs in manufacturing (thousands) and percentage of workforce employed in manufacturing in Yorkshire and the Humber 2000-2014

### 3.4 Supporting and promoting economic growth: social dialogue

The incoming government has set out a vision for a ‘Northern Powerhouse’, first set out by UK Chancellor George Osborne in 2014, in which investment is focussed on uniting the northern cities, providing modern transport connections; strong backing for their science and universities; support for creative clusters; and local power and control.

From a public authority perspective in Yorkshire and the Humber, a multitude of different organisations are engaged on energy and economic growth issues, but no one entity encompasses the entire area covered by this study<sup>29</sup>.

The Conservative-Liberal Democrat Coalition replaced former regional development bodies with 39 Local Enterprise Partnerships (LEPs) across England. Yorkshire Forward, the Regional Development Agency responsible for Yorkshire and the Humber, closed at the end of 2011.

LEPs are partnerships between local authorities and businesses, responsible for determining priorities for investment in roads, buildings and facilities in the area. In a number of cases, Local Authorities belong to more than one LEP.

This study region is now served by five LEPs and 14 local authorities:

- All of the Humber LEP – incorporating Kingston upon Hull, East Riding of Yorkshire, North Lincolnshire and North East Lincolnshire.
- Most of Leeds City LEP – incorporating Barnsley, Bradford, Calderdale, Kirklees, Leeds City, Selby, and Wakefield. York, Craven and Harrogate are also included within the LEP but are largely rural and do not fall under the region covered by this report.

<sup>29</sup> Between 1998 and 2010, nine Regional Development Agencies (one for each of the NUTS 1 regions) were responsible for generation and delivery of economic development plans in England, providing a single unified authority with overarching vision for each region.

- Part of the Sheffield LEP – namely Sheffield, Rotherham, and Doncaster. Other Local Authorities within this LEP are Barnsley (overlapping with Leeds City LEP), Bassetlaw, Bolsover, Chesterfield, Derbyshire Dales, and North East Derbyshire.
- Part of Greater Lincolnshire LEP – namely North Lincolnshire and North East Lincolnshire. This LEP covers the area from the Humber to Wash.
- Part of York and North Yorkshire LEP – namely Selby and East Riding of Yorkshire. Other Local Authorities within this LEP are Craven, Hambleton, Harrogate, Richmondshire, Ryedale, Scarborough, and York.

In addition to the 39 national LEPs, 24 Local Enterprise Zones were created that offer a range of incentives to encourage business start-up or expansion, including business rate discounts, and simplified Local Authority planning. These include the Sheffield City Region and the Humber Renewable Energy Super Cluster and Green Port Corridor.

The government is also giving cities greater powers to grow their economies via City Deals; agreements between cities and government that allow cities responsibility for business growth and the allocation of public money. Leeds and Sheffield City regions were included in the eight core city deals created in the first wave in 2012. This approach was reinforced by the 2015 Conservative manifesto which continued to pledge devolution of power, in particular to large cities which choose to have elected mayors.

In 2014, Bradford, Calderdale, Kirklees, Leeds, and Wakefield councils, alongside the Leeds City Region LEP combined forces to form the West Yorkshire Combined Authority; responsible for the strategies to drive growth and investment in the region, with powers and funding devolved from government to manage the £1bn transport investment and £400m economic investment in the region.

There are a number of non-governmental forums that foster discussion with and help to influence the decision makers. These include both national bodies with a regional focus and exclusively regional organisations. Examples of the former are:

- Energy Intensive Users Group, which campaigns on behalf for secure industrial energy supplies at internationally competitive prices.
- Trade Associations (e.g. Chemical Industries Association, British Ceramics Confederation), which not only offer advice and support to members, but play a significant role in challenging the government on policy issues such as competitiveness and climate change.
- Sector specific organisations such as the Chemistry Growth Partnership<sup>30</sup> and British Glass.

There are also regional initiatives that bring together interested stakeholders to develop a common approach to sector development and other regional issues. Examples are:

- The Yorkshire and Humber Carbon Capture and Storage Partnership (YHCCSP), established to represent the interests of its members in the development of a carbon capture and storage network for Yorkshire and the Humber.
- Humber Chemical Focus (HCF CATCH), an industry led partnership supporting the process, energy, engineering and renewable industries across the UK, and in Yorkshire and the Humber in particular.
- YCF, a not-for-profit membership organisation for the Manufacturing Industry and its supply chain which operates across sectors to share best practice and address common challenges.

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<sup>30</sup> Sector stakeholders were involved in developing a chemicals sector Growth Strategy, supported by the Department for Business Innovation and Skills (BIS). The Chemistry Growth Partnership was formed to oversee and ensure the development of an action plan to drive the implementation of the recommendations resulting from the Chemistry Growth Strategy. Members includes government, business and trade unions representatives.

## 4 Region and low carbon transition

### 4.1 Regional energy generation, use and emissions

Energy consumption and emissions within Yorkshire and the Humber reflects the dominance of foundation industries, as well as the presence of significant power generating capacity. Yorkshire and the Humber is the second biggest energy consuming region in the UK<sup>31</sup> (see Figure 8).

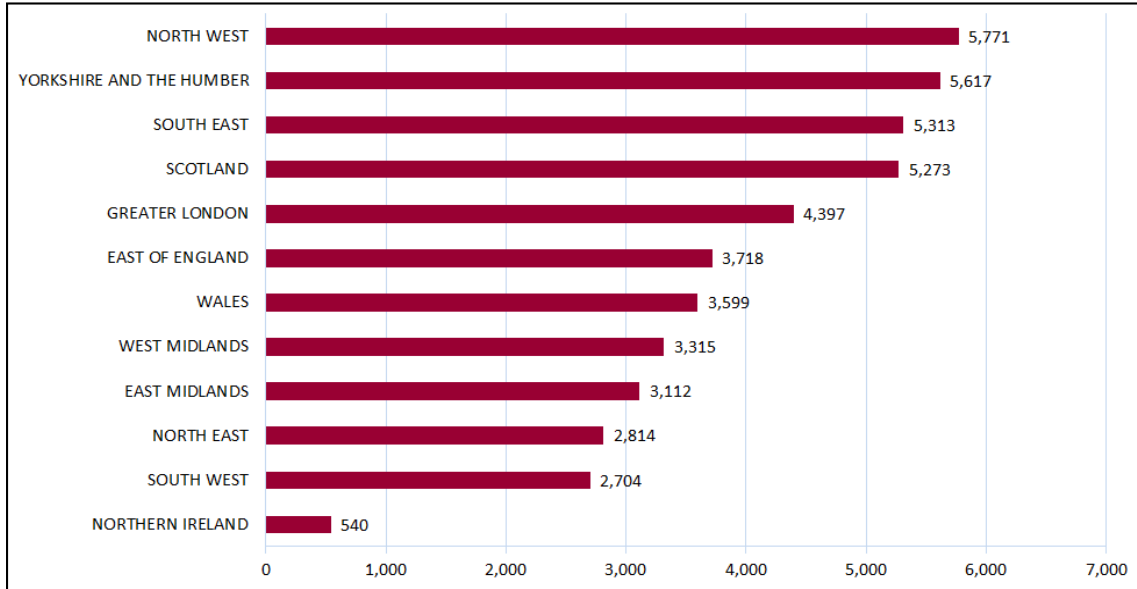


Figure 8: Regional industrial consumption of energy, 2012 (ktoe)

Industries in Yorkshire and the Humber consume more oil and coal (manufactured fuels)<sup>32</sup> than those in Wales, Scotland and Northern Ireland put together.<sup>33</sup> 34 per cent of the UK’s manufactured fuels used in industry are consumed in the region (see Figure 9). Yorkshire and the Humber is also second only to the North East in its use of gas for industrial applications.

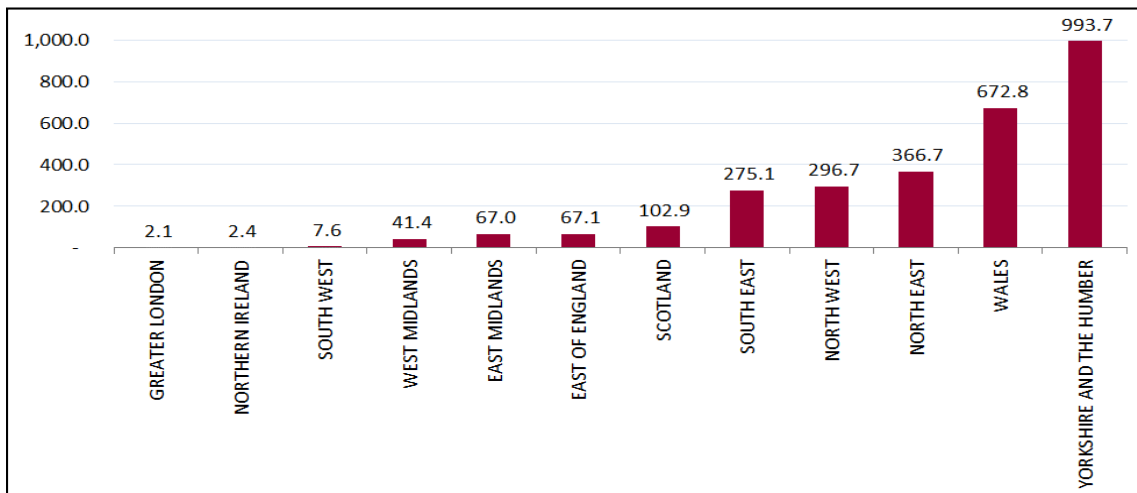


Figure 9: Regional industrial consumption of manufactured fuels, 2012 (ktoe)

<sup>31</sup> DECC September 2014: Sub-national final energy consumption in the UK, 2005-12

<sup>32</sup> This includes coal/petroleum (as appropriate) consumed in heat generation, energy industry use, industry, public administration, commerce, agriculture, and ‘miscellaneous’. See: DECC, October 2014: Sub-national final energy consumption in the United Kingdom 2005-2012

<sup>33</sup> Ibid.

According to DECC,<sup>34</sup> Yorkshire and the Humber end-users have historically emitted roughly 10 per cent of the UK's carbon dioxide emissions. At both the national and regional level, there was a notable uptick in emissions after the initial economic downturn shock to the economy; however since 2010, emissions in the region have continued a long-term decline (See Figure 10).

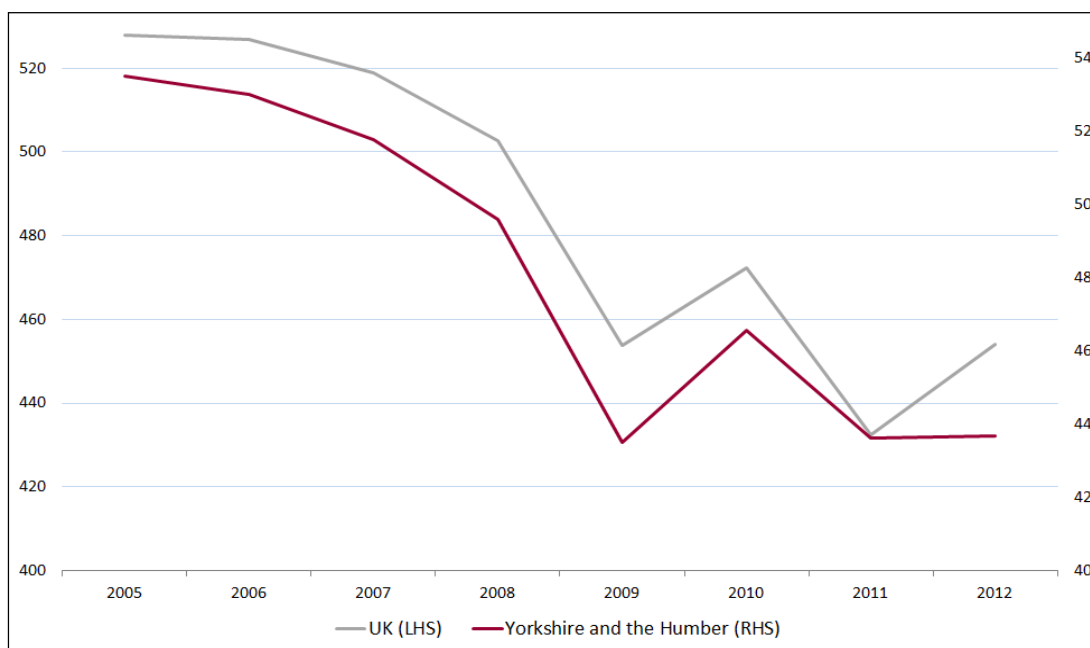


Figure 10: Regional vs national carbon dioxide emissions, 2005 to 2012 (million tonnes)

Industrial activity accounts for >50 per cent of these emissions, measured by end user (Fig. 11).



Figure 11: Regional composition of CO2 emissions 2005-2012 (million tonnes)

By source, emissions from UK industry as a whole were estimated to be around 170 MtCO<sub>2</sub>e in 2013<sup>35</sup>, 90 per cent of which is CO<sub>2</sub>. Industry CO<sub>2</sub> emissions are 74 per cent direct emissions (of which 92 per cent are from the combustion of fossil fuels and 8 per cent are from chemical processes) and 26 per cent indirect emissions (i.e. electricity-related).

<sup>34</sup> Local and Regional CO<sub>2</sub> Emissions Estimates for 2005-2012, Ricardo-AEA, September 2014

<sup>35</sup> Committee on Climate Change Industry Fact Sheet, 2013

On an equivalent basis, industrial emissions within Yorkshire and the Humber are estimated at 21 MtCO<sub>2</sub> per annum of which approximately half originate from the 18 industrial sites identified in this study. If, however, emissions associated with power generation within the region are included, irrespective of location of use, then emissions rise to more than 50 MtCO<sub>2</sub> per annum.<sup>36</sup>

27 of the largest carbon dioxide emitting sites in Yorkshire and the Humber are listed in Table 1 and include 18 industrial sites and 9 power generation sites, ranging from 16.6 million tonnes of CO<sub>2</sub> emissions from Drax, to 60,000 tonnes of CO<sub>2</sub> at Allied Glass, Nottinghamly. Together these 27 sites emit in excess of 43 MtCO<sub>2</sub> every year<sup>37</sup>. Their location is shown in Figure 12, and the relative scale of emissions of the largest 19 sites is presented in Figure 13.

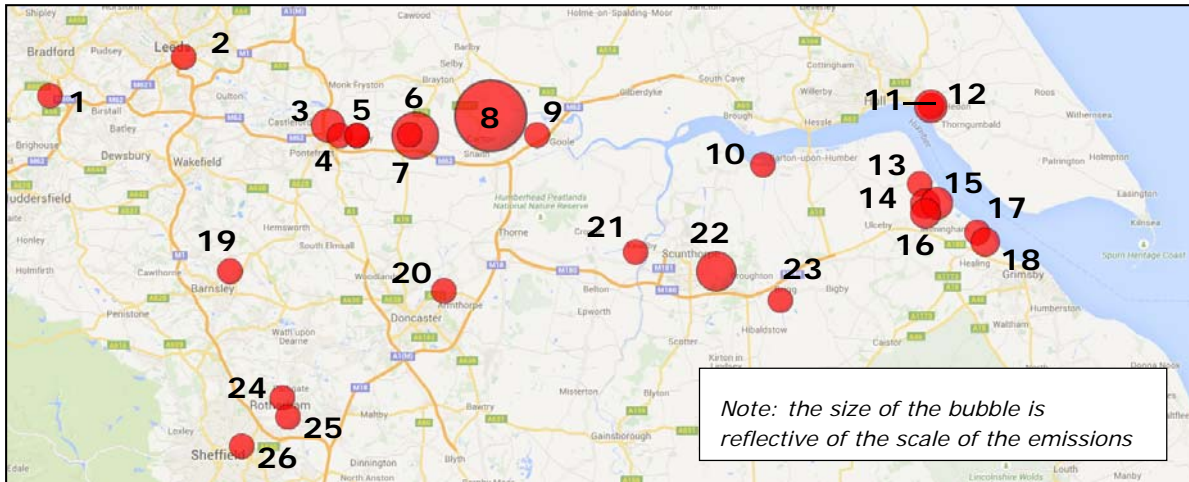


Figure 12: Map showing the largest CO<sub>2</sub> emitting sites in Yorkshire and the Humber

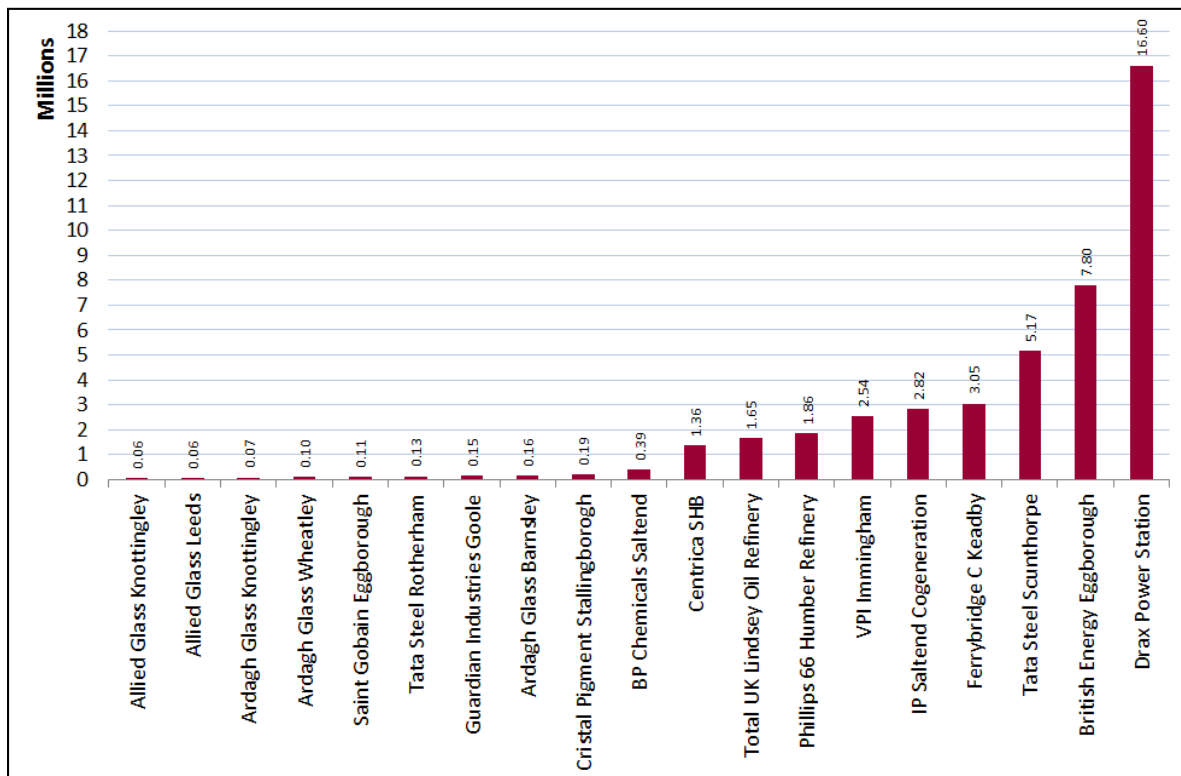


Figure 13: Annual CO<sub>2</sub> emissions by sites (MtCO<sub>2</sub>)

<sup>36</sup> Based on EU ETS Registry data, 2014

<sup>37</sup> Ibid.

**Table 1: 27 of largest CO<sub>2</sub> emitting industrial sites in Yorkshire and the Humber**

Note: the site number corresponds with the map shown in Figure 12.

Site No.	Sector	Name	2013 CO <sub>2</sub> emissions	2014 CO <sub>2</sub> emissions	% change	Notes
10	Cement	Cemex, South Ferriby	283,208	19,312	-93.1	Flooded
1	Chemicals	BASF, Bradford	7,952	5,682	-28.5	Under redevelopment
11	Chemicals	BP Chemicals, Saltend	352,471	392,923	+28.5	
17	Chemicals	Cristal Pigment, Stallingborough	177,982	192,460	+8.1	
14	Refinery	Total UK, Lindsey	1,662,086	1,653,025	-0.5	
16	Refinery	Phillips 66 Ltd, Humber	1,890,830	1,863,580	-1.4	
22	Steel	Tata Steel, Scunthorpe	5,456,826	5,172,746	-5.2	
26	Steel	Outokump Stainless Ltd	32,414	34,499	+6.4	
25	Steel	Tata Steel, Rotherham	124,906	132,526	+6.1	
3	Coal Power Station	Ferrybridge C	8,311,632	3,053,338	-63.0	Temp. closure (fire).
6	Coal Power Station	British Energy, Eggborough	11,495,905	7,799,832	-32.1	
8	Coal Power Station	Drax Power Station	20,319,513	16,595,193	-18.3	
15	CHP station	VPI Immingham	2,199,240	2,544,552	+15.7	
21	Gas Power Station	Scottish and Southern Energy, Keadby	24,417	51	-99.9	Mothballed for upgrading
12	Gas Power Station	IP Saltend Cogeneration	2,879,178	2,820,501	-2.0	
18	Gas Power Station	Centrica Killingholme A	212,818	33,888	-84.0	
18	Gas Power Station	Centrica SHB	1,094,402	1,364,050	+24.0	
23	Gas Power Station	Glanford Brigg Generating Station	10,146	9,642	-5.0	
2	Container Glass	Allied Glass, Leeds	65,408	63,976	-2.19	
5	Allied Glass	Allied Glass Knottingley	56,003	56,309	0.55	
4	Container Glass	Ardagh Glass Knottingley	79,713	73,059	-8.35	
20	Container Glass	Ardagh Glass, Wheatley	112,725	101,012	-10.39	
19	Container Glass	Ardagh Glass, Barnsley	145,452	160,094	10.07	
24	Container Glass	Beatson Glass, Rotherham	44,843	43,120	-3.84	
9	Flat Glass	Guardian Ind., Goole	138,718	146,540	5.64	
7	Container Glass	Saint Gobain, Eggborough	98,666	106,695	8.14	
5	Container Glass	Stoelzle Flaconnage, Knottingley	30,127	30,898	2.56	

Note: Beyond these very largest CO<sub>2</sub> emitters in the chemical sector there is a long tail of some 32 chemical sites in the region making basic and consumer chemicals and sharing interdependencies. Examples include including FTSE quoted companies like Victrex, Synthomer and Croda and those from large global concerns like Dow Chemical, Solvay and Novartis.

## 4.2 Securing the present: energy policy and EII support packages

The TUC and industry bodies such as the Energy Intensive Users Group both support the shift to a low carbon economy as an essential response to the challenge of climate change, and believe that energy intensive industries have a vital role to play to realise this ambition. They produce the primary inputs of much of what we manufacture and consume, contribute hugely to the national economy and their products are essential in the shift to a low carbon future.

However government energy and climate change policies have added significantly to the energy prices paid by energy intensive industries – the UK’s standalone carbon tax of £18.08 per tonne of CO<sub>2</sub> emitted is one example, a tax unique to the UK.

In response to representations from industry and trade unions the government made its first compensation payments to a number of firms in 2013, with a package worth about £30m to offset the UK’s carbon tax and the EU ETS. The package is forecast to pay out £60m this year (Table 2), with the budgeted sum rising to £430m in future years as other forms of compensation for the pass through costs of Renewable Obligation (RO) and Feed-in Tariffs (FITs) come on stream. The RO and FIT plans are also subject to EU State Aid approval this year, for which the UK government has committed £25m of support.

**Table 2: Foundation industry compensation packages, £m<sup>38</sup>**

Package	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
<b>EU ETS</b>	20	20	30	30	30	30
<b>Carbon tax</b>	40	80	70	70	70	70
<b>RO</b>	-	-	230	240	260	260
<b>Feed-in Tariff</b>	-	-	60	60	70	70
<b>Total</b>	<b>60</b>	<b>100</b>	<b>390</b>	<b>400</b>	<b>430</b>	<b>430</b>

However, the cost burden of government policies appears to be much heavier in the UK than among EU competitors, notably Germany, and its relief measures appear to be less generous in scope and duration. The TUC estimates<sup>39</sup> just 53 (or ~1 per cent) UK foundation industry enterprises have received compensation from the various government support packages, of which nine enterprises are in Yorkshire and the Humber (Table 3). Furthermore, industries such as ceramics, cement and glass manufacture do not qualify for support, either because they do not appear on EU approved lists of sectors exposed to carbon leakage and eligible for support<sup>40</sup>, or because the UK Government has chosen not to extend support schemes to all eligible sectors.

**Table 3: Yorkshire and the Humber companies receiving compensation, 2012-2013<sup>41</sup>**

Firm	Location	Sector
AMG Aluminium UK Ltd	Rotherham	Metal alloy
Sapa Profiles UK Ltd	Chesterfield	Aluminium can recycler
Weidmann Whiteley Ltd	Otley	Paper and board
Lenzing Fibers Grimsby Ltd	Grimsby	Man-made fibres
SGL Carbon Fibers Ltd	Hebden Bridge	Man-made fibres
INEOS Manufacturing Hull Limited	Hull	Chemicals
Tata Steel UK Limited	Scunthorpe	Steel
Sheffield Forgemasters	Sheffield	Steel
Caparo Merchant Bar Plc	Scunthorpe	Steel

<sup>38</sup> Source: BIS communication – response to Freedom of Information request, 12 March 2015.

<sup>39</sup> Manufacturing in the balance, TUC, 2015 <https://www.tuc.org.uk/industrial-issues/regional-policy/manufacturing/energy/manufacturing-balance>

<sup>40</sup> <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0746&from=EN>

<sup>41</sup> Derived from information provided by BIS, 2014.

### 4.3 Securing the future: low carbon technology solutions

Vital though transitional support programmes are, the future of our intensive industries lies in an ambitious investment programme in innovative low carbon technology solutions.<sup>42</sup> In spring 2015, following consultation with industry, academia and trade unions, the government published<sup>43</sup> eight *Industrial decarbonisation and energy efficiency roadmaps to 2050*. Energy intensive industries within our study region contributed to these roadmaps. The recommendations in these reports, if well followed through, will undoubtedly impact on their long-term future.

The roadmaps highlight the importance of successful development of CCS, emphasising the importance of the region's White Rose project, the first full scale CCS demonstration project in the UK. The findings from the roadmaps and the White Rose project are described in more detail in the sections below.

Across Europe, low carbon roadmaps "elaborated by industrial sectors show a clear need for the development and large scale demonstration of innovative low carbon industrial processes, as well as new high added value low carbon products." The EU's *Policy framework for climate and energy in the period from 2020 to 2030* proposed increased funding for industrial innovation through an expanded use of funds drawn from the EU ETS, "directing revenues towards the demonstration of innovative low carbon technologies in the industry and power generation sectors."

#### 4.3.1 Sector roadmaps to carbon reduction

Five 'pathways' were used for the potential carbon abatement analysis, each characterised by a different outcome in terms of abatement:

- BAU: Business as usual: no additional interventions are made to accelerate decarbonisation.
- Three carbon reduction scenarios: cuts of 20-40 per cent, 40-60 per cent and 60-80 per cent relative to the base year.
- Max Tech: the maximum possible technical potential for decarbonisation in the sector.

A summary of the Business as Usual (BAU) and Maximum Technology (Max Tech) pathways are set out in table 4 below:

- The combined Max Tech pathways for the eight industrial sectors deliver overall emissions abatement of 73 per cent between 2012 and 2050, saving 59 million tonnes (MtCO<sub>2</sub>) of carbon emissions. The Max Tech pathways rely heavily on four developments:
  - Successful development of CCS – making the role of Yorkshire and the Humber pivotal;
  - Grid "decarbonisation" – the replacement of coal and gas fired power stations by cleaner renewables, new nuclear power, or the adoption of CCS;
  - Fuel switching, to use biogas or synthetic gases;
  - Heat recovery and energy efficiency processes.
- An approach based on business as usual (BAU) reduces emissions by just 28 per cent, or 23 MtCO<sub>2</sub>. Emissions reductions are primarily achieved via decarbonisation of the grid and 'incremental' energy efficiency measures.

The reports contain the primary drivers and barriers associated with the uptake of the required technologies and a set of strategic conclusions for driving forward decarbonisation, but these have yet to be reflected in a programme of actions. Furthermore, who and how this will be funded has still to be defined. The net present value of the investment required ranges from £6bn to £16bn (excluding carbon price or other policy costs).

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<sup>42</sup> *Technology Innovation for Energy Intensive Industry in the UK*, Centre for Low carbon Futures for the Energy Intensives Users Group (EIUG) and TUC, July 2011.

<sup>43</sup> *Industrial decarbonisation and energy efficiency roadmaps to 2050*, March 2015. Prepared for DECC and BIS by WSP, Parsons Brinckerhoff and DNV GL.



Table 4: Summary overview of Max Tech and BAU pathways for EIs

Sector	Maximum Technology Development	Business as Usual
Iron & steel	<b>9.2 MtCO<sub>2</sub></b> by 2050, corresponding to emissions reduction of <b>60%</b> on 2012 base. Heavily reliant on CCS, and retrofit or rebuild of all sites with advanced technologies, e.g. Hlsarna, Corex or Finex. Also improved site integration and upgrading of onsite steam and power plants to improve combustion efficiency.	Approximately <b>15%</b> emissions reduction from 2012 baseline, with incremental options providing savings earlier in the pathway, and major options including stove flue gas recycling and steam or power plant upgrades implemented by 2050.
Cost / <sup>44</sup> abatement	£600m / 122 MtCO <sub>2</sub>	£300m / 26 MtCO <sub>2</sub>
Chemicals	<b>2.2 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>88%</b> on 2012 base. Critical interventions are: biomass heat; CCS; biomass as a source of chemical feedstock; use of low carbon methane; further deployment of energy efficiency measures; clustering of chemical production to optimise energy and materials. <sup>45</sup>	<b>12.6 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>31%</b> compared to 2012. Existing trends in energy efficiency and decarbonisation continue.
Cost / abatement	£4000m / 270 MtCO <sub>2</sub>	£600m / 90 MtCO <sub>2</sub>
Oil Refining	<b>5.9 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>64%</b> compared with 2012. This is reliant on the introduction of CCS or new refinery rebuild using best available technology (BAT) (considered very unlikely), in addition to all options listed under BAU.	<b>44%</b> emissions reduction from 2012, based on incremental improvements: optimising process controls, improving maintenance, and plant retrofits; and <i>some</i> major options e.g. upgrading process units, fuel switch (fuel oil to natural gas), new CHP (where not installed), waste heat/energy recovery.
Cost / abatement	£500m / 102 MtCO <sub>2</sub>	£200m / 45 MtCO <sub>2</sub>
Cement	<b>2.8 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>62%</b> compared with 2012. Heavily reliant on CCS, plus fuel switching to biomass, cementitious substitution, O <sub>2</sub> enrichment and alternative cements. The Max Tech pathway without CCS only provides a reduction of 33%.	<b>6.7 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>12%</b> compared with 2012, primarily through electrical efficiency improvement; electricity from waste heat, cementitious substitution, alternative raw materials (calcined) and alternative cements.
Cost / abatement	£600m / 50 MtCO <sub>2</sub>	£300m / 4 MtCO <sub>2</sub>
Ceramics	<b>0.48 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>60%</b> compared with 2012. Primarily through decarbonisation of heat by substituting fossil fuel with electricity or biomass and CCS.	<b>27%</b> emissions reduction from 2012 baseline, based on incremental improvements to existing technology and the deployment of BAT across the sector.
Cost / abatement	£700m / 8.1 MtCO <sub>2</sub>	£300m / 4.1 MtCO <sub>2</sub>
Glass	<b>0.4 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>83%</b> compared with 2012; either via use of CCS or carbon utilisation, or by use of electric melting and biogas.	<b>36%</b> emissions reduction from 2012, primarily through decarbonisation of the grid, recycling; improved furnace construction; waste heat recovery; and improved process control.
Cost / abatement	£150m / 22 MtCO <sub>2</sub>	£30m / 7.7 MtCO <sub>2</sub>
Pulp and paper	<b>0.08 MtCO<sub>2</sub></b> pa by 2050, corresponding to a reduction of <b>97/98%</b> compared with 2012 via 1) clustering and heat networking, 100% electricity, hood heat recovery; or 2) biomass based CHP/boiler, and heat recovery on hoods.	<b>32%</b> emissions reduction from 2012, primarily via improved process control; extended nip press; (waste) heat recovery & heat integration; and energy management.
Cost / abatement	£1000m / 71 MtCO <sub>2</sub>	£700m / 26 MtCO <sub>2</sub>

<sup>44</sup> Total discounted capital cost 2013-2050 (£m) and Cumulative Carbon Dioxide Abated 2013-2050 (MtCO<sub>2</sub>). Note that costs are dependent on future fuel costs, and assume that CCS increases energy costs. There is a high degree of uncertainty associated with cost calculations, in particular for technologies still in R&D stage.

<sup>45</sup> Note: For the Chemicals sector, the 60-80 % pathway is achieved using Max Tech options without biomass.

In addition to the technologies listed under the different pathways, decarbonisation of the grid is an essential contributor across all sectors to indirect emissions reduction.

#### **4.3.1.1 Enablers and barriers**

There is a high degree of commonality amongst the primary enablers and barriers to decarbonisation across the energy intensive industries identified within these reports. These are summarised below. It is worth noting that these often form the reverse perspective of the same challenge. Enablers include a 'wish list' by industry participants, rather than existing conditions.

##### Key enablers

1. Government leadership and recognition of long term strategic importance of the sector.
2. Stable energy and CO<sub>2</sub> policy framework that incorporates a long term energy security plan, but at the same time enables companies to maintain competitiveness.
3. Location near to CCS infrastructure.
4. Enhanced collaboration between industry, government, trade associations and academia, in particular in realising demonstration projects.

##### Key barriers

1. HQs outside the UK are reluctant to sanction investment in plant that are often seen as expensive to operate (in terms of energy, fuel, regulation, and labour) in comparison with other regions.
2. Lack of a consistent and balanced regulatory environment that reduces risk of carbon leakage.
3. Lack of capital for advanced technologies (access to alternative financing therefore key) and lack of certainty over backing for CCS.
4. Long equipment replacement cycles.
5. Shortage key skilled staff in energy and heat engineering.
6. Progress is dependent on options that are outside the direct control of the sector, such as CCS infrastructure, availability of biomass feedstock.

Innovative sources of funding are clearly crucial in supporting technology transformations at the scale and speed required. As previously noted, the EU's *Policy framework for climate and energy in the period from 2020 to 2030* has suggested expanding the use of EU ETS revenues for the demonstration of innovative low carbon technologies in the industry and power generation sectors.

#### **4.3.1.2 Implications for the Yorkshire and the Humber region**

All the sector strategies recognise the benefits from industrial clustering, not only to facilitate technology demonstration and deliver CCS solutions, but also to sell by-products and waste streams to neighbouring sites, share infrastructure, and develop a local supply chain.

Clustering also presents challenges, including the need for collaboration across companies and the risk that cluster partners will exit, leaving a crucial gap in the supply chain. Stronger encouragement for increased clustering needs to be established, including a means for companies to reflect the benefits of clustering in business cases.

CCS is recognised as being a significant potential contributor to emissions reduction in a number of sectors, but individually no single sector produces emissions of sufficient scale to justify their own CO<sub>2</sub> pipeline and storage infrastructure. Key barriers include the need for demonstration at scale; the need for R&D into sector specific CCS solutions; uncertainty about return on capital; access to sources of financing; regulatory uncertainty; and operational complexity.

Multi-stakeholder collaboration both within and between sectors is therefore considered essential in overcoming these barriers, in particular in order to progress with research and development (R&D), to establish shared networks, and to share costs and improve access to project finance. Clustering around sites near the North Sea is considered a particularly good early opportunity, as it

is geographically viable for CCS, and indeed the chemical cluster in Teesside has been taking a lead role in demonstrating the business case for CCS.

#### **4.3.2 White Rose**

The White Rose CCS project is being implemented by Capture Power, formed from project partners, Drax, Alstom and BOC. Subject to development consent and funding being agreed, a new, up to 448MW<sub>e</sub> (gross), coal-fired demonstration oxy-fuel power plant with full CCS equipment will be built on land adjacent to the existing Drax Power Station. The plant will also have the potential to co-fire biomass.

The power station will generate electricity for export to the Electricity Transmission Network as well as capturing approximately 2 MtCO<sub>2</sub> per year (approximately 90 per cent of all CO<sub>2</sub> emissions produced by the plant). The CO<sub>2</sub> will be transported through National Grid's proposed pipeline for permanent undersea storage in the North Sea. As a separate associated project, National Grid will construct and operate the CO<sub>2</sub> transport pipelines and, with partners, the permanent CO<sub>2</sub> undersea storage facilities at a North Sea site.

The project is now half way through its two-year Front End Engineering and Design (FEED) study; a detailed engineering, planning and financial exercise to examine and finalise all aspects of the project ahead of taking the final investment decision. In December 2014, a Development Consent Order (DCO) application was accepted for examination by the Planning Inspectorate,<sup>46</sup> and a final decision about whether to grant consent to White Rose is likely to be announced in the first half of 2016.

If successful, a phased construction period lasting up to 60 months could begin in mid-2016. Expected job creation is an average of 1,250 new construction jobs over the three-year plant development period, as well as at least 60 operational jobs at the new plant and further indirect supply and maintenance posts. The project is believed to have the potential to play an important role in establishing a carbon dioxide transportation and storage network in Yorkshire and the Humber that would be available for decades to industrial users.

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<sup>46</sup> [www.whiteroseccs.co.uk](http://www.whiteroseccs.co.uk)

## 5 Local stakeholder views

### 5.1 Introduction

Orion Innovations and the TUC engaged with more than 40 individuals from 30 organisations across industry, the public sector, LEPs, trade unions, and academia in order to explore their perspectives on regional low carbon industrial strategy and Yorkshire and the Humber in particular. Insights were gathered through questionnaires, interviews and a workshop and encompassed:

- The status and insights into existing regional governance structures and low carbon industrial strategies in Yorkshire and the Humber;
- The need for regional low carbon industrial strategy;
- Evidence of best practice in regional low carbon industrial strategy;
- The challenges and opportunities for regional low carbon industrial strategy, including participant views on the main causes of recent industrial decline and the impact of climate change policies.

A list of the stakeholder organisations consulted is given in Table 5 below. Although interviewees expressed a broad range of views, in part reflective of the organisations and the sectors in which they operate, there was an enormous amount of common ground. These findings are summarised in Section 5.2 below.

**Table 5: Participant stakeholders**

<b><u>Unions:</u></b>	
ACV (Confederation of Belgian Trade Unions)	NUM
CCOO Asturias (Spanish Trade Union)	Prospect
Community	Solidarnosc (Polish Trade Union)
DGB (Confederation of German Trade Unions)	TUC Yorkshire and Humber
ETUC	Unite
GMB	University and College Union
LO (Confederation of Swedish Trade Unions)	
<b><u>Industry and Trade Associations:</u></b>	
AMEC	Ceramics Federation
BP Chemicals	Chemicals Industry Association
British Glass Manufacturers Association	EIUG
Capture Power Limited	EEF
CCSA	HCF CATCH
CEMEX	
<b><u>Academia:</u></b>	
ETUI (European Trade Union Institute)	Sheffield University
<b><u>National and Local Government:</u></b>	
BIS (National)	Humber LEP
BIS Yorkshire and the Humber	Leeds City Region LEP

## 5.2 Findings

### 5.2.1 Existing regional governance structures and low carbon industrial strategies

All stakeholders recognised that the UK is dominated by national rather than regional governance structures, unlike many other parts of Europe.

The views of stakeholders with regards to current Yorkshire and the Humber governance structures and low carbon industrial strategies were largely consistent and can be summarised as follows:

- No single organisation has currently assumed overall responsibility for facilitating the region's drive for energy and resource productivity.
- There are however two Enterprise Zones within the Humber region: Humber Renewable Energy Super Cluster and the Green Port Corridor which, together with the local LEPs, have been instrumental in creating growth in renewable energy-related sectors. A notable achievement has been attracting wind turbine manufacturer, Siemens, to the area.
- Low carbon industrial strategy does not feature significantly within current LEP activities. However, LEPs are a creation of the current government and have good access to central government Ministers. They are structured as partnerships between public and private sector stakeholders so are also well placed to facilitate widespread public-private engagement.
- The LEPs offer a useful platform and could provide an appropriate regional governance structure for effective development and deployment of low carbon industrial strategy. There is however need for all stakeholders, including trade unions, to take a proactive approach to exploiting these structures. A number of stakeholders recommended the creation of regional low carbon working groups focused on mutually beneficial projects.
- So far as CCS is concerned, the LEPs are sub-scale and no single LEP has taken a leadership role within Yorkshire and the Humber. By contrast, through the Teesside Collective<sup>47</sup>, industry and five councils have come together to promote a regional CCS cluster for the North East, in an effort to overcome the problem of sub-scale governance structures for CCS.
- The Yorkshire and the Humber CCS Partnership is also looking for seed funding for administrative costs.
- A number of interviewees expressed the view that if CCS is to prosper, there is a need for an open forum that enables National Grid and Drax to interact with local regional interests in a manner that encourages the uptake of their transport and storage infrastructure by third parties. This infrastructure creates a natural monopoly and needs transparent management.
- Looking back, a number of industry stakeholders familiar with the region's recent economic history acknowledged the role of the former RDA, Yorkshire Forward, which was understood to have been a key driver of the former government's low carbon industrial strategy in the region and the coordinating force behind the Yorkshire and the Humber CCS Partnership. This Partnership between business and the regional body was primarily focused on establishing an evidence base for the development of the CCS proposition, and produced reports which are believed to have made a significant difference to the political landscape in highlighting the scale economies for infrastructure and in creating an appropriate CCS cluster.

### 5.2.2 Need for regional low carbon industrial strategy

Interviewees expressed contrasting views on the need for and nature of a regional low carbon industrial strategy.

**There was consensus that businesses within Yorkshire and the Humber need:**

- Clear energy policy certainty from national government that assures investors the low carbon economy is fully supported;

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<sup>47</sup> Teesside Collective: <http://www.teessidecollective.co.uk/>

- A clearly defined low carbon industrial strategy and leadership for its implementation, whether at a regional or national level;
- Energy policies that deliver energy security and internationally competitive energy prices.
- Business policies that address the cost of capital, competition for capital, and the business case for investment in low carbon solutions;
- Support for industrial technology innovation;
- Support to encourage and facilitate the value chain or cross-sector collaboration needed to deliver solutions such as CCS or heat networks;
- Engagement to ensure relevant skills, training and infrastructure are available to industry.

However, while there was consensus on the need for active low carbon industrial strategy, there was a difference of opinion as to whether a regional strategy is needed and if so, what form it should take.

**Those that were less convinced by the need for regional strategy thought that:**

- National policies and strategies are essential for decarbonisation. Regional delivery is important, however there is a need to avoid duplication of effort and conflict between regions.
- Regions should not develop local strategies in isolation from a national strategy.
- Regional strategy is difficult to develop in isolation from national and international policies without risking carbon leakage. Most EITs are multinational companies that will be looking at what they require individually.
- Regional policy may be more important where there are clusters and co-dependence but this will not be common across the country.
- CCS infrastructure is capital intensive and a natural monopoly. It may be necessary for a regulated entity to be in control.
- Outside of CCS, most things can be left to market forces.

**A number of interviewees commented on the need for better coordination**

- The lack of a regional strategy to take us to a low carbon 2030 has been a constraint on jobs growth within the energy sector in the region, and has held back the development of investment in new low carbon technologies. Some years ago, with its strong mixture of coal, gas, mining and petroleum industries, Yorkshire and the Humber was a world class energy region. There are now a number of LEPs covering Yorkshire and the Humber and none of them have been able to get their arms around the CCS opportunity. The lack of a regional strategy has had a detrimental impact on the quality of the region's energy infrastructure needed to attract other low carbon energies to the region.
- There is value in having some form of entity that can act as an honest broker. In order to get CCS to work there is a need to get large number of disparate organisations to come together. Because they are acting on behalf of the region, this entity is able to act as facilitator for discussion (access arrangements etc.).
- What is not being done in Yorkshire and the Humber is the longer term strategic thinking. What happens beyond the initial White Rose project?
- The lack of a regional entity introduces political risk as there is no-one to reflect the regional interests at national level.

**Those that were supportive of regional strategy and governance structures thought that they mattered in a number of ways:**

- They can be a route to getting a number of companies and industries to talk to one another to get critical mass to move things forward. An individual company, no matter how big, may not be able to move things forward alone, in particular given the international nature of the businesses and competition for investment.
- Facilitating links back to central government. Central government had listened if the former regional body had supported industry and added credibility to what they were saying e.g. getting CCS off the ground.

- Devolved bodies help in terms of ensuring focus and importance at a national/international level. A devolved body in some form would look to ensure that larger employers remain in the region and continue to be profitable in order to maintain and grow GVA. From a steel sector perspective, in South Wales and Netherlands the companies receive a lot more attention because the individual companies are recognised as such important contributors to local GVA. Conversely steel in Yorkshire, Humber and Teesside get lost in a much larger UK economy.
- A lot of European funding is open to regions to apply for. It is, for example, difficult for a UK company to access funding for a biomass co-firing project in ceramics in the absence of a regional body with match funding. This is not true of European competitors.

In terms of value for money, PriceWaterhouseCooper's 2010 assessment of the RDAs was cited as evidence of the effectiveness of regional governance, strategy and delivery. This assessment of the value of the English RDAs found that "there is credible evidence that RDAs have generated regional economic benefits, especially taking account of the persistence of the projected benefits"; every £1 of RDA spend will add £4.50 to regional GVA. The RDAs created or supported over 35,000 businesses, assisted many in skills development and remediated great areas of land for development.

### 5.2.3 Best practice in regional low carbon industrial strategy

Few interviewees felt able to point to best practice in regional low carbon industrial strategy. The region's former CCS stakeholder group was cited as an example of best practice that could be useful to reflect on as a manufacturing contribution to the 'Northern Powerhouse', and as the case for CCS in industrial roadmaps gathers momentum in the region. Others pointed further afield.

Key findings from stakeholder interviews relating to best practice in regional low carbon strategy can be summarised as follows:

- Members of the CCS partnership included Tata steel, which chaired it, the main power generators within the region (e.g. Drax), engineering companies such as AMEC, the main oil and gas companies in the region, chemical plant and steelworks, the Centre for Low Carbon Futures, and others. Trade unions were represented through the regional TUC, industry unions such as Community, and the TUC head office.
- A lot of work was put into this regional CCS strategy. Its aim was to develop a strategy to help lower the region's overall carbon footprint, estimated at that time to be around 60 MtCO<sub>2</sub> from some 13 principle emitters in the region. The then Labour government had published a low carbon industrial strategy which aimed to make the UK a global leader in CCS technology, and designated a leading role for the region.
- The Netherlands, similar in scale to many regions elsewhere in Europe, has developed the concept of *Energy Agreements for Sustainable Growth*. These Agreements unite divergent interests and bring together multiple organisations, including central, regional and local government, employers' associations and unions, nature conservation and environmental organisations, and other civil society organisations and financial institutions, in terms of what is needed to deliver sustainable growth. These covenants set out what each party will contribute and deliver in terms of sustainable growth. This approach could offer an example of best practice to other regions in Europe.

### 5.2.4 Challenges and opportunities for regional low carbon industrial strategy

Yorkshire and the Humber is seen as having substantial strategic advantages in terms of access to energy resources (oil, gas, power and offshore wind), infrastructure (port facilities), and the breadth and strengths of foundations industries (oil refining, chemicals, steel, cement etc.).

Ensuring that these industries develop and invest in the most technically advanced and energy efficient processes and technologies will ensure that Yorkshire and the Humber continues to make a significant contribution to all that we produce and consume in the UK.

The development of CCS infrastructure, available to both power generators and industry, will provide the region with an international competitive advantage, and act as a magnet for inward investment by firms seeking carbon storage facilities.

Achieving this will be challenging. The primary drivers and barriers identified in the 2050 roadmaps and set out in Section 4.2 have been reflected in many interview responses.

There is also a broader issue, yet to be resolved, regarding who bears the cost of industrial decarbonisation. In the power sector there is broad acceptance that society should pay through energy bills. The question of who will pay for those industries that operate in globally competitive markets is particularly challenging and in the absence of suitable policies, runs the risk of causing carbon leakage. In public funding terms this issue is in the balance as the new government is yet to publish details on where public spending cuts will be made as part of the nationwide Spending Review.

All interviewees saw national, EU and international policy as critical to overcoming challenges and ensuring the delivery of effective low carbon industrial strategy. While the stakeholders expressed differing views as to which aspects of low carbon industrial strategy are best managed at a regional as opposed to a national level, there was broad consensus as to the opportunities that effective low carbon industrial strategy can offer to Yorkshire and the Humber, and the significant challenges to delivery.

### **5.2.5 Summary conclusions**

There is consensus that it is not possible to look at energy, environment and industrial policy separately from one another. The three need to be woven together nationally and regionally, and must recognise the realities and constraints of globalisation.

There is widespread concern that current UK energy and environmental policies are having a serious and detrimental impact on the energy costs, competitiveness, and ability and willingness of EII's to make long term investment in the UK.

There is also a broader issue, yet to be resolved, regarding who bears the cost of industrial decarbonisation. In the power sector there is broad acceptance that society should pay for the UK's energy transformation through consumers' energy bills. The question of who will pay for the new industrial technologies for those industries that operate in globally competitive markets is particularly challenging. In the absence of suitable policies, the UK runs the risk of further "carbon leakage" – the loss of jobs, plant and investment to countries with weaker carbon controls or none at all, particularly counties on the periphery of the EU.

Yorkshire and the Humber is seen as having substantial strategic advantages in terms of access to energy resources (oil, gas, power and offshore wind), infrastructure (port facilities), and the breadth and strengths of foundation industries (oil refining, chemicals, steel, cement etc.).

Ensuring that these foundation industries develop and invest in the most technically advanced and energy efficient processes and technologies will ensure that Yorkshire and the Humber continues to make a significant contribution to all that we produce and consume in the UK.

For this to happen there is a need for:

- A clearly defined low carbon industrial strategy and leadership for its implementation, whether at a regional or national level.
- Policies that deliver decarbonisation and energy security without undermining the competitiveness of UK industry;
- Long term energy, environmental and industrial policy certainty, reflective of the long lifetime of EII capital investment decisions;
- Investment in the innovation needed to deliver the technologies that underlie the government's 2050 industrial energy efficiency roadmaps;
- Investment in the accompanying skills and training needed to develop, deliver and deploy these technologies;



- Ready access to substantial investment finance and implementation of business policies that address the cost of capital, competition for capital, and the business case for investment in low carbon solutions.
- Support to encourage and facilitate the cross-sector collaboration needed to deliver solutions such as CCS or heat networks.
- Engagement with working people and employers in order to ensure a just transition that builds high value jobs, and enhances productivity.

For many foundation industries, delivery of the government's 2050 industrial energy efficiency roadmaps also requires access to CCS infrastructure.

The White Rose CCS Project has the potential to deliver a long term competitive advantage for energy generation and EII's in Yorkshire and the Humber region. However there is concern about the pace of development and a belief that there is a small window of opportunity that needs to be grasped. Specific recommendations for government related to CCS include the following:

- Enable final investment decisions on the two CCS competition projects by early 2016;
- Retain the £1bn capital funding for the CCS competition;
- Allow the CCS competition projects access to Contracts for Difference in the current Levy Control Framework;
- Support the development of further CCS projects in parallel with the first two, not in sequence;
- Urgently develop an incentive to invest in industrial CCS similar to the Contract for Differences for energy projects.

No single organisation has currently assumed overall responsibility for facilitating the Yorkshire and the Humber region's drive for energy and resource productivity. LEPs provide a recognised platform in the region, and have the potential to form an appropriate regional governance structure for effective development and deployment of regional low carbon industrial strategy. However, there is a need for stakeholders, including trade unions, business and others, to take a proactive approach to exploiting these governance structures. A number of stakeholders recommended the creation of regional forum to work with the LEPs, and low carbon working groups focused on mutually beneficial projects.

There is considerable appetite amongst local and national government, businesses, and trade unions to ensure a just transition to a low carbon economy, the retention and creation of high quality sustainable employment, and delivery of enhanced productivity and value added. It is widely recognised that this timely transition would make a significant contribution to the development and success of the Northern Powerhouse agenda. The deployment of the 2050 industrial decarbonisation roadmaps are considered to be a key determinant of the sustainable future for the industries assessed in this report, and there is broad recognition amongst participants in this project that all parties, including trade unions, have a leadership role to play in ensuring the necessary collaboration between government, business, academia, and society as a whole.