Energising the North

An evaluation of the economic contribution of the energy sector to the North of England

A report for Northern Gas Networks

January 2017

Document Classification - KPMG Public

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Glossary

BEIS	Department for Business, Energy & Industrial Strategy, into which the Department of Energy and Climate Change was incorporated from July 2016.
Building energy	For the purposes of this report, 'building energy' refers to the manufacturing and installation of energy efficient appliances, heating appliances (boilers), building improvements and distributed energy systems (e.g. heat pumps, CHP, solar PV, etc.).
Carbon Capture and Storage (CCS)	A technology that can capture up to 90% of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere.
Combined Heat and Power (CHP)	A technology which generates heat and electricity simultaneously, from the same energy source, in individual homes or buildings.
Combined Cycle Gas Turbines (CCGT)	A form of highly efficient electricity generation technology that combines a gas-fired turbine with a steam turbine.
DECC	Department of Energy and Climate Change (incorporated into newly formed Department for Business, Energy & Industrial Strategy in July 2016).
Direct impacts	The measure of the total amount of additional expenditure within a defined geographical area, which can be directly attributed to the development of an industry. Direct impacts occur when additional demand for a unit generates a corresponding unit of output, e.g. production of a chair.
Distributed generation (DG)	An electricity generating plant that is connected to a distribution network rather than the transmission network such as Combined Heat and Power (CHP) plants, wind farms, hydroelectric power. Larger DGs can be located near consumption hubs. Smaller DGs can be installed in homes and buildings where excess electricity generated can be sold to the grid.
Distribution Network Operators (DNOs)	DNOs own and operate the distribution network of towers and cables that bring electricity from the national transmission network to homes and businesses.
Electric Vehicle (EV)	A vehicle which uses one or more electric motors for propulsion. The electric motor uses electricity stored in a battery to function.
Energy Company Obligation (ECO)	A Government energy efficiency scheme in Great Britain to help reduce carbon emissions and tackle fuel poverty.
Energy Service Companies (ESCOs)	A company that develops, designs, builds, and funds projects that save energy, reduce energy costs, and decrease operations and maintenance costs at their customers' facilities
FAME Bureau Van Dijk (FAME)	A database for detailed financial, contact and company ownership information for 2.3 million companies in the UK and Republic of Ireland. The database uses raw data from Companies House.
Feed-in Tariffs (FIT) scheme	A Government programme designed to promote the uptake of small-scale renewable and low-carbon electricity generation technologies. The scheme requires participating licensed electricity suppliers to make payments on both generation and export from eligible installations.
Gas Distribution Networks (GDNs)	GDNs own and operate the distribution that bring gas from the national transmission network to homes and businesses.
Gross Domestic Product (GDP)	The main measure of UK economic growth based on the value of goods and services produced during a given period.

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Gross Value Added (GVA)	A measure of the contribution to the economy of each individual producer, industry or sector in the UK.
Heat networks	A system for distributing heat generated in a centralised location for residential and commercial heating requirements such as space heating and water heating.
Heat pumps	A device that takes heat from one source and moves it to another location through electric or mechanical means. There are two main types of heat pumps: air source heat pumps (which extract heat from the outside air) and ground source heat pumps (which extracts heat from the ground).
HGV	Heavy goods vehicle.
Hydrogen Fuel Cell vehicle	A vehicle which combines hydrogen and oxygen to produce electricity to run its motor.
Iron Mains Replacement Programme (IMRP)	The IMRP was introduced in 2002 to address 'societal concern' regarding the potential for failure of cast iron gas mains and the consequent risk of injuries, fatalities and damage to buildings. The objective of the IMRP was to decommission all cast iron mains within 30 metres of property in 30 years. The IMRP accelerated the replacement of cast iron mains to a level that was estimated to be as fast as practicable at that time, given the potential risks faced by society and the resources required.
Indirect impacts	Indirect impacts arise as demand for materials and fuels used to create that additional unit of output generates, in turn, outputs in other industries, e.g. wood, steel, paint, fabric, electricity, gas, water and other materials, fuels, and services used in furniture production. There will be associated increases in labour, profits and capital
Induced impacts	Employment or other economic benefits that emerge in other sectors of the economy resulting from changes in economic activity the sector being considered. Induced impacts are felt as increases in compensation of employees lead to increased spending on goods and services in the economy.
I&C customers	Industrial and commercial customers.
Leakage	Leakage is the proportion of economic outputs that benefit those outside of the intervention target area or group.
Liquefied natural gas (LNG)	A clear, colourless and non-toxic liquid which forms when natural gas is cooled to -162ºC (-260ºF). The cooling process shrinks the volume of the gas 600 times, making it easier and safer to store and ship in its liquid state.
Ofgem	The Office of Gas and Electricity Markets which regulates the gas and electricity markets in Great Britain.
Office for National Statistics (ONS)	The ONS is the UK's largest independent producer of official statistics and the recognised national statistical institute of the UK.
Oil and Gas Authority (OGA)	The Oil and Gas Authority's role is to regulate, influence and promote the UK oil and gas industry in order to achieve its statutory principal objective of maximising the economic recovery of the UK's oil and gas resources.
Regulatory Asset Value (RAV)	The value ascribed by Ofgem to the capital employed in the licensee's regulated distribution or (as the case may be) transmission business (the 'regulated asset base').
Renewable Heat Incentives (RHI)	A Government financial incentive to promote the use of renewable heat. People who join the scheme and stick to its rules receive quarterly payments for seven years for the amount of clean, green renewable heat it is estimated their system produces.

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RIIO	Revenue = Incentives + Innovation + Outputs. Ofgem's regulatory framework which has been implemented in the recent price controls.
Smart Grid	An electricity network that can intelligently integrate the actions of all the users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.
Smart thermostat	A smart technology that lets users remotely control their home's temperature via a tablet, smartphone or desktop for greater control over their central heating.
Solar PV	A system that captures the sun's energy using photovoltaic cells and convert it into electricity to run household appliances and lighting.
Standard Industry Classification (SIC) Codes	SIC codes are used to classify business establishments and other standard units by the type of economic activity in which they are engaged.
Steam Methane Reformer (SMR)	A production process in which high-temperature steam (700°C–1,000°C) is used to produce hydrogen from a methane source, such as natural gas.
Total expenditure (Totex)	All the expenditure relating to a licensee's regulated activities but with the exception of some specified expenditure items. Includes capital expenditure (capex), operating expenditure (opex) and, in some cases, development expenditure (devex).
Ultra-low emission vehicles (ULEVs)	A motor vehicle which conforms with European 'M1'-type approval standards and has the potential to operate with 'well-to-wheel' CO_2 emissions of less than 75 gCO_2/km, as measured on the New European Drive Cycle (or similar). This includes EVs and hydrogen fuel cell vehicles.
Value-added tax (VAT)	An indirect tax that is placed on a product whenever value is added at a stage of production.

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1 Executive summary

The new, post-EU referendum Government has signalled its intent to develop a ‘modern industrial strategy’ and to address the problem of uneven economic progress across the country[1]. The Chancellor’s Autumn Statement in November 2016 reiterated the Government’s intent and commitment to infrastructure and innovation in order to contribute to raising Britain’s productivity[2]. The Government has also signalled its intent to harness innovation in energy systems to meet emissions targets at lowest cost.[3]

Northern Gas Networks (NGN) commissioned KPMG LLP to produce an independent report looking at the present and future economic contribution of the energy sector in the North of England (defined in this report as the Yorkshire and The Humber, North West and North East regions), and ways in which it can address the ‘energy trilemma’ of needing to balance the considerations of security of energy supply, decarbonisation and affordability.

The ‘Northern energy economy’ is already making an important contribution towards economic growth. The region has deployed projects, programmes and initiatives to address the energy trilemma. The region has developed potentially transformative low-carbon technologies of the future such as hydrogen networks. Its universities are conducting research into the smart energy networks that will be required in future to ensure security of supply in an energy system with high levels of distributed energy and intermittent renewables. It has already invested in proven low-carbon technologies such as biomass conversion. These initiatives have put the region in a good position to take advantage of the economic opportunities afforded by the ongoing decarbonisation of the UK. This means that, as the Government defines its new industrial strategy, the Northern energy economy has the potential to deliver jobs, innovation and investment.

Our analysis focuses on the energy sector as a driver of economic growth. Previous reviews identified energy as one of the North’s four ‘prime’ capabilities. ‘Prime’ capabilities were identified as differentiated and distinctive at a pan-Northern

[1] ‘The importance of industrial strategy’ - Speech by Greg Clark, Secretary of State for Business, Energy and Industrial Strategy, to Institute of Directors annual conference, 27 September 2016. Available at: https://www.gov.uk/government/speeches/the-importance-of-industrial-strategy

[2] Autumn Statement 2016: The Chancellor's speech in full, 23 November 2016. Available at: http://www.telegraph.co.uk/business/2016/11/23/autumn-statement-chancellors-speech-full/

[3] https://www.gov.uk/government/speeches/greg-clark-speech-at-energy-uk

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level, highly productive, and able to compete at national and international scales[4]. The sector also supports economic activity through the provision of safe, secure and affordable energy supplies. Continued investment in the Northern energy economy can help all sectors of the Northern economy to achieve their economic potential.

The key messages of our analysis are summarised as follows:

The Northern energy sector is already vibrant	The North plays an important role in energy innovation in the UK	The North has the potential to act as an 'energy leader' in the UK
The energy sector is already contributing to the Northern and UK economy. From 1997 to 2014, the Northern energy sector (comprising the North West, the North East and Yorkshire and The Humber) accounted for c23% of total UK economic value[5] for the energy[6] sector. In 2014, the Northern energy sector contributed some £3.5bn in GVA to the regional and the UK economy.	The North plays an important role in areas including smart grids, decarbonised gas (e.g. hydrogen), offshore wind and transport. Key projects include development of electric vehicles by Nissan in Sunderland, H21 City Gate Project in Leeds, the Smart Grids Centre based in Newcastle, the National Centre for Energy System Integration, the National Institute for Smart Data Innovation and the Siemens offshore wind turbine factory in Hull. Many other developments are also underway across the region.	We identify the potential for energy to increase GVA growth by up to £2.3bn by 2050 by building on existing capabilities and exploiting opportunities in smart power, decarbonised gas and transport. Innovation and efficiencies across these energy systems will be needed to realise secure, clean and lowest cost energy supplies.

We have developed a snapshot of the current annual economic activity associated with the 'Northern energy economy', in terms of Gross Value Added (GVA), disaggregated into its key component parts. GVA measures the contribution to the economy of each individual producer, industry or sector in the country/region in question[7].

Figure 1.1 shows the current adjusted breakdown of the energy sector GVA in the North of England. Our GVA baseline totals £3.5 billion in 2014 prices.

[4] SQW http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf (Prime sectors are defined as Advanced Manufacturing, Health Innovation, Energy and Digital).

[5] 'Economic value' defined as Gross Value Added (GVA). Figures taken from GVA (Income Approach) reference tables. Available at: http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

[6] This excludes oil & gas production and is defined as the electricity, gas, steam and air conditioning supply sector.

[7] ONS. Available at: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/national-accounts/gva/relationship-gva-and-gdp/gross-value-added-and-gross-domestic-product.html

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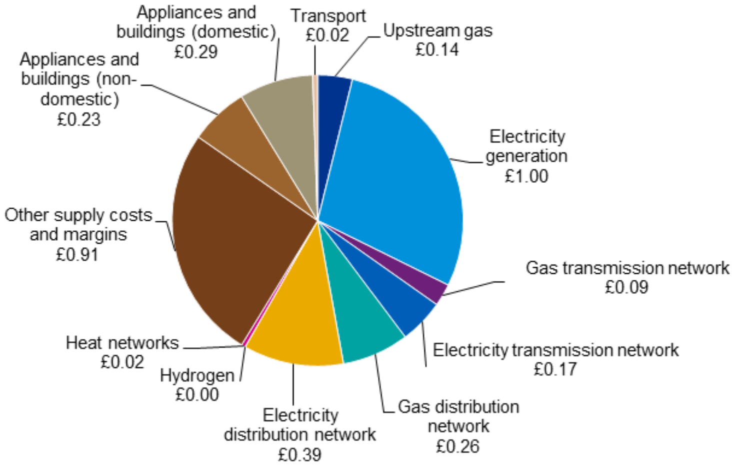
Figure 1.1 Breakdown of current energy sector GVA in the North of England (in £billion)



Source: KPMG analysis

Component	Description
Upstream gas	Gas extraction production and services
Electricity generation	Generation of electricity at power plants such as Drax, distributed generation, batteries, etc.
Gas/electricity transmission networks	Infrastructure, building and maintenance of pipes and transport services provided by the networks Conversion to hydrogen networks, appliance conversions, building of hydrogen production plants, CO2 transportation, investment in storage facilities (offshore gas fields, salt caverns), etc. Conversion to heat networks
Gas/electricity distribution networks	
Decarbonised gas (Hydrogen)	
Heat networks	
Other supply costs and margins	Energy supply businesses in the North
Appliances and buildings (domestic and non-domestic)	Appliances manufactured, designed, installed, repaired, etc. in the North
Transport	EVs, hydrogen fuel cell vehicles, ULEV components, batteries, etc.
Upstream gas	Gas extraction production and services Generation of electricity at power plants such as Drax, distributed generation, batteries, etc.
Electricity generation	
Gas/electricity transmission networks	Infrastructure, building and maintenance of pipes and transport services provided by the networks

In order to assess the future economic contribution of the Northern energy economy, we consider how GVA associated with each component part (as set out in Figure 1.1) will evolve in the period out to 2050. Given the considerable uncertainty around future economic growth, we plot growth prospects for each component part of the Northern energy economy under three different scenarios, or ‘energy pathways’, in which a different energy mix is used to meet expected future consumer demand.

For the purposes of this study, KPMG have developed three illustrative scenarios to quantify the economic growth of the energy in the North in terms of GVA and employment. Our scenarios are subject to a number of variables, all of which are uncertain. As such, the scenarios outlined in this report should be considered illustrative and should not be used for forecasting purposes.

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All three energy pathways, summarised in Table 1.1, use technologies and fuels that are available and could, with the will and investment, start to be implemented today. We have chosen these scenarios from a published report that we completed earlier this year for the Energy Networks Association (ENA)[8], as representative of the different extremes of decarbonisation solutions.

Table 1.1 High level description of energy pathways used in our economic growth scenarios

Energy pathway	Description
Evolution of gas	Hydrogen becomes a key fuel in heat and transport.
Diversified energy sources	Uses a mix of heat networks, hydrogen, natural gas and electricity networks for heat and electric vehicles for transport.
No progression	Assumes that the energy mix used today remains the same to 2050 both in terms of fuels and demand proportions.

While we consider our analysis is an informative contribution to this matter, the uncertainty around the assumptions we make in each scenario means that the results of the calculations that are based on them, and the conclusions we reach in this report, are also subject to a significant level of subjectivity and uncertainty.

The results of our analysis are highlighted in the summary and charts below:

Estimated total GVA in 2050[9]

Scenario 1: £5.6 billion

Scenario 2: £5.8 billion

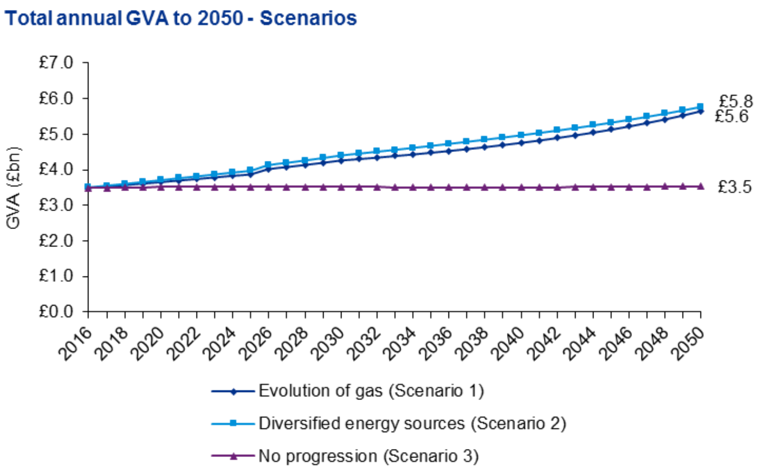
Scenario 3: £3.5 billion

Total jobs in 2050[10]

Scenario 1: 68,674

Scenario 2: 83,956

Scenario 3: 61,098



8 https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

9 Direct and indirect GVA.

10 Direct and indirect jobs.

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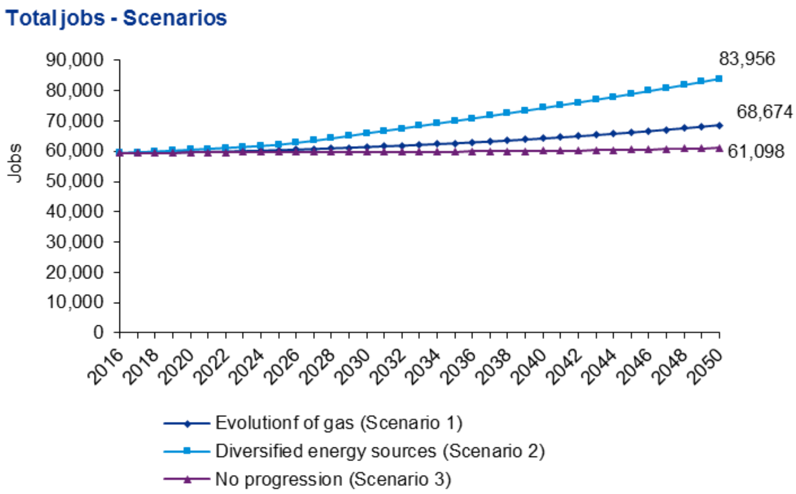

It is worth noting that the difference in jobs between Scenarios 1 and 2 can be attributed to the fact that we have not included supply chain jobs related to hydrogen due to a lack of data to calculate these. We expect these to run into several thousands which would narrow this difference.

Meeting 2050 decarbonisation targets will be challenging. It will require changes to heat and transport energy supplies alongside decarbonisation of power.

Scenario 1 (Evolution of gas) assumes that gas provided to homes and businesses is decarbonised through the substitution of hydrogen for natural gas. Scenario 2 (Diversified energy sources) assumes that a mixture of hydrogen, heat networks and additional electrification substitutes for natural gas.

Scenario 2 shows a slightly higher economic activity than Scenario 1 because a diversified decarbonisation is likely to involve greater changes to existing infrastructure than the hydrogen solution in Scenario 1. Scenario 3 (No Progression) assumes that decarbonisation targets are not met, but existing energy assets are replaced with equivalent resources.

Making it happen

The future Northern energy economy is likely to comprise power, heat and transport in a more integrated way than currently exists. Expected key features of the future energy mix:

- Generation, but with a more diverse, low carbon fuel mix;
- Networks should remain vital to transport energy to consumers and businesses;
- Low carbon appliances and transport should become increasingly important; and
- Different parts of the power sector should become increasingly interlinked e.g. power and heat through hydrogen conversion, and transport and power through electric cars and HGVs. Delivering across these energy vectors in the most efficient and cost effective way will be an important factor to deliver low cost, secure, and clear energy supplies.

Given these developments and based on our analysis we have suggested four key ‘pillars’ that could enable the Northern energy economy to take advantage of the opportunities on offer. Embracing this could allow the North to play a full role in addressing the energy trilemma and increase the economic competitiveness of the region.

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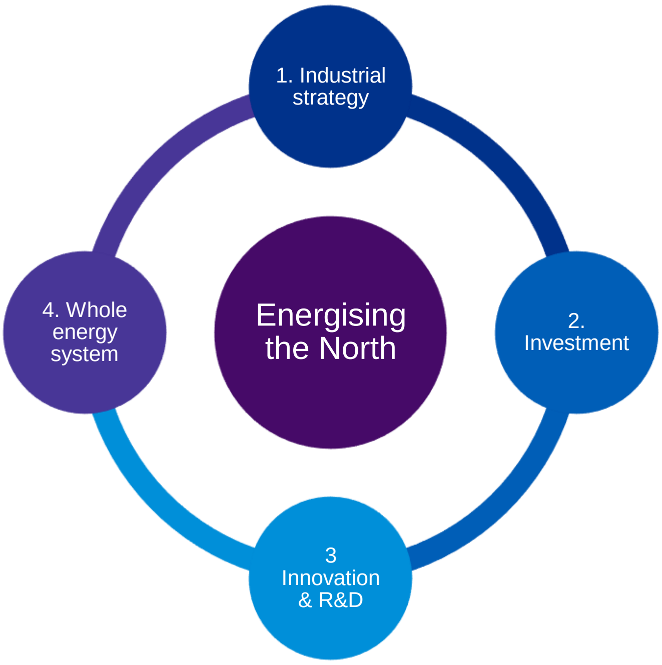
1 **Industrial strategy**: The Government is prioritising its industrial growth strategy, alongside meeting emissions targets. We suggest that low carbon energy should play a key role in an industrial strategy for the North. It could embrace the resourcing, training and skills provision that a growing and evolving energy sector requires, together with infrastructure (e.g. digital, transport) improvements that could drive increased productivity and enable growth.



2 **Investment:** Continuing investment should ensure that the Northern energy economy is able to meet the demand of the region and develop the low-carbon, decentralised, energy systems of the future. Investor confidence is vital in attracting the required investment to the North.

3 **Innovation & R&D**: Changing energy systems may offer considerable opportunities for innovation that can create new goods and services. The North already has capabilities in energy-related R&D, for example in relation to smart networks. It would be important that this focus is maintained (and even strengthened) in the future.

4 **Whole energy system**: Different parts of the energy system are becoming increasingly interlinked. Solutions developed in one sector can have implications elsewhere. For example, increased penetration of electric vehicles may have implications for the energy demand profile of households. By looking across customer needs for energy, the Northern energy economy could deliver the powerful synergies and efficiencies that benefit customers and businesses. Another example relates to the use of hydrogen to power vehicles – if hydrogen vehicles are adopted and rolled-out at scale, electrolyser systems could offer grid balancing services (which enhances the grid's ability to manage renewables) and power to gas storage, which would have an impact on the gas infrastructure.

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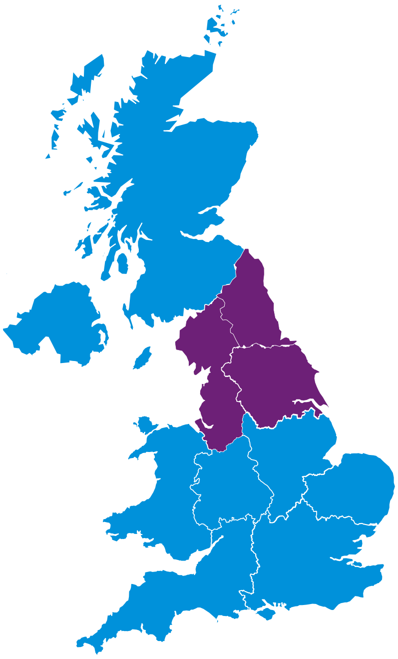
2 Introduction

2.1 Overview

There are currently high levels of interest in improving the economic performance of the North of England. In a speech to the Institute of Directors in September 2016, Greg Clark set out the new Government's belief in the importance of industrial strategy. As well as stating the Government's intent to deliver better infrastructure, education and training, the speech stressed the need for any industrial strategy to be local, and to recognise the different needs of different parts of the country. Mr Clark pledged to deliver 'an upgrade in the development and regeneration of those of our towns and cities that have fallen behind the rest of the country'[11].



The Autumn Statement 2016 reinforced Mr Clark's September 2016 statements. The Chancellor outlined the Government's commitment to infrastructure and innovation, with the prioritisation of additional high-value investment, a new National Productivity Investment Fund, additional funding in the transport networks, vehicles (especially in low emissions vehicles) and R&D. The Government also committed to allocating monies from the Local Growth Fund to the English regions of which c30% will be allocated to LEPs in the North of England[12].

Prior to the EU referendum, the Government signed devolution deals with several cities and regions in the North of England, including Greater Manchester, Sheffield City Region, Tees Valley, North East Combined Authority and Liverpool City Region. It is still looking into settlements with those areas that did not take up the devolution offer, so that a wider area of the North can take advantage of the likely benefits of this political approach. The Autumn Statement 2016 made clear that devolution remains on the Government's agenda in supporting local growth[13].

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11 'The importance of industrial strategy' – Speech by Greg Clark, Secretary of State for Business, Energy and Industrial Strategy, to Institute of Directors annual conference, 27 September 2016. Available at: https://www.gov.uk/government/speeches/the-importance-of-industrial-strategy

12 Autumn Statement 2016: The Chancellor's speech in full, 23 November 2016. Available at: http://www.telegraph.co.uk/business/2016/11/23/autumn-statement-chancellors-speech-full/

13 Autumn Statement 2016: The Chancellor's speech in full, 23 November 2016. Available at: http://www.telegraph.co.uk/business/2016/11/23/autumn-statement-chancellors-speech-full/

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A more productive Northern economy can have significant benefits both for the inhabitants and businesses of the region and also for the overall economic wellbeing of the country. The North of England together makes up c23%[14] of the UK's population, and 19% of UK economic activity (based on 2014 GVA)[15].

The region already boasts several high-growth, high value sectors such as the energy sector, advanced manufacturing, health innovation and digital sector, as highlighted by SQW[16], as well as world class universities engaging in extensive research and development.

The energy sector can be a key enabler of the future growth of the whole Northern economy, both as a growth sector in its own right, and as an 'enabler' of growth in other sectors. As the UK moves towards a low carbon future, the sector faces significant challenges, as it seeks to balance the investment and change required for decarbonisation with the need to maintain secure, affordable energy supplies. These same challenges also represent opportunities for growth: the energy sector in the North is vibrant, with high levels of research, investment and innovation already occurring.

2.2 The purpose of this Report

KPMG was commissioned by Northern Gas Networks (NGN) to produce an independent report that analyses the potential for the 'Northern energy economy' to develop and grow, and steps that can be taken to facilitate this, and to examine ways in which it can address the 'energy trilemma'.

This report provides:

— A high-level snapshot of the energy sector in the North of England and a description of how its supply chains currently contribute to economic activity;
— An identification of sectors of the 'energy economy' that can drive future economic growth and help address the energy trilemma; and
— An assessment of the wider political, regulatory and economic framework that will be required to ensure that these benefits are realised, and a description of what a broader 'energy strategy' for the North of England could look like.

The rest of this report is structured as follows:

— Chapter 3 provides a snapshot of the 'energy economy' in the North of England, in terms of its assets;
— Chapter 4 looks at the energy trilemma and how the Northern energy economy is acting to address it;
— Chapter 5 looks at the current economic contribution of the energy sector;
— Chapter 6 looks at how the sector might grow in the future, using an assessment of growth prospects in key energy segments; and
— Chapter 7 discusses how these benefits can be secured, and the economic, regulatory and political framework which can best deliver growth.

14 Table A1-1, Principal Projection – UK Summary, Population projections, ONS, 2015. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea11principalprojectionuksummary

15 Regional Gross Value Added (Income Approach), ONS, 2015. Available at: http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

16 Page 1, The Northern Powerhouse Independent Economic Review: Final Executive Summary Report, SQW, 24 June 2016. Available at: http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf

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3 The energy sector in the North

This chapter gives a brief overview of the assets of the energy sector in the North of England, and estimates its current contribution to UK GDP.

3.1 A brief history

The North of England was at the centre of the major changes that affected the UK economy as it industrialised during the 18th and 19th centuries and became 'the workshop of the world'[17]. Urban areas grew rapidly, and industry specialised in particular areas, such as Liverpool with its focus on trade, the textile manufacturing towns and cities of Lancashire, and the ports of the North East with their focus on shipbuilding. Energy from the North of England, in the form of the region's plentiful coal deposits, facilitated the development of transport networks and powered the region's factories. As industrialisation progressed, the population of the North of England grew rapidly to meet the region's labour demands, with the North's share of England's population peaking at 36.5% at the time of the 1911 census[18].

Over the course of the late 19th and early 20th century, the economy became electrified, initially to supply lighting but with an increasingly broad range of applications over time. The use of energy sources now described as 'renewable' dates back a long way- Cragside, a country house near Rothbury, was the first building in the world to be lit by hydroelectricity in 1878 and was the residence of Lord Armstrong, an armaments manufacturer[19].

The UK's first three-phase electric power station (Neptune Bank) was opened at Wallsend in the North East by the Newcastle Electricity Supply Company in 1901. By 1910, coal was established as the dominant fuel to power steam turbines[20]. As demand for electricity grew during the 20th century, so did the need for coal, supplied by the coalfields of Yorkshire. Consequently, the coal mining industry remained a major part of the region's economy until the 1980s.

17 The Workshop of the World, Professor Pat Hudson, 2011. Available at: http://www.bbc.co.uk/history/british/victorians/workshop_of_the_world_01.shtml

18 'North of England Economic Indicators', ONS, November 2014. Available at: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/dcp171776_383620.pdf

19 Hydropower returns to Cragside, National Trust. Available at: https://www.nationaltrust.org.uk/features/hydropower-returns-to-cragside

20 '20th century coal and oil-fired electric power generation', Historic England, June 2015. Available at: https://content.historicengland.org.uk/images-books/publications/iha-20thcentury-coal-oil-fired-electric-power-generation/heag056-electric-power-generation-iha.pdf/

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In the later part of the 20th century, a range of factors, including the discovery of North Sea oil and gas and increasing evidence around global warming and air quality, led to move away from coal-fired electricity generation. The North of England has been active in these efforts. For example, the UK's largest coal-fired power station, Drax (in Yorkshire) has converted 2 out of its 6 units from coal to biomass and has one unit using wood pellets for the majority of its fuel. The region now has a significant amount of renewables generation (in 2014, the region supplied around 30% of the renewable electricity generated in the UK[21]) and is home to the UK's principal manufacturing site for offshore wind turbines (the Siemens factory in Hull).

Following urbanisation and economic development came the establishment of the North of England's principal universities. The first university in the region was Durham (founded in 1832), while the so-called 'red brick' universities of Manchester, Liverpool and Leeds were founded in the 1880s. Newcastle University was established in the 1960s. Today, these institutions are at the forefront of research and development in the energy industry. For example, the Universities of Manchester and Sheffield lead the UK's Nuclear Advanced Manufacturing Research Centre (AMRC), which combines manufacturing companies'[22] experience in the area with the knowledge and expertise of the universities. In 2015, the Nuclear AMRC helped companies win over £600 million of new business and created/supported over 3,000 jobs[23].

Recently, Lancaster University and the University of York announced a joint collaboration with the solar park community (civil society, policy and industrial partners) to deliver the Solar Park Impacts on Ecosystem Services (or SPIES) Project[24]. The project aims to develop a decision-support tool to provide a standardised means of identifying the best way to install and manage solar parks.

The National Centre for Energy Systems Integration, led by Newcastle University with Durham, Edinburgh, Heriot Watt and Sussex universities, investigates the challenges of energy supply, sustainability and affordability. Its aim is to pave the way to a flexible smart infrastructure, empowering customers and giving them greater control of their energy use while meeting low carbon targets[25] and working towards energy systems integration.

There are also other research and development centres in the North including Energy Lancaster (Lancaster University), Dalton Nuclear Institute (University of Manchester) and Centre for Integrated Energy Research (University of Leeds). Newcastle University is also host to the new National Institute for Smart Data Innovation (NISDI) which brings together industry, the public sector and academics to develop the skills, ideas and resources needed to exploit opportunities offered in digital data[26].

3.2 Energy assets in the North

3.2.1 Natural resources

The North has natural resources that could potentially play a part in the UK's transition to a low carbon economy, while providing a local source of energy. These include:

[21] Regional Renewable Statistics, BEIS, September 2016. Available at: https://www.gov.uk/government/statistics/regional-renewable-statistics

[22] Founding partners were Rolls Royce, Areva, Westinghouse, Tata Steel and Sheffield Forgemasters.

[23] Nuclear AMRC. Available at: http://namrc.co.uk/about/background/

[24] 'SPIES tool aims to support solar park developments', Energy Lancaster, 2 September 2016. Available at: http://www.lancaster.ac.uk/energy-lancaster/news-and-events/news/2016/spies-tool-aims-to-support-solar-park-developments/

[25] NCL. Available at: http://www.ncl.ac.uk/cesi/about/

[26] 'Chancellor announces funding for Newcastle smart data institute', NCL, 16 March 2016. Available at: http://www.ncl.ac.uk/press/news/2016/03/chancellorannouncesfundingfornewcastlesmartd/

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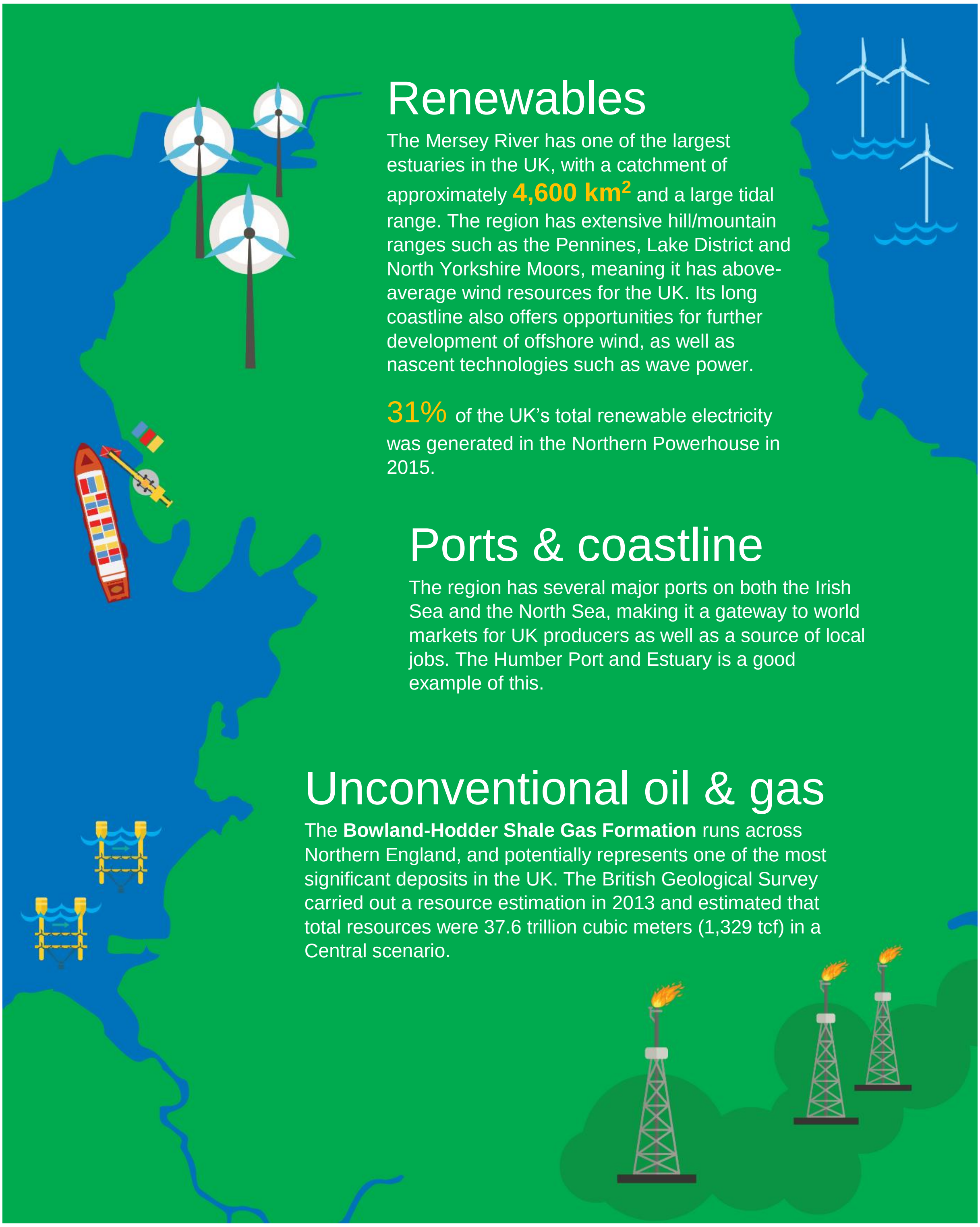
Figure 3.1 Natural resources in the North of England



Source: Regional Renewable Statistics, BEIS 2016. Available at: https://www.gov.uk/government/statistics/regional-renewable-statistics
Page 3, The Carboniferous Bowland Shale gas study: geology and resource estimation, BGS, 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226874/BGS_DECC_BowlandShaleGasReport_MAIN_REPORT.pdf

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The Humber is host to large ports complex which has contributed to the development of a number of industries in the North of England. The Humber markets itself as 'the UK's Energy Estuary', bringing 'everything from coal to cars, food to freight, passengers to petroleum'[27] and serves both the UK and European markets. The region also hosts the UK's second largest chemical cluster and heavily contributes towards the demand for renewable sources of energy and fuel through investment in offshore and marine engineering and energy infrastructure, to name but a few[28].

3.2.2 Industry and research

The region's industrial past means it now has many significant urban and industrial centres, principally Leeds, Liverpool, Manchester, Newcastle, Hull, York, Sheffield and Teesside[29].

Densely populated, urban areas can provide valuable testing grounds for new energy technologies, in particular around smart grids and networks. As alluded above, universities in these cities are closely involved in energy R&D. Furthermore, the region also hosts the Offshore Renewable Energy Catapult in Blyth, which is the UK's flagship innovation and research centre for offshore wind, wave and tidal energy.

The North also has a strong industrial base. This includes the Nissan automotive plant in Sunderland. There will be increasing scope for shared learning and technological development between the transport and energy sectors in the future, as batteries and EVs become increasingly prevalent. Additionally, the Wilton Centre and Wilton International are centred on Teesside. The complex includes one of the largest research and technology facility in Europe for its petrochemical, plastics and advanced materials businesses as well as process manufacturing sites and has been used as the economic cluster for the North East of England Process Industry Cluster[30].

The region will also become a focal point of the renewable electricity industry with the completion of the Siemens offshore wind factory in Hull. Together Siemens and Associated British Ports (ABP) have invested £310 million in the Green Port project. This direct investment is expected to create up to 1,000 direct jobs, with additional jobs during construction and indirectly in the supply chain, and is expected to begin assembling turbines in 2017[31]. The Government has signalled its intent to continue to support the deployment of offshore wind into the 2020s[32], which will ensure a longer term pipeline of orders for the factory. The North also has offshore specialist services operating out of the Newcastle area based originally around the oil and gas industry. It is now expanding its product and service offerings[33] to cover wind given the four consented wind farms to be constructed on Dogger Bank.

As well as the automotive sector, the North has various strengths in other advanced manufacturing and materials sectors, for example:

— **High precision engineering:** Building on Sheffield's tradition of steelmaking, the city is now a centre of expertise in high precision engineering, metals and alloy production. It supplies many manufacturing sectors, both in the UK and internationally, such as civil nuclear, offshore wind,

27 'Welcome to the Humber, the UK's Energy Estuary ', The Humber, 2016. Available at: http://arlingtonmoore.co.uk/media/Bondholders_Welcome_to_the_Humber.pdf

28 'Welcome to the Humber, the UK's Energy Estuary ', The Humber, 2016. Available at: http://arlingtonmoore.co.uk/media/Bondholders_Welcome_to_the_Humber.pdf

29 Teesside, Middlesbrough, Stockton and Billingham are the home of major industry and could host hydrogen production and carbon capture and storage in the future.

30 Wilton International. Available at: http://www.wiltoninternational.com/

31 'Siemens freezes new UK wind power investment following Brexit vote', Guardian, 28 June 2016. Available at: https://www.theguardian.com/environment/2016/jun/28/siemens-freezes-new-uk-wind-power-investment-following-brexit-vote

32 'Offshore wind to compete for 4GW of UK CfDs by 2020', Rechargenews, 16 March 2016. Available at: http://www.rechargenews.com/wind/1427026/offshore-wind-to-compete-for-4gw-of-uk-cfds-by-2020

33 Cable laying, for example.

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aerospace, defence and oil and gas. It is also home to the Advanced Manufacturing Park, one of the UK's most important hubs for advanced manufacturing technology[34].

— **Aerospace:** Lancashire is home to the North West Aerospace Cluster. This is the largest of its kind in Europe, comprising over 220 companies and generating over £7 billion in annual sales[35];

The North is highly productive in manufacturing and materials, electricity and gas, services (financial and insurance, architectural and engineering services, other professional services) IT and electronics and media, printing and recording[36]. Many of these components form part of the energy industry supply chain and contribute to GVA and jobs in the North.

3.2.3 The energy industry in the North

The energy sector is generally recognised as having the following three main components:

— **Energy production**: Includes the generation of electricity at power plants and the extraction of natural gas. The supply chain of this segment is associated with building rigs and supporting infrastructure together with the production of materials associated with drilling. Although no gas extraction currently takes place in the North, there are over 2,000 supply chain workers that support the industry[37]. Furthermore, as set out in Section 3.2.1 above, the region has potentially significant resources of unconventional oil and gas in the form of the Bowland field, and permissions have recently been granted for exploratory drilling in North Yorkshire and Lancashire[38]. Additionally, electricity generation in the North employs over 18,000 people directly and through its supply chain[39] as host to the Dalton Nuclear Institute, the Urenco/Capenhurst Uranium enrichment plant, Drax, Eggborough, offshore wind farms near Liverpool and in Yorkshire and The Humber, etc.

— **Energy networks**: Includes the transmission and distribution networks to transport electricity and gas from generation hubs to consumption points. The networks require large infrastructure, building and maintenance of pipes and transport services. The North is host to two Gas Distribution Networks (GDNs) and three electricity Distribution Network Operators (DNOs) which employ over 15,000 people directly and through their supply chains[40].

— **Energy retail (energy suppliers):** Includes the provision of energy to final users; this involves billing and managing price risk for end users, providing metering services and communicating information to consumers. These activities involve customer services staff and call centres, IT infrastructure for billing, workers to install and read meters and media, advertisement and print services to communicate information to customers. There is no large energy supplier with headquarters based in the North of England. However, the region benefits from the presence of a number of energy supplier businesses/offices such as the EDF call centre in Sunderland, RWE npower offices in the North East[41], British Gas's smart meter centre[42] and Engie's energy supply and solutions employing over 13,500 people directly and through its supply chain[43].

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34 'Your Next Location', Sheffield City Region. Available at: http://scrinvest.com/wp-content/uploads/2014/03/Your-Next-Location-Sector-brochure.pdf

35 Northwest Aerospace Alliance. Available at: http://www.aerospace.co.uk/about-us

36 Page 8, The Northern Powerhouse Independent Economic Review: Final Executive Summary Report, SQW, 24 June 2016. Available at: http://www.sqw.co.uk/files/3814/6723/8721/16987_-_TfN_-_Workstream_3_-_Pan-Northern_Capabilities_-_FINAL_Report_-_1_May_2016.pdf

37 Fame database.

38 'Fracking given UK go-ahead as Lancashire council rejection overturned', Guardian, 6 October 2016. Available at: https://www.theguardian.com/environment/2016/oct/06/uk-fracking-given-go-ahead-as-lancashire-council-rejection-is-overturned

39 Fame database.

40 Fame database.

41 **Houghton le Spring**: customer services, domestic services and CTP (2,500 staff), **Leeds**: metering, SMART, Green Deal, compliance, energy services and customer services (1,200 staff), **Burton on Trent**: energy services division (200 staff), **Hull**: customer services, business change and customer transformation projects (600 staff). Source: https://www.npowerjobs.com/jobs-in-burton-on-trent

42 Employing c1,600 engineers. Available at: __https://www.britishgas.co.uk/media/r/1369/british_gas_hires_200_smart_meter_apprentices

43 Fame database.

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In addition, two other sectors contribute to overall energy sector economics:

— **Appliances and buildings**: Includes manufacturing and installation of energy efficient appliances, heating appliances (boilers), dwelling improvements and distributed energy systems (e.g. heat pumps, CHP, solar PV, etc.). The appliances and building energy sector is extensive in the North with an estimated 9,600 jobs employed directly or indirectly through the supply chain. This includes the manufacture of electric domestic appliances and electrical equipment, the repair of electrical equipment, electrical installations, roofing activities and the repair of household appliances and home.

— **Transport:** Includes the manufacture of EVs, fuel cells vehicles and ULEV components for low emission transportation solutions. The Nissan factory in Sunderland supports 7,200 direct jobs[44] alone and another 27,000 in its supply chain[45].

We provide further details on the economics of these sectors in Chapter 5.

3.2.4 Electricity generation

The North of England hosts a number of major power stations, across a range of generating technologies. A summary of total capacity in the region is shown in Table 3.1 Capacity and major installations in the North of England

Table 3.1 Capacity and major installations in the North of England

Technology	Capacity (MW)
Biomass	2,100
CCGT	5,400
Coal	5,900
Gas and gas oil	1,700
Nuclear	3,600
Wind (onshore and offshore)	2,200
Other (solar, hydro)	40
Total	**20,940**

Source: DUKES, BEIS. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540948/DUKES_5.10.xls

3.2.5 Energy network assets

The high voltage/high pressure electricity and gas transmission networks for the UK are owned and run by National Grid. The North has its own lower pressure/voltage distribution networks, details of which are set out in the Table 3.2 Electricity distribution networks in the North of England and Table 3.3 Gas distribution networks in the North of England

44 Fame database.

45 'Nissan to invest £100m in Sunderland plant as new Juke gets the green light', Daily Telegraph, 3 September 2015. Available at: http://www.telegraph.co.uk/finance/newsbysector/industry/engineering/11840148/Nissan-to-invest-100m-in-Sunderland-plant-as-new-Juke-gets-the-green-light.html

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Table 3.2 Electricity distribution networks in the North of England

Electricity		
Electricity North West Limited (ENWL)	**Northern Powergrid (NPG)**	**SP Energy Networks**
Region: North West Planned investment (annual average): £110 million [46] ENWL owns and operates the network of 57,000 km of cables in the North West of England. That means that the money invested is spent solely on the North West[47]: — 55% of their customers live in Greater Manchester; — 30% live in Lancashire; — 10% live in Cumbria; and — 5% of their customers live in Cheshire, Derbyshire and North Yorkshire.	Region: Yorkshire and North East Planned investment (annual average): £175 million[48] NPG is the electricity distribution network operators and owner serving over 8 million people across the Northeast, Yorkshire and north Lincolnshire. The DNO distributes electricity to 3.9 million homes and businesses across the region through their network of more than 60,000 substations and 93,000 km of overhead power lines and underground cables spanning some 26,000 square km[49].	Region: Merseyside, Cheshire[50] Planned investment (annual average): £115 million[51] SP Energy Networks serves 1.5 million customers, using more than 48,000km of cables and overhead lines.

Source: KPMG.

Table 3.3 Gas distribution networks in the North of England

Gas	
Northern Gas Networks (NGN)	**National Grid Gas Distribution (NGGD)**
Region: Yorkshire and North East Planned investment (annual average): £129 million[52] NGN delivers gas to 2.7 million homes and businesses in the North East, Northern Cumbria and much of Yorkshire; that is around 6.7 million individuals. — The GDN owns more than 37,000 km of gas pipes delivering gas to large cities such as Newcastle, Sunderland, Leeds, York, Hull and Bradford and rural areas such as North Yorkshire and Cumbria[53]**.**	Region: North West Planned investment (annual average): £120 million [54] NGGD delivers gas to the North West with a network of 33,000 km of pipes[55] to 2.7 million customers.

Source: KPMG.

46 Average over current price control period (2015-2023) in actual load and non-load related capex in £m12/13 prices. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-ed1-price-control-financial-model-following-annual-iteration-process-2015

47 ENWL. Available at: http://www.enwl.co.uk/about-us/who-we-are

48 Average over current price control period (2015-2023) in actual load and non-load related capex in £m12/13 prices. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-ed1-price-control-financial-model-following-annual-iteration-process-2015

49 Northern Powergrid. Available at: http://www.northernpowergrid.com/about-us

50 SP Energy Networks also covers North Wales and North Shropshire.

51 Average over current price control period (2015-2023) in actual load and non-load related capex in £m12/13 prices. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-ed1-price-control-financial-model-following-annual-iteration-process-2015. Figures also include investment in wider SP Energy Networks area.

52 Average over rest of current price control period (2017-2021) in actual load and non-load related capex as well as repex in £m09/10 prices. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

53 Northern Gas Networks. Available at: http://www.northerngasnetworks.co.uk/about-us/where-we-work/

54 Average over rest of current price control period (2017-2021) in actual load and non-load related capex as well as repex in £m09/10 prices. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

55 Price Control, National Grid, July 2016. Available at: http://www.talkingnetworksngd.com/price-control-more-detail.aspx

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3.2.6 Network interconnectors

The North will soon be host to a major electricity interconnector, the North Sea Link (NSL), which will connect the UK and Norway electricity systems via a subsea cable running from Kvilldal in Norway to Blyth in the North East of England. Jointly owned by Statnett and National Grid, it will have a capacity of 1.4 GW and cable length of 720 km. It is expected to begin construction in 2017/18 and be operational in 2021[56].

The Langeled pipeline imports Norwegian gas into Easington, UK. It has an annual capacity of 25.5 billion cubic metres, equivalent to around 20% of Britain's peak gas demand[57].

Additionally, ConocoPhillips Norway operates an export pipeline from the Ekofisk Complex in Norway to Teesside in England[58]. The oil pipeline is 354 km long and has an external diameter of 34 inches. It came on stream in October 1975 and transports oil extracted in the UK continental shelf[59].

56 North See Link. Available at: http://nsninterconnector.com/about/project-timeline/

57 Page 122, 'Politics, Markets and EU Gas Supply Security- Case Studies of the UK and Germany', S-D Kopp, 2015.

58 The pipeline is owned by Norpipe Oil AS.

59 'The Pipelines', ConocoPhillips. Available at: http://www.conocophillips.no/EN/our-norway-operations/greater-ekofisk-area/Pages/the-pipelines.aspx

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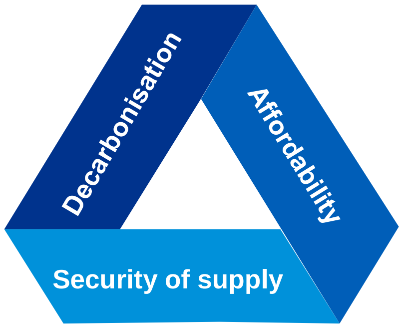
4 The North’s role in addressing the energy trilemma

The ‘energy trilemma’ is the challenge faced by governments, regulators, individuals, and public and private sector players with regards to providing reliable, low-carbon energy at an affordable price. Reconciling these three, often conflicting elements can help ensure a prosperous, sustainable future for the UK’s inhabitants.

The challenges, but also the opportunities, that the energy trilemma presents will play a key role in the development of the energy sector in the North of England and the UK more widely.



In this section, we describe in more detail each element of the trilemma (security of supply, decarbonisation and affordability), and what the North is currently doing to address it.

4.1 Ensuring security of supply

Current situation

Security of supply is a vital factor in the wellbeing and comfort of households and is crucial in the performance of businesses and for economic growth.

The UK faces a challenging outlook on security of supply, with declining domestic production of oil and gas from the North Sea, an ageing nuclear fleet and coal power stations facing closure or reduced running hours under EU environmental directives. In addition, the increasing penetration of variable renewable energy sources such as wind and solar PV, and the advent of decentralised energy, make the challenge of balancing the electricity system even more demanding.

The North of England currently contributes to ensuring security of supply in the UK with major power plants supplying a significant amount of electricity to meet UK demand and a diverse mix of generation technologies whose different characteristics allow risk to be more easily managed. However, some of the key generating technologies in the North face major future challenges. The region’s nuclear power

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plants are ageing[60], as are the region's 5,900MW of coal-fired generation[61][62]. These nuclear and coal-fired power plants represent 9.5GW of installed capacity, representing over 15% of the installed capacity used to meet the UK's average electricity peak demand of 60 GW[63]. As such, plant decommissioning is a concern for both the region and the UK.

What is the North currently doing?

Investment in alternative technologies to generate power can contribute to the UK's security of supply while stimulating economic growth and jobs. An example of this is the conversion to biomass of two of Drax's units. This has enabled capacity that would otherwise have faced a cap on its running hours to run unconstrained while generating zero-carbon electricity.

The North could also contribute to the UK's security of supply through the development of its unconventional oil and gas resources. As mentioned in Section 3.2.1, the region potentially has significant resources, although more testing and exploration is needed to ascertain the extent of these resources, and whether they can be extracted economically. If significant amounts of oil and gas could be extracted, this could at least partially offset the decline in production from the North Sea, and could reduce the UK's reliance on overseas energy sources.

Other alternatives also include the ability to reduce demand through demand-side response (DSR) and energy efficiencies (EE) measures. The Business Energy Efficiency Project (BEEP) led by County Durham and funded by the EU has been developed to increase the uptake of energy efficient technologies and processes within the SMEs. It has secured support from the European Regional Development Funding for the period 2014-2020 and has been endorsed by the North East Chamber of Commerce, the North East LEP, the Federation of Small Business, Business Durham, Northern Powergrid and the Energy Institute of Durham. The project aim to provide advice and guidance, promote the long-term advantages of EE, provide SME energy audits and grants to encourage EE measures[64].

Electrical energy storage can also contribute to lowering peak demand in the future. The Centre for Research into Electrical Energy Storage and Applications (CREESA) of the University of Sheffield is one of the UK's leading research centres on all aspects of electrical energy storage. Their projects include the Battery Energy Storage Demonstrator and a 2MW grid connected research facility utilising a lithium titanate battery which could contribute to tackling the challenges of energy storage[65].

The ability to integrate new energy technologies, smart grids, DSR and EE measures and intra-utilities collaboration can altogether contribute to the North's and the UK's security of supply. Examples of this include Infrastructure North, Northern Gas Networks (NGN), Northern Powergrid, Yorkshire Water and Northumbrian Water, who together make up Infrastructure North. Additionally, there is potential to develop an integrated energy system where the power networks rely on gas networks to store excess energy (power-to-gas) and use gas networks to provide fast response local generation back to the grid. The National Centre for Energy Systems is exploring the options available.

60 Hartlepool and Heysham 1 both began generation in 1984, and Heysham 2 in 1988. Total installed capacity is 3,565MW.

61 Ferrybridge C Power Station officially closed on 23 March 2016. Eggborough began generation in 1967 and is due to close in 2017 (after being granted an extension by participating in National Grid's Supplemental Balancing Reserve (SBR). Fiddlers Ferry began generation in 1971 and is due to close in 2025 while Drax (coal units) began generation in 1974 and is expected to close in 2025 as well.

62 We also note the recent closure of the Kellingley pit in North Yorkshire which brought deep coal mining to an end at the end of 2015.

63 Table PD30b and Table PD36b, Residential, industrial and commercial electricity peak demand, FES 2016. Available at: http://fes.nationalgrid.com/

64 The Business Energy Efficiency Project, Visit County Durham. Available at: http://www.visitcountydurham.org/images/uploads/files/beep.pdf

65 CREESA, The University of Sheffield. Available at: https://www.sheffield.ac.uk/creesa

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Networks and universities in the North are closely involved in R&D projects to ensure that the network is resilient to these challenges. In Table 4.1 we provide details of some of these projects:

Table 4.1 Security of supply R&D projects

Project	Parties involved	Description
Demand scenarios with Electric Heat and Commercial Capacity Options	ENWL	Aims to demonstrate better technical approaches to estimate future peak load by distribution network asset, and analyse commercial solutions to capacity problems. The project aims to deliver benefits including reinforcement deferral, better targeted investment, improved demand forecasting, carbon reduction, etc. The project is expected to close down in October 2016[66].
Offgrid substation environment for the acceleration of innovative technologies (OSEAIT)	NGET	Aims to modify an existing 400kV substation into an easily reconfigurable, field trial facility. This offgrid facility will replicate a live substation environment to overcome the operational barriers associated with the implementation of innovative methods and technologies on the electricity network.
Smart Grid Laboratory	Newcastle University, Northern Powergrid	Experts from Newcastle University are leading the UK's largest smart grid project looking at how different power sources can be managed at an acceptable cost. The University has collaborated with industry to set up a Smart Grid laboratory and energy storage test bed, the £2 million cost of which has been met through funding from the Engineering and Physical Sciences Research Council (EPSRC), Newcastle University and industrial partners Northern Powergrid and Siemens. The Smart Grid lab is designed to simulate distribution networks under future scenarios. The lab is able to simulate the working of energy networks in real time, enabling the evaluation of new network technologies. The energy storage test bed is a grid-connected facility which houses a variety of electrical energy storage technologies with a wide range of performance characteristics, enabling a wealth of grid services and case studies to be supported.
Customer Led Network Revolution	Northern Powergrid	Northern Powergrid and partner's 'Customer-Led Network Revolution project', which completed a major four year smart grid demonstration project in 2014. The project generated important new learning, from trials with real customers on real networks, and was at the forefront of research into how UK electricity networks can rise to the challenges presented by a low carbon future[67].

[66] NIA Progress Report, ENWL, 22 July 2016. Available at: http://www.enwl.co.uk/docs/default-source/future-nia/2016-nia-ppr-demand-scenarios-v1-0.pdf?sfvrsn=2

[67] Customer-Led Network Revolution. Available at: http://www.networkrevolution.co.uk/

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Project	Parties involved	Description
Activating Community Engagement (ACE)	Northern Powergrid	NPG's ACE is a three-year project explores the long-term opportunity for domestic householders to trade appliance load curtailments in an online game. It trials gaming options with customers in the Weardale area of County Durham to test ease of recruitment, the size of load response available and whether this can be reliably sustained to be of use to distribution network operators and other potential users of demand-side reduction services[68,69].
NEDO Smart Heat project	Greater Manchester Combined Authority	Greater Manchester Smart Energy project is a smart energy programme launched in 2015 through the partnership between Greater Manchester's Combined Authority (GMCA) and Japan's New Energy Development Organisation (NEDO). The project aims to replace the heating systems of 600 homes in the Greater Manchester region with new air source heat pumps. The pumps are connected to a 'smart grid' system which is used to monitor and control the energy produced in each home. This will help to balance and reduce peak demand on the National Grid, which is currently close to capacity. The scheme sets out to In March 2016, 300 social housing properties have participated in this scheme.[70]

What the North could do in future

The development of smart grids which allows more efficient customer solutions to be developed while still ensuring security of supply is expected to grow in the future. The experience gained to date in the North is expected to provide a strong foundation for future development.

In addition, hydrogen networks could also provide the impetus the development of a CCS infrastructure which the power sector could share. Although the Government cancelled a competition to build a CCS demonstration plant in 2015, a recent report (commissioned by Government) suggests that CCS has a central role to play in the UK's decarbonisation efforts[71]. The development of a CCS infrastructure would allow the continued deployment of coal- and gas-fired power stations in the North, which would increase the diversity of the fuel mix and provide valuable flexibility given high amounts of intermittent renewable generation in the future.

There are also further opportunities to be found by investing into research and development looking at the potential for cross-vector energy systems. This could include research on dual fuel appliances (low/zero carbon appliances) and power to gas technologies, to name but a few.

[68] Innovate UK funded projects since 2004, Innovate UK. Available at: https://www.gov.uk/government/publications/innovate-uk-funded-projects

[69] 'We're Activating Community Engagement in Weardale', NPG, 16 September 2015. Available at: http://www.npg-ace.com/news/were-activating-community-engagement-in-weardale/

[70] 'Greater Manchester Smart Energy project hits halfway mark', GMCA, 7 March 2016. Available at: https://www.greatermanchester-ca.gov.uk/news/article/52/greater_manchester_smart_energy_project_hits_halfway_mark

[71] 'Lowest cost decarbonisation for the UK- the critical role of CCS', Parliamentary Advisory Group on Carbon Capture and Storage, September 2016. Available at: http://www.ccsassociation.org/news-and-events/reports-and-publications/parliamentary-advisory-group-on-ccs-report/

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4.2 Driving decarbonisation

Current situation

The Climate Change Act 2008 sets the framework for the UK to transition to a low-carbon economy and requires that Greenhouse gas emissions, the majority of which is carbon dioxide (CO_2) will be reduced to 20% of 1990 levels[72] by 2050. Legally binding 'Carbon Budgets' set the UK's trajectory towards meeting the 2050 target. The Fifth Carbon Budget (covering the 2028 to 2033 period) was passed into law in June 2016 and will require a 57% reduction of emissions from 1990 levels by 2030[73]. Internationally, the Paris Agreement to limit global warming to 'well below 2 degrees Celsius' has now come into effect following ratification by the EU[74]. The UK plans to ratify the Paris agreement by the end of the year[75].

Although the UK has made some good progress in decarbonising the power sector, the heat and transport sectors, which account for roughly 44% and 41%[76] of UK emissions respectively, are making slower progress. The Government had put in place policies to encourage decarbonisation of heat, in particular the Renewable Heat Incentive (RHI), but these polices have had limited impact so far. To meet decarbonisation targets reducing emissions from electricity generation alone will not be possible, and a significant degree of decarbonisation of heat and transport will also be required.

What the North is currently doing

Trialling technologies and investing in R&D prior to committing to full expenditure is important, especially for new and unproven technologies. Desktop research and trial projects have demonstrated that some technologies have the potential to be deployed at scale. Table 4.2 below shows some of the projects that are currently being undertaken to look at ways of decarbonising the energy system:

Table 4.2 Decarbonisation R&D projects

Project	Parties involved	Description
Leeds H21 City Gate project	NGN	This project is looking into the feasibility of substituting natural gas with hydrogen in the gas distribution network. Basing the study around the city of Leeds to show that the concept is a system solution applicable to all the major cities of the UK and as such contributing to a highly significant reduction in carbon by tackling directly the issue of heat. So far, the project has proved, via a desktop exercise that the current gas network in the UK is large enough to convert to hydrogen. NGN believe Leeds would be well-placed to be the first UK city to convert, and estimate costs of around £2 billion. This project has identified a number of economic benefits from the hydrogen conversion programme to Leeds and the wider region. These are driven by the establishment of Leeds as a 'centre of excellence' for the hydrogen economy, which would in turn lead to the development of 'hydrogen clusters' by technology developers and other parts of the supply chain. There is also a significant growth opportunity in relation to the infrastructure needed to have hydrogen, this includes SMR plants CO2 storage facilities (depleted oil and gas fields in the UKCS) and salt caverns to store hydrogen for seasonal and daily storage.

[72] Climate Change Act 2008. Available at: http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf

[73] 'UK sets ambitious new 2030s carbon target', The Guardian, 30 June 2016. Available at: https://www.theguardian.com/environment/2016/jun/30/uk-sets-ambitious-new-2030s-carbon-target

[74] 'Paris Agreement to enter into force as EU agrees ratification', European Commission, 4 October 2016. Available at: http://europa.eu/rapid/press-release_IP-16-3284_en.htm

[75] 'Theresa May: UK to ratify Paris climate change deal this year', The Guardian, 20 September 2016. Available at: https://www.theguardian.com/world/2016/sep/20/theresa-may-uk-ratify-paris-climate-change-agreement-this-year

[76] The Future of Heating: Meeting the challenge, DECC, March 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/190149/16_04-DECC-The_Future_of_Heating_Accessible-10.pdf

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Project	Parties involved	Description
		The conversion would be a major infrastructural transformation, requiring the manufacture of large quantities of new hydrogen-compatible appliances and burners, and the training of a large workforce to undertake the conversion. The Leeds workforce could then form the basis of the teams that converted other cities' networks to hydrogen. CCS is expected to play a key role in the decarbonisation trajectory of many countries besides the UK, including Canada, Japan, Russia and the US. The skills and expertise developed on projects in the North East could be exported to other countries which need to develop CCS, thus driving exports and growth[77].
Electric vehicles	Nissan	The Nissan factory in Sunderland is leading the development of ultra-low emission vehicles. The plant supports 6,700 jobs directly and another 27,000 in its supply chain. Nissan is also collaborating in a £19 million research project on battery technology with Universities of Warwick and Newcastle.
Heat networks delivery funding		Recent data compiled by BEIS unveil that more than one third of local authorities in the country are working on heat network schemes, where 38 councils have been successful as part of the latest £2.8 million funding round (Heat Networks Delivery Unit (HNDU) Round 6) to support feasibility studies for heat networks. This would bring the overall total to 131 councils out of 381 in England and Wales[78]. The North of England has had high participation levels in the HNDU funding competition in Rounds 1 to 5[79]. This demonstrates the potential for heat networks in the North of England and how the region could become a national leader in the district heating supply chain. The region also makes up a significant proportion of renewable heat capacity: as of January 2016, 14% of capacity accredited under the non-domestic RHI scheme was in the region[80].
Smart Systems and Heat Programme	Catapult/ETI	The ETI's Smart Systems and Heat (SSH) programme aims to create local heating solutions for the UK. The programme provides the foundation for energy systems design that help to deliver low carbon heating for the UK in the future. Phase 1 of the programme involves working with three local communities (Bridgend, Greater Manchester and Newcastle) to create the capability to deliver local energy plans for these communities. The programme will also create heat supply and demand products and services through a number of consumer behaviour research, business modelling and supply-chain activities. Phase 2 of the programme will include a demonstration of the designed local smart energy systems to prove its capability and approach that can be adopted nationally[81].

What the North could do in future

Northern cities could play an even more significant role in driving decarbonisation in the future and contributing to cross-vector technology research and development. This could involve the development of a regional decarbonisation pathway which takes account of the North's natural

[77] H21, Leeds City Gate, July 2016. Available at: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

[78] Heat networks delivery funding, BEIS, 2016. Available at: https://www.gov.uk/government/publications/heat-networks-funding-stream-application-and-guidance-pack

[79] Map of successful HNDU rounds 1-5 Local Authorities, Heat networks delivery funding, BEIS, 2016. Available at: https://www.gov.uk/government/publications/heat-networks-funding-stream-application-and-guidance-pack

[80] Figures quoted above relate to Yorkshire and Humber and the North East from RHI Deployment data, BEIS, 2016. Available at: https://www.gov.uk/government/statistics/rhi-deployment-data-january-2016

[81] 'Catapult to deliver the ETI's Smart Systems and Heat Programme as its first major project for the energy industry', ETI, 2 November 2015. Available at: http://www.eti.co.uk/news/catapult-to-deliver-the-etis-smart-systems-and-heat-programme-as-its-first-major-project-for-the-energy-industry/

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resources and makes the appropriate trade-offs between investments in different technologies. Northern cities have already acted as the testing ground for new technologies – in particular, hydrogen networks – and are offering significant intellectual property benefits for the UK as a whole along with advanced skillsets in this field. In addition, the region's many urban and industrial centres could see the development of municipal energy delivery models which harness the region's decentralised energy resources.

As well as driving decarbonisation in the North, the experience of the region would provide a model for similar developments in other parts of the country and help to identify the low carbon technologies which would allow the UK to meet its decarbonisation targets at least cost.

Trialling technologies and investing in R&D prior to committing to full expenditure is important, especially for new and unproven technologies. Desktop research and trial projects have demonstrated that some technologies have the potential to be deployed at scale. The concentration of expertise and know-how in the North would act as a powerful driver of economic growth as Northern cities become centres of energy excellence, 'exporting' to the rest of the UK and beyond.

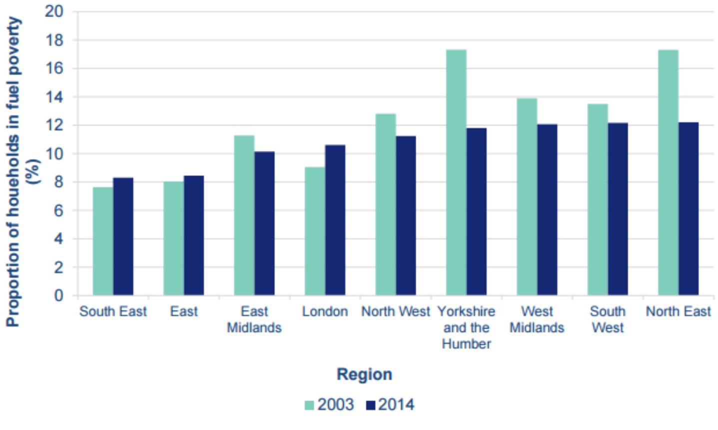
4.3 Ensuring affordability

Current situation

Lower energy costs free up household and business financial resources that can be directed to more productive, value-adding activities. Furthermore, access to reliable and affordable energy is critical to regional and national economic prospects. Affordable warm homes is a key aim of tackling fuel poverty and would have significant health benefits for the fuel poor[82].

The North-East of England has the highest proportion of households in fuel poverty, with over 12 per cent of households classed as fuel poor in 2014[83] Yet, between 2003 and 2014, the North East and Yorkshire and the Humber have both seen the largest percentage decrease in fuel poverty levels, from over 17.0 per cent in 2003, to approximately 12.0 per cent in 2014 as shown in Figure 4.1 below. In general, regions with higher fuel poverty rates tend to have lower average incomes[84] so ensuring affordable energy supply in the North of England is key.

Figure 4.1 Fuel poverty by region, 2003-2014



Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540034/Annual_Fuel_Poverty_Statistics_Report_2016_-_revised.pdf Page 42

82 This has a knock-on effect to the NHS in terms of funding, beds, etc.

83 Annual Fuel Poverty Statistics Report, DECC, June 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540034/Annual_Fuel_Poverty_Statistics_Report_2016_-_revised.pdf

84 Annual Fuel Poverty Statistics Report, DECC, June 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540034/Annual_Fuel_Poverty_Statistics_Report_2016_-_revised.pdf

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Energy efficiency is another aspect that help decrease fuel poverty as less energy is consumed, hence lowering energy bills. The next two sections outline a few initiatives taken by local councils towards energy efficiency.

What the North is currently doing

Many of the initiatives referred to above which contribute to addressing the challenges of decarbonisation and energy security in the most efficient way will also help ensure that energy remains affordable. Table 4.3 below sets out some examples of where stakeholders in the Northern energy economy are working together to ensure that energy prices remain low and energy consumption falls for the area's most vulnerable people:

Table 4.3 Fuel poverty initiatives

Project	Parties involved	Description
Extending gas networks	NGN, incommunities	Incommunities has teamed up with Northern Gas Networks (NGN) the north of England's gas distributor, and Community Energy Solutions (CES) to deliver more affordable energy solutions to 79 social housing properties in Bradford, Bingley and Shipley. The investment from NGN, worth £156,000, saw nearly 500 meters of new plastic gas mains installed which will deliver gas to homes that were previously not served by the existing gas mains network. Now that the properties have been connected to the network, the Incommunities' tenants will be able to benefit from gas central heating systems for the first time. The new heating systems, which will be installed later this year by Property solutions, part of Incommunities Group, include energy efficient gas condensing combination boilers and radiators[85].
Fairerpower	Cheshire East Council, Ovo Energy	Partnership between Cheshire East Council and OVO Energy. Partnering agreement for energy supply and management services, whereby OVO supply energy and back office functions e.g. billing, metering, and Cheshire East Council set tariff and promotes scheme[86].
Your Homes Newcastle	Newcastle	Your Homes Newcastle (YHN) is an Arms' Length Management Organisation (ALMO) responsible for managing council homes on behalf of Newcastle City Council. It was set up in 2004 to manage council properties, to improve housing in order to meet the Government's Decent Homes standard, and to provide a range of support services for Newcastle City Council. Part of YHN's remit include helping council homes with energy and water efficiency measures including home insulation and providing tips and guides on how to be more energy efficient[87].
White Rose Energy	Leeds	White Rose Energy is an energy supplier that has been set up by Leeds City Council in partnership with Robin Hood Energy to provide residents from across the region with a fairer alternative for their gas and electricity. This supplier is available to all residents across the region, regardless of whether customers own or rent their properties[88]. It offers a number of tariff structures, competitive prices regardless of tariff types and affordable deals for lower energy users and pre-payment customers.

85 'Partnership brings gas central heating to residents', West and North Yorkshire Chamber of Commerce, 29 July 2015. Available at: https://www.wnychamber.co.uk/partnership-brings-gas-central-heating-to-residents-in-west-yorkshire/

86 Fairerpower. Available at: http://fairerpower.co.uk/about-us/

87 YHN's Guide to being green, Your Homes Newcastle. Available at: https://www.yhn.org.uk/i-need-support/save-energy-save-money/yhns-guide-to-being-green/

88 White Rose Energy, Leeds City Council. Available at: http://www.leeds.gov.uk/council/Pages/White-Rose-Energy.aspx

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Project	Parties involved	Description
Warm Up North	British Gas and local councils in the North East	Warm Up North is an initiative sponsored by British Gas and local Councils in the North East to help households in the North East to deliver a range of energy efficiency into homes. The programme aims to help reduce fuel poverty and improve health and well-being in the local area. It offers free Home Energy Survey, provide advice on energy saving measures to help households reduce their energy consumption and bills[89].

What the North could do in future

Energy suppliers and networks should continue to make targeted interventions to address fuel poverty. This could include:

— The development of local ‘white label’ tariffs (similar to the Fairerpower initiative in Cheshire East);

— Municipal power models whereby local councils are involved in integrated supply, distribution and generation companies;

— Converting off gas grid properties located close to a live gas pipe in the short to medium term; and

— Local targeted energy efficiency initiatives including home insulation which can have a large impact on fuel bills irrespective of the price of fuel as consumption is lower.

[89] Warm Up North. Available at: https://warmupnorth.com/about-us/

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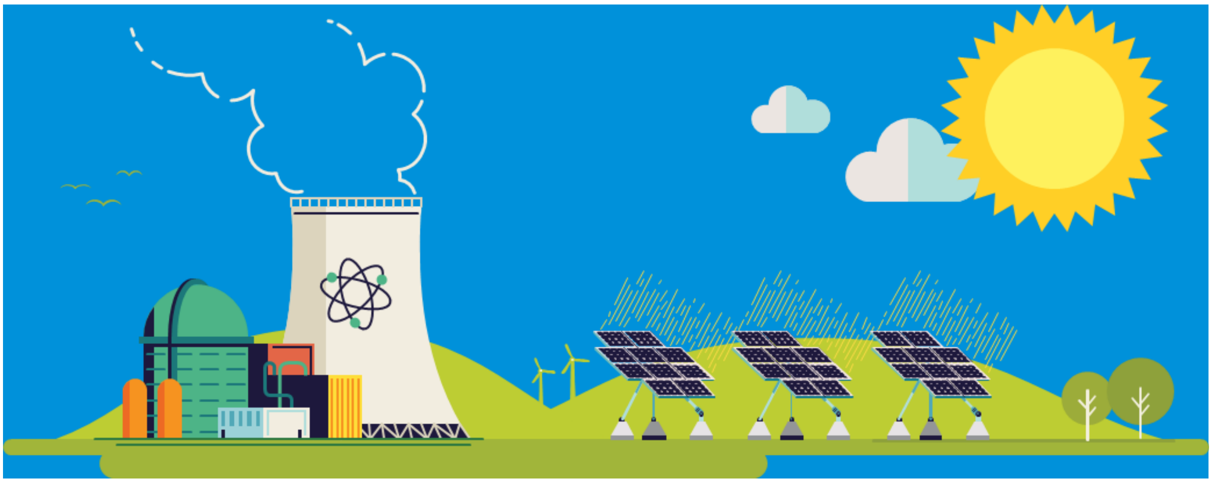
5 The economic contribution of the energy sector in the North



In this Chapter, we explain how we have estimated the economic activity associated with the component parts of the energy sector in the North. For the purposes of this report, we quantify the GVA generated in the North that remains in the North[90].

This analysis forms the basis for the growth scenarios for the sector which we set out in Chapter 6.

5.1 Literature review

We have conducted a review of previous studies looking at the current and future economic contribution of the North of England. Several have been published recently, following the launch of the Northern Powerhouse initiative[91]. Some provide evidence on the 'energy economy' in the North of England.

The Northern Powerhouse Independent Economic Review recently published by SQW highlighted the importance of the energy sector to the northern economy[92]. The study was based on the analysis of 'top down' data on specialisms and productivity and 'bottom up' local evidence on wider knowledge and innovation assets.

The authors found that the energy sector in the North is highly productive, particularly in the areas of electricity generation, storage and low carbon technologies, especially in areas such as Cheshire and Warrington, Cumbria, Hull and Humber, Lancashire, Liverpool, Manchester and Tees Valley[93]. According to the report, the North's productivity in the electricity and gas sector is at 231% of the rest of England (excluding London) in 2013[94]. SQW concluded that the North is 'well-placed to seize the opportunity for Low/Zero carbon technology and energy portability'[95]. The authors recommended that

90 This excludes leakage (economic value generated in the North which accrues to economic agents elsewhere) and the GVA generated by Northern 'exports' to the rest of the UK and abroad.

91 We note that the Northern Powerhouse strategy was published in November 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/571562/NPH_strategy_web.pdf

92 Northern Powerhouse Independent Economic Review, SQW, June 2016. Available at: http://www.sqw.co.uk/insights-and-publications/northern-powerhouse-independent-economic-review/

93 Table D-2, Page D-3 Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

94 Table B-3, Page B-4 Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

95 Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

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the North builds on its long-standing sectorial strength in energy capability to develop an expertise in the production of low carbon energy through advanced manufacturing processes[96].

The study compiled data on Northern GVA by sector and spatial distribution across the Northern Local Enterprise Partnerships (LEPs)[97]. It revealed that Northern GVA for electricity and gas was £3.644 billion[98] in 2013[99] and is expected to grow by 1.2% p.a. from 2015 to 2030[100] [101]. SQW estimated GVA for electricity and gas will be £4.098 billion[102] in 2030[103].

Similarly, SQW state that the energy sector, which includes the entire supply chain for energy and water[104], is a prime sector in the North. SQW estimated that the GVA growth rate for this sector being 1.9% per annum from 2030 to 2050[105]. Using the energy sector GVA growth rate from 2030-2050 as a proxy for GVA growth in the electricity and gas sector[106] gives us a total GVA of £5.97 billion in 2050 in £2011 prices (or £6.30 billion in £2014 prices[107]).

A report entitled 'Rhetoric to Reality' by the Institute for Public Policy Research (IPPR) demonstrated that the North has clear comparative advantage in the renewable energy sector in the UK. The IPPR noted that the North has consistently increased its share of UK exports in this sector over the past decade[108]. It also noted that the North could 'play a vital part in boosting the nation's poor productivity levels'[109]. The report identified potential opportunities such as driverless vehicles and new forms of energy generation and supply for the North such as solar power[110].

With regards to electricity generation in the North, a recent report by Oxford Economics on the economic impact of Drax Group in the UK concludes that Drax's direct impact in terms of GDP contribution totalled £284 million, of which £277 million was in Yorkshire and the Humber, and supported over 900 jobs in 2015. In terms of indirect impact, Drax supported approximately £650 million in GVA and 7,700 jobs in 2015. Yorkshire and the Humber, the North East and the North West were host to over 35%, (around £240 million) of Drax's supply chain impact and approximately

96 The Northern Powerhouse strategy published on 23 November 2016 highlight the government's support to the North to make this region an outstanding location for research and innovation, especially in energy. Further Science and Innovation Audits are planned to take place as they develop the evidence base for the region's research strengths, allowing them to better compete in national competitions for awards of science and research funding. One such audit will cover Offshore Energy in the North East, Liverpool, Tees Valley and Humber LEPs as well as Scottish Enterprise.

97 Table B-4, Page B-7, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

98 2011 prices.

99 Table B-4, Page B-7, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

100 Table B-6, Page B-12, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

101 1.2% growth pa for the electricity and gas sector is high compared to the coke & petroleum (-1.1% pa) and mining & quarrying (-4.3%) sectors but low compared to retail trade (2.2% pa), land transport (2.0% pa), construction (2.4% pa) and water, sewerage & waste (2.5% pa). Source: Table B-6, Page B-12, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

102 2011 prices.

103 Table B-6, Page B-12, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.

104 This includes some Mining, Extraction of Petroleum and Gas Supporting Activities, Manufacture of Coke and Refined Petroleum Products, Manufacture of Batteries, Electricity and Gas, Water, Waste, Sewerage and Environmental Consulting activities.

105 Workstream 4, Northern Powerhouse Independent Economic Review, SQW, June 2016.

106 SQW estimate that a number of sectors included under 'Energy' will experience a future projected decline while other will experience growth. As the Electricity and Gas sector is somewhere in the middle (see footnote 81), the Energy sector is a good proxy for estimating future growth in the electricity and gas sector.

107 The difference between nominal and real values is that real values are adjusted for inflation, while nominal values are not. The GVA has been adjusted for inflation using 2014 GDP deflator provided by the ONS. 2014 is the base year with a GDP deflator of 100. The 2011 GDP deflator is 94.746. The GDP deflator data is available at: https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-march-2016

108 Page 34, 'Rhetoric to Reality',Public Policy Research, IPPR, 2015. Available at: http://www.ippr.org/files/publications/pdf/rhetoric-to-reality-sep2015.pdf?noredirect=1

109 Page 34, 'Rhetoric to Reality',Public Policy Research, IPPR, 2015.

110 'Great North Plan',Public Policy Research, IPPR, 2014. Available at: http://www.ippr.org/files/publications/pdf/great-north-plan_Nov2014.pdf?noredirect=1

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half of overall supply chain jobs, i.e. around 3,550 jobs[111]. In total, Drax Group's operations contributed to over £500 million in GVA and approximately 4,450 jobs in the North of England in 2015. These numbers are even higher when taking account of Drax Power Station's biomass conversion.

5.2 Measuring economic growth

Regional gross value added (GVA) is the value generated by all economic units in a defined area engaged in the production of goods and services[112]. It is defined as:

GVA = Operating income before tax + Employee Costs + Depreciation and Amortisation

Or

GVA = Turnover (or sales) – Cost of goods sold + Employee costs

Gross Domestic Product (GDP), a key indicator of the size of an economy, is closely linked to the sum of GVA across sectors in the following way[113]:

GDP = GVA for all organisations in the economy + taxes on products – Subsidies on products

UK-wide GVA for the electricity, gas, steam and air conditioning supply sector was approximately £25 billion in 2014, less than 1% of total UK GVA across all industries. In the same year, the North East, North West and Yorkshire and the Humber generated £4.5 billion in GVA from the wider electricity, gas, steam and air conditioning supply sector[114], representing approximately 20% of UK-wide GVA for the sector[115]. Figure 5.1 provides a graphical representation of this.

[111] Economic Impact of Drax in the UK, Oxford Economics, September 2016. Available at: http://www.oxfordeconomics.com/recent-releases/economic-impact-of-drax-in-the-uk

[112] Gross Value Added, ONS. Available at: https://www.ons.gov.uk/economy/grossvalueaddedgva

[113] ONS. Available at: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/national-accounts/gva/relationship-gva-and-gdp/gross-value-added-and-gross-domestic-product.html

[114] Our understanding is that SQW definition of the energy sector excludes steam and air conditioning, hence the lower GVA estimate.

[115] Regional Gross Value Added (Income Approach) reference tables, ONS. Available at: http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

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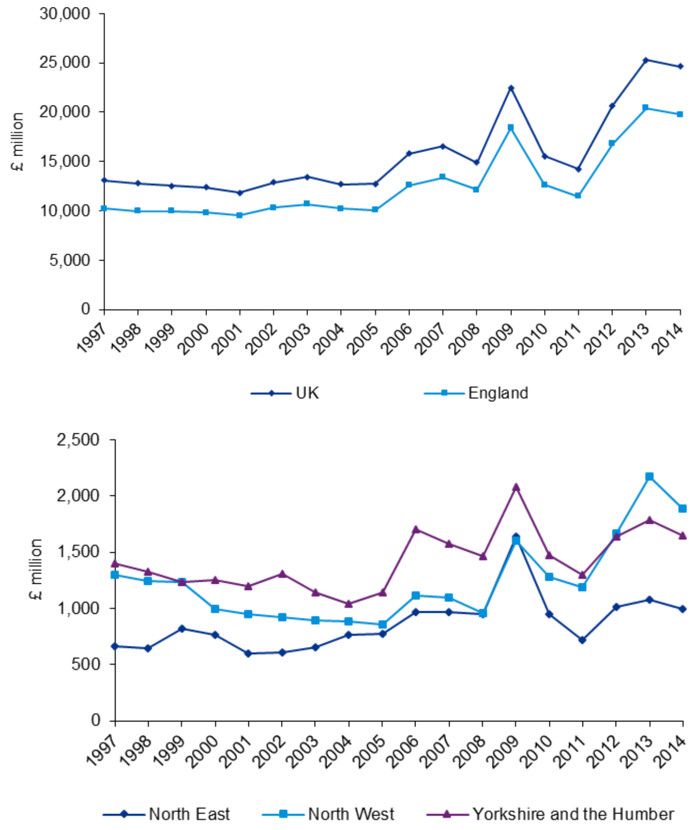
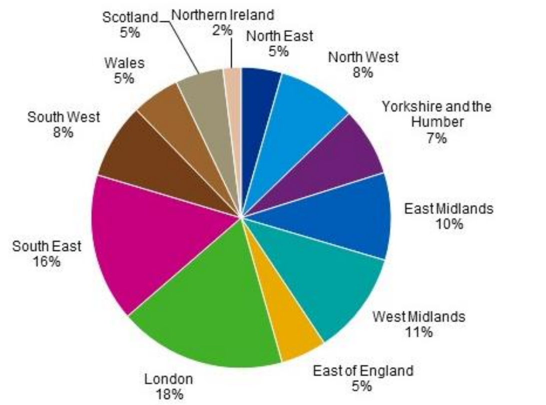
Figure 5.1 GVA for the electricity, gas, steam and air conditioning supply sector from 1997 to 2014



Source: Regional Gross Value Added (Income Approach) reference tables. http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

A snapshot of 2014 energy sector GVA is provided in Figure 5.2 for each region of the UK:

Figure 5.2 2014 UK-wide GVA for electricity, gas, steam and air conditioning supply sector



Source: Regional Gross Value Added (Income Approach) reference tables. Available at: http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

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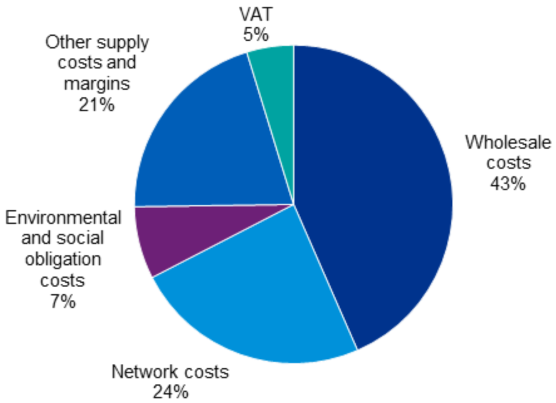
5.2.1 Estimating current GVA from the energy sector in Northern England

5.2.1.1 GVA breakdown

When we look at the future economic contribution of the energy sector in the North in Chapter 6, we have developed three economic growth scenarios to estimate GVA and employment out to 2050 in each of the component parts of the energy sector. As a starting point, we have broken down our estimate of current GVA for the energy sector into component parts based on BEIS/Ofgem's analysis of the breakdown of the fuel bill. Appendix A explains the rationale for using the breakdown of the duel fuel bill as a proxy to estimating GVA for the electricity and gas sector in the North of England. The breakdown provides an estimate of the proportion of different costs in the **dual fuel bill** of an **average domestic customer** of the large suppliers ('Big Six') in 2014/15[116] [117]. Ofgem/BEIS estimate the share of the energy bill for each constituent part as follows:

Figure 5.3 Breakdown of a dual fuel bill



Source: https://www.ofgem.gov.uk/information-consumers/domestic-consumers/understanding-energy-bills
https://www.gov.uk/guidance/policy-impacts-on-prices-and-bills

We have adjusted the BEIS/Ofgem bill breakdown to reflect the GVA share of the appliances and transport sectors in the North. Our results are presented in Table 5.1. Appendix 1 provides a description of how the bill breakdown was adjusted to include appliances and transport and how we took into account the localisation of spend.

Table 5.1 Breakdown of current GVA in Northern energy economy (excludes leakage)[118]

Cost category	Notes	Bill breakdown (BEIS, Ofgem)	Adjusted % breakdown of Northern GVA
Wholesale		46%	32%
Upstream gas	No gas extraction taking place in the North of England. Some spend is attributed to workers living in the North of England but working in the gas extraction sector elsewhere.	23%	4%
Electricity generation	Power plants using biomass, coal, gas, nuclear, etc.	23%	28%
Networks		**21%**	**26%**

[116] Understanding your gas and electricity bills, Ofgem. Available at: https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills

[117] Policy impacts on prices and bills, BEIS. Available at: https://www.gov.uk/guidance/policy-impacts-on-prices-and-bills

[118] Throughout this report, when we refer to GVA in the North of England, the GVA excludes leakage, i.e. the proportion of outputs that benefit those outside the North of England. Leakage was factored in our analysis through a 'localisation factor'. See Appendix 1 for more details.

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Cost category	Notes	Bill breakdown (BEIS, Ofgem)	Adjusted % breakdown of Northern GVA
Gas transmission	Owned and operated by National Grid	2%	2%
Electricity transmission	Owned and operated by National Grid	4%	5%
Gas distribution	Two GDNs (NGN, National Grid Distribution)	6%	7%
Electricity distribution	Three DNOs (ENW, NPG, SP Energy Networks)	9%	11%
Hydrogen	Conversion of the gas network to run on hydrogen gas.	n/a	0%
Heat[119]	Heat networks which already contribute to c0.4% of GVA in 2016.	n/a	~0%
Other supply costs and margins	Supply businesses in the North	21%	26%
Environmental and social obligations	Does not go to the North directly.	7%	n/a
VAT	VAT does not go to the North directly. It gets redistributed by HMT.	5%	n/a
Appliances (non-domestic)	Spend attributed to appliances manufactured, designed, installed, repaired, etc. in the North	n/a	7%
Appliances (domestic)	Spend attributed to appliances manufactured, designed, installed, repaired, etc. in the North	n/a	8%
Transport	Spend attributed to EVs, hydrogen fuel cells vehicles, ULEV components, etc.	n/a	1%
Total		**100%**	**100%**

Source: KPMG analysis.

5.2.2 Estimating energy sector and supply chain employment in the North

To estimate the number of direct energy sector jobs and supply chain jobs in the North, we have used FAME, a database of companies in the UK.

We have filtered for active companies based on Government regions (North East, North West and Yorkshire and The Humber) and UK Standard Industry Classification Codes (SIC) 2007 (a list of the SICs used is provided in Appendix 2) to identify the companies that operate in the North, and are involved in the energy economy.

The SIC codes are based on sectors directly involved in the electricity and gas industry as well as indirectly through the supply chain. Based on the SIC codes we classified jobs as: i) direct jobs or ii) supply chain jobs and adjusted these to approximate the number of jobs in the electricity and gas sectors only (see Appendix 2 for the details). We then link these SIC codes with the component parts of the energy sector identified in Table 5.1 on the previous page.

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[119] The region also makes up a significant proportion of renewable heat capacity: as of January 2016, 14% of capacity accredited under the non-domestic RHI scheme was in the region. The North of England has had high participation levels in the Heat Network Delivery Unit funding competition. This demonstrates the potential for heat networks in the North of England and how the region could become a national leader in the district heating supply chain. See https://www.gov.uk/government/statistics/rhi-deployment-data-january-2016. Figures quoted above relate to Yorkshire and Humber and the North East & https://www.gov.uk/government/publications/heat-networks-funding-stream-application-and-guidance-pack

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This methodology gives us an indicative number of direct and supply chain jobs in the North. We note that there are a number of companies that do not provide employee numbers which may underreport jobs in the North. Additionally, our estimates do not include self-employed workers (i.e. sole traders) in the energy sector which would not be accounted for in the FAME database. It is also worth noting that we have included sectors in the supply chain where activities are not solely confined to the energy sector e.g. roofers' work will involve roof repairs as well as energy-related insulation activities. This might, therefore, lead to an overestimation of the number of indirect Full Time Employee (FTE) jobs in the energy sector.

5.3 Current economic contribution of the energy sector in the North

Our estimate of the current economic contribution of the energy sector in the North is presented in Table 5.2 below. This includes direct and indirect GVA and jobs generated through downstream activities in the electricity and gas sector itself, as well as indirect supply chain activity. This estimate excludes leakage, i.e. the proportion of outputs that benefit those outside of the North.

Table 5.2 GVA and employment in the energy sector in the North (excludes leakage)

Cost category	2016 GVA in the North (£bn)	Direct jobs in the North (no.)	Supply chain jobs in the North (no.)	Total jobs in the North (no.)
Wholesale	**1.13**			
Upstream gas	0.14	-	1,675	**1,675**
Electricity generation	1.00	7,296	11,069	**18,365**
Networks	**0.91**			
Gas transmission	0.09	2,673	579	**3,252**
Gas distribution	0.26			
Electricity transmission	0.17	3,878	7,010	**10,888**
Electricity distribution	0.39			
Heat	0.02	-	-	**-**
Other supply costs and margins	0.91	12,261	1,290	**13,551**
Environmental and social obligations	n/a	-	-	**-**
VAT	n/a	-	-	**-**
Appliances (non-domestic)	0.23	4,980	4,715	**9,695**
Appliances (domestic)	0.29			
Transport	0.02	1,000	1,000	**2,000**
Total	**3.51**	**32,088**	**27,338**	**59,425**

Source: KPMG analysis based on Fame database.

We have also used publicly available data and reports to compare our results. These comparisons are set out below.

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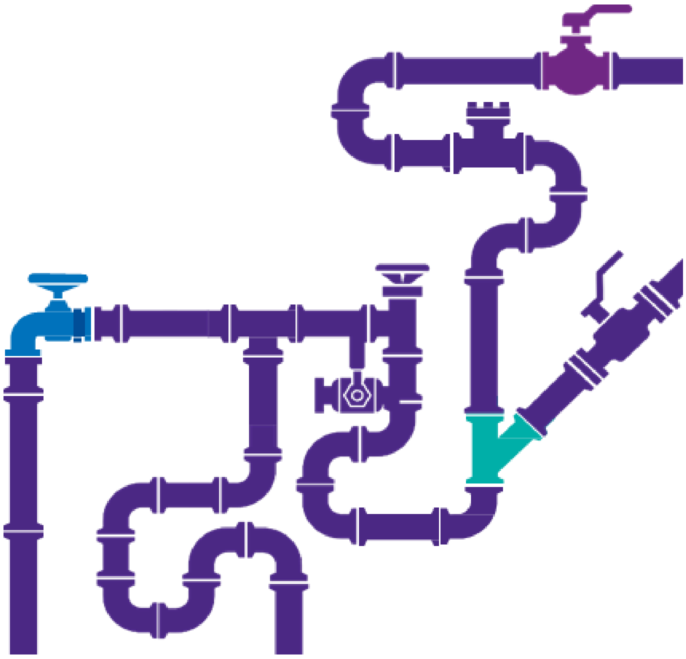
For **gas extraction**, the latest ONS data provides an estimate of around £140 million for GVA in the extraction of crude petroleum and natural gas in the North of England[120]. This is roughly equal to our estimate of GVA in upstream gas in 2016.

In terms of jobs, it is difficult to take account of the workers employed in upstream gas in the North Sea but who reside in the North of England, as the companies these workers are employed by will be based outside of the North of England. These would be considered direct jobs. It is, therefore, possible that our total direct and supply chain jobs for the North of England estimate is a conservative one.

For **electricity generation**, Oxford Economics estimate that Drax Group's operations contributed to over £500 million in GVA and approximately 4,450 jobs in the North of England in 2015, which is roughly half of our overall electricity generation GVA estimate of £1,100 million.

Our top-down results for the **electricity and gas networks** are within 10% of the results obtained by estimating GVA based on the networks' revenue and totex[121]. Employment numbers from FAME also align with quoted employee numbers from NGN, ENW, NPG and National Grid.



Similarly, our top-down results for **energy supply** are within 10% of our GVA estimate for the six main energy suppliers based on their revenue, operating costs and employee costs. The energy supply component also makes a significant contribution to GVA reflecting its wide range of activities such as metering and meter readings, marketing, customer services, energy trading, advertising, etc.

Chapter 6 discusses how economic growth can be realised based on three different energy pathways and growth scenarios.

[120] Annual Business Survey, ONS, July 2016. Available at: http://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveyregionalresultsqualitymeasures

[121] Using Method 2 as described in Appendix 1.

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6 The energy sector's contribution to future economic growth in the North

6.1 Overview

In this chapter, we develop illustrative scenarios for the future economic growth of the energy sector in the North of England. These scenarios are intended to illustrate the potential for growth based on a number of assumptions that anticipate significant change in the Northern energy economy, driven by the energy trilemma. As such, these scenarios are subject to uncertainty.

Using these growth scenarios, we attempt to answer two fundamental questions:

1 What will the energy sector in the North look like in the future?

2 What are the opportunities for participants in the Northern energy economy (firms, universities, workers, Government) to react to these changes?

Energy is a key enabling sector playing a crucial role in the UK's transition to a low-carbon economy. In the North it is already stimulating investment and creating much needed jobs to the region. Energy is a key input for businesses and an important element of household expenditure. Affordable energy allows businesses to be competitive and increases households' disposable income helping to reduce fuel poverty which in turn drive economic activity. As such, it is important to note that a thriving energy sector will have knock on effects for the rest of the economy that are not measured by this methodology.

In the rest of this chapter, we look at the two overarching questions above. In relation to the first question, we take two decarbonisation pathways for the UK (based on a recent publication by KPMG on energy scenarios to 2050[122]) and a business-as-usual pathway based on National Grid FES 2016 and adapt these to show how the energy sector in the North of England might evolve out to 2050. These pathways provide an insight into the opportunities for growth which the Northern energy economy faces.

In looking at the second question, we consider how each of the component parts of the Northern energy economy can grasp the opportunities offered by each decarbonisation pathway. We assess this by considering the following factors:

[122] 2050 Energy Scenarios, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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— **Market share:** If Northern firms maintain or increase their market share where demand is increasing, turnover and profits will increase, and firms will hire more workers. Demand for goods and services could be located both in the North and in other regions of the UK, as well as the rest of the world.
— **Investment/localisation:** Capital investment to upgrade assets makes companies and their employees more productive and creates new jobs. Investment in the North's energy assets also ensures that the region's businesses are able to meet future demand and remain competitive. Localisation refers to the degree to which local firms and businesses are able to meet demand in the region – The more they are able to do so, the more wages and profits will be retained and reinvested in the region.
— **Innovation:** Innovation allows companies to create new markets, develop new products and services and reduce costs. Companies become more competitive and are able to differentiate themselves with different product and services offerings.
— **Value:** By creating higher value goods and services through innovation, firms are able to increase their turnover and profits.
— **Workforce skills**: By developing their skills, workers can increase their productivity, allowing them to work on higher value projects and driving increased turnover for the firms they work for.

We then draw our analysis of the two questions together to develop GVA and job growth scenarios for each component part of the Northern energy economy out to 2050 for each of the three energy pathways. These growth scenarios are based on quantitative data, when available, and a qualitative assessment of expected growth based on evidence around networks' business plans, expected investment in innovation, manufacturing, wider supply chain, etc. These GVA growth scenarios are then combined with the baseline GVA growth (estimated in Chapter 3) to provide an overall projection of GVA growth in the Northern energy economy out to 2050 under each pathway.

Section 6.2 describes the energy pathways to 2050 followed by Section 6.3 on economic growth scenarios.

6.2 Energy pathways to 2050

We use three different energy pathways that make use of a different energy mix to meet consumer demand. The Evolution of gas (Pathway 1) and the Diversified energy sources (Pathway 2) 'solve' the CO_2 emissions target whereby the mix of technologies used produce no more than 20% of 1990 CO_2 emission by 2050. Both pathways use technology and fuels that are available and could, with the will and investment, start to be implemented today. Additionally, the pathways focus on different ways of supplying heat to households and businesses customers.

The pathways described in Table 6.1 are national pathways and we assume that the North of England would mimic these pathways as energy consumption trends would not vary significantly from one region to another. The pathways are based on a number of assumptions such as the energy mix and the use of technologies to meet energy demand. For example, Pathway 1 uses hydrogen for heat and transport while Pathway 2 uses a mix of heat networks, hydrogen, natural gas and electricity networks for heat and electric vehicles for transport. Pathway 3, No progression, assumes that the energy mix used today remains the same to 2050 both in terms of fuels and demand proportions. Section 6.3 presents a high level summary of our scenarios.

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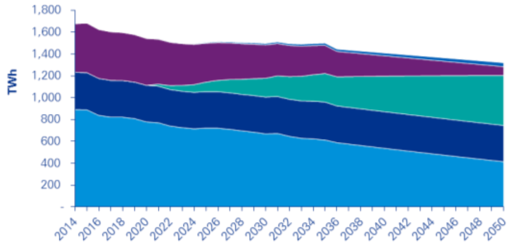
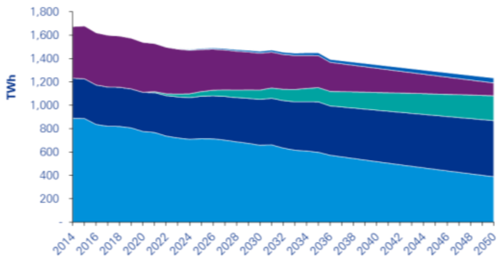
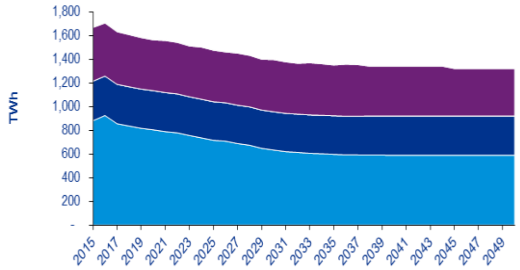
Table 6.1 Summary of energy pathways to 2050 for the North of England

Scenario	Evolution of gas	Diversified energy sources	No progression
Summary	— UK gas production decreases by 5% year-on-year[123]. Gas imports are likely to rise to balance the shortfall. — Fuel source for residential and commercial customers remains the same as today with gas providing for the majority of heating. — Role of methane declines over time as the main source of heat becomes hydrogen gas and the whole distribution network in the North is converted to hydrogen. — Hydrogen fuel cells vehicles become the predominant form of road transport, accounting for the majority of transport energy demand. — Demand for electricity declines marginally to 2050 as demand for heat is met by hydrogen.	— UK gas production decreases by 5% year-on-year. Gas imports are likely to rise to balance the shortfall. — 'Patchwork' of energy solutions where cities in the North meets their energy needs based on methods appropriate for their area. — Heat is available from four different technologies: heat networks, hydrogen, electricity and gas. — Decisions on energy are taken at local government level with each town/city having one of the four heat technologies. — A whole energy system is created where cities, towns and sub-urban areas use the same energy system. — Demand for electricity increases over time as the economy becomes more electrified.	— UK gas production decreases by 5% year-on-year. Gas imports are likely to rise to balance the shortfall. — Scenario is based on National Grid's FES 2016 where the energy mix used today remains the same to 2050 both in terms of fuels and demand proportions. — There are some EVs on the road but petrol vehicles remain the predominant form of transport.
National fuel mix to 2050 Gas Electricity Hydrogen Petrol Bio-methane			

123 BEIS. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503851/OGA_production_and_DECC_demand_projections_-_February_2016.xls

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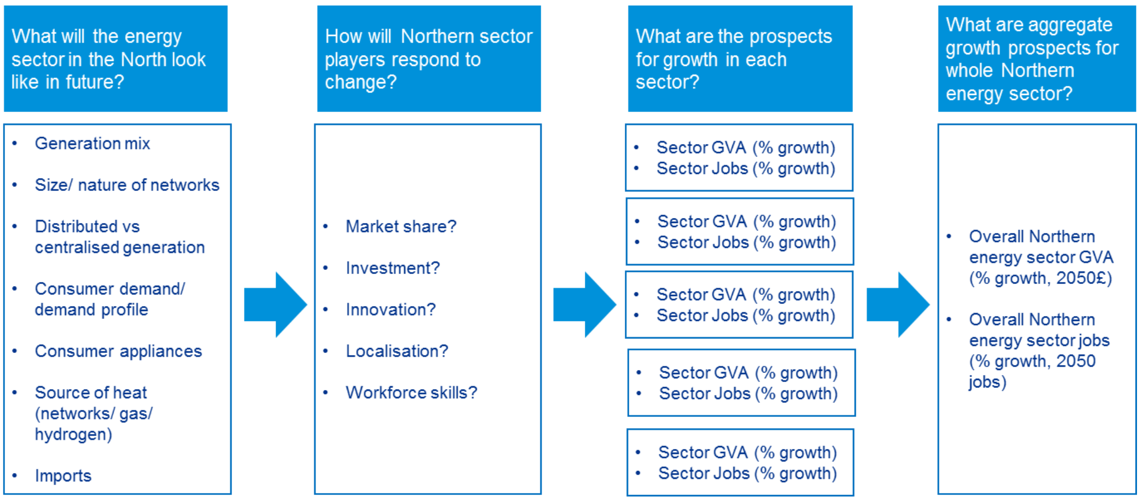
6.3 Economic contribution: the scenarios considered

In this section, we present a summary of the three economic growth scenarios. These scenarios are presented in detail in Appendix 3. We then compare and contrast our scenarios to put our results into context.

6.3.1 Methodology

To estimate GVA and employment growth rates, we took the GVA by component part as estimated in Chapter 5 and projected these forward using an assessment of the prospects for growth in each sector. Underpinning each growth scenario is a different pathway for the development of the energy sector which allows the UK to meet its CO_2 reduction targets while meeting energy demand to 2050[124] (excludes the No progression pathway). Growth prospects are based on quantitative data, when available, and a qualitative assessment of expected growth in line with the networks' business plans, expected investment in innovation, manufacturing, wider supply chain, etc. Figure 6.1 presents our approach to estimating economic growth.

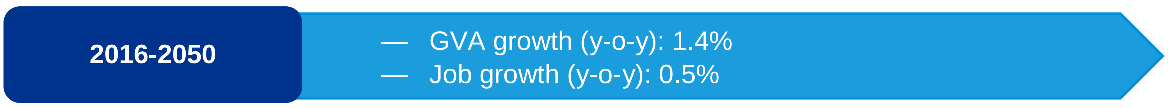
Figure 6.1 Summary of approach to estimating economic growth



Source: KPMG

6.3.2 Scenario 1: Evolution of gas

Figure 6.2 Energy sector growth to 2050: Evolution of gas



This section sets out the key assumptions for this illustrative scenario.

The balance between gas and electricity as the fuel source for residential and commercial customers remains the same as today. The difference is that hydrogen gas is used and a large part of the gas distribution network in the North of England i.e. mainly urban areas, is converted to use hydrogen. This implies that the heat sector is completely decarbonised by 2050.

124 We use a common demand assumption across all three scenarios based on KPMG's recent publication: 2050 Energy Scenarios, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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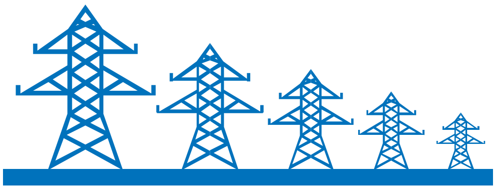
At the retail level, demand for natural gas remains at current levels. North Sea production of natural gas declines overtime resulting in less demand for supply chain and workers in the North. At the wholesale level, natural gas is increasingly used to derive hydrogen to heat homes and businesses. Given the decline in North Sea production, LNG imports will be needed to meet wholesale gas demand to convert to hydrogen. We expect that additional investment in import facilities will not be sufficient to offset the impacts of the decline of oil and gas production from the North Sea. Interconnectors and LNG facilities are significantly capital and labour-intensive than oil and gas extraction[125]. We, therefore, assume that the increase in local LNG jobs would not offset jobs losses in the gas extraction sector. As a result, the value of the upstream gas sector declines over time by -5% and -7% year-on-year for GVA and jobs respectively.

None of our scenarios for the development of the upstream oil and gas sector attempt to model the potential economic impact of the extraction of the North's unconventional oil and gas resources. This reflects current uncertainty around the extent of the resources in the region, and whether they are economically viable. If the region's unconventional oil and gas resources were developed at scale, this would create jobs and investment in the region as highlighted by two studies looking at the potential economic impacts of shale gas in the Ocean Gateway (Bowland Shale)[126]. The author of these reports stipulate that employment in the Ocean Gateway could reach approximately 3,500 jobs[127] at peak with associated cumulative development costs of £9.8 billion to 2035[128]. Additionally, the development of a shale supply hub in the Bowland shale area could employ over 13,100 people at peak and the industry could invest over £30 billion from 2019 to 2048[129].



Demand for electricity decreases marginally over time as hydrogen gradually replaces electricity and gas for heating. The North is currently a net 'exporter' of electricity to the rest of the UK as it hosts a significant proportion of the UK's largest thermal power stations. In this scenario, electricity output in the region will decline over time as assets are only partially replaced, such that the North no longer exports power to other regions of the UK by 2050 i.e. output equals regional demand in 2050. Despite a decrease in installed capacity, there is still a degree of innovation whereby more established technologies are replaced by ones that retain the potential for significant cost reduction, both in construction and operation. Furthermore, the development of smart networks for gas and power could have the potential to further reduce energy demand.

In addition, the Siemens offshore wind turbine manufacturing facility at Hull will play key role in the continued development of the offshore wind sector. In this scenario, there is continued significant deployment of offshore wind out to 2030[130], ensuring steady demand for turbines. In addition to the turbines themselves, the Siemens factory is likely to attract investment in the wider offshore wind supply chain to the region. This is high value manufacturing activity, and a very high proportion of the benefits could remain within the region[131] assuming that clear guidelines for developers are put in place around supply chain content. Given that the deployment of offshore wind is expected to be largely complete by 2030, the benefits to the regional economy will be realised in the early part of the

125 Data from FAME shows that the O&M subcontractor for Teeside GasPort employed 243 people. National Grid Grain LNG Limited employs 145 people while South Hook LNG Terminal Company Ltd employs 94 people. This is significantly lower than employment in the UK offshore oil and gas industry with 34,000 direct jobs in 2016. Available at: http://oilandgasuk.co.uk/oil-gas-uk-figures-show-impact-of-oil-price-downturn-on-jobs/

126 The Ocean Gateway is defined as the Liverpool, Manchester and Cheshire and Warrington Local Enterprise Partnership (LEP) areas.

127 Direct, indirect and induced jobs.

128 Potential Economic Impacts of Shale Gas in the Ocean Gateway, AMION Consulting, June 2014. Available at: http://www.igasplc.com/media/10851/ocean-gateway-shale-gas-impact-study.pdf

129 http://www.amion.co.uk/news/2015/april/shale-gas-%E2%80%93-creating-a-supply-hub-for-the-bowland-shale/

130 See National Grid Future Energy Scenarios 2016. In the 'Gone Green' scenario, 24GW of additional offshore wind capacity is projected by 2030. http://fes.nationalgrid.com/fes-document/

131 Offshore wind turbines are currently estimated to cost around £1 million/MW (estimate for an 8MW turbine). P19, The Crown Estate, 'Offshore Wind Cost Reduction Pathways Study', https://www.thecrownestate.co.uk/media/5493/ei-offshore-wind-cost-reduction-pathways-study.pdf

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period. As a result, GVA for this sector increases to 1.9% to 2030, and remains constant for the rest of the period. Meanwhile, jobs decrease by 1% year-on-year as productivity improvements are realised.

The gas transmission system exists largely in the same form as today except a large proportion of the natural gas it currently carries is used to feed the SMR plants for hydrogen production. Investments and highly skilled labourers and hydrogen experts are required to carry out the conversion of networks to hydrogen. We, therefore, estimate that GVA would grow by 2% to 2021 and 1% thereafter. The gas distribution network completes the iron mains replacement programme to pave the way to hydrogen network conversion in the entire region by 2050 with a growth of 1% to 2030 and 0% thereafter. The GVA growth for hydrogen is included in the Hydrogen section (see below).

The hydrogen sector develops along the lines of the roll-out presented in NGN's H21 City Gate Project. The conversion process will require substantial capital expenditure, and means that all gas appliances, boilers, hot water tanks, cookers, are either replaced or converted to run on hydrogen. Other technologies will also be required to support the conversion, such as CCS, salt caverns and Steam Methane Reformers (SMRs). Hydrogen offers significant opportunities for innovation in supply chain firms in the North, and for major upskilling of the gas workforce. Firms in the region will also have the opportunity to export their expertise to other regions of the UK and the rest of the world as hydrogen networks are adopted more widely[132]. By 2050, the North of England plays host to a 'centre of excellence' for the hydrogen economy which increases the region's economic contribution through higher direct spend and spend related to the supply chain. As a result, both the gas distribution and the hydrogen sector contribute to increasing GVA in the North, the former to a greater extent than the latter with a growth rate of 9.7% year-on-year from 2026 onwards. We have not attempted to quantity the number of hydrogen jobs due to the lack of data, but as with other industries, the hydrogen sector would generate hundreds of direct jobs and thousands of supply chain jobs. Gas network jobs would increase slightly over time, growing by 1% until 2030 and remaining constant thereafter.

The electricity distribution network becomes a 'smart grid'. Smart grids offer significant opportunities for distribution networks to innovate and develop new business models. This creates additional GVA contribution of 1% year-on-year as a result of further investment in R&D and innovation to upgrade and modernise the network to ensure it supports deployment in renewable technologies as well as meet changing customer needs. The electricity transmission networks continue to grow at current rate to adapt to large amounts of renewable coming from Scotland but remains constant from 2030 onwards with a growth of 4% year-on-year to 2030 followed by a decrease to 0% by 2050. Employment in electricity networks follows the same upward trend as electricity distribution.

Suppliers become 'energy service companies'. As more households invest in distributed energy and storage, suppliers could potentially offer energy management and aggregation services to households and businesses looking to sell energy back into the grid. The services offered by energy suppliers as well as growth in the number of households and businesses contribute to increasing both GVA and jobs by 0.5% annually to 2050.

In this scenario, consumers aspire to be more energy efficient by spending on buildings improvements such as insulation and buying more energy efficient appliances. Some consumers go a step further by taking up distributed generation. The majority of jobs and GVA contribution in this sector is assumed to come from installations of appliances. In this scenario, the number of households and businesses on natural gas appliances decrease each year. This results in a reduction in spend on gas appliances each year and by 2050 all gas appliances in urban households are replaced by hydrogen appliances. The costs of the first hydrogen conversions are not covered in this category (i.e. Appliances). However the costs of maintenance and replacement of hydrogen appliances are included. We, therefore, assume a growth in GVA for buildings (hydrogen conversions are accounted for separately) of 0.3%

132 The hydrogen sector would offer opportunities for the North to be a leader. We have not attempted to quantify the benefits coming from exporting the North's expertise to the rest of the UK/world. As there is still some uncertainty with regards to hydrogen roll-out across the UK, we believe this is a cautious approach.

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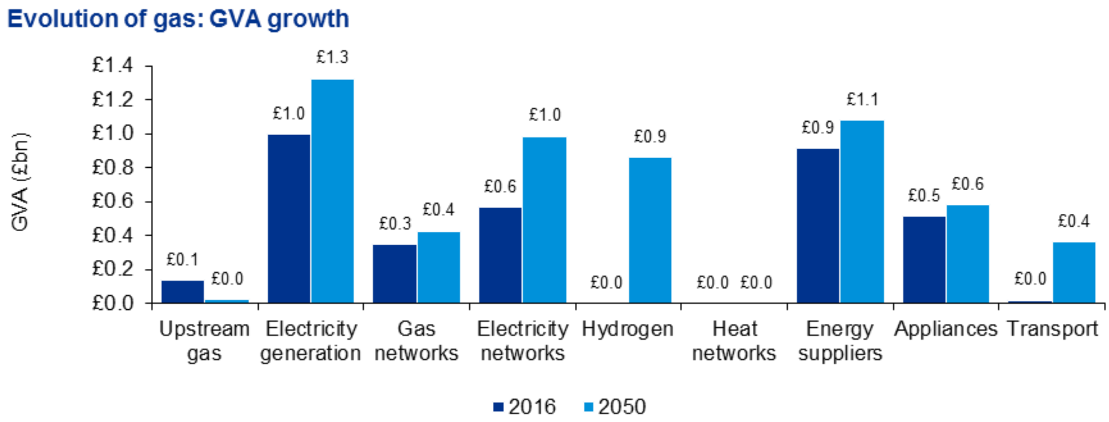
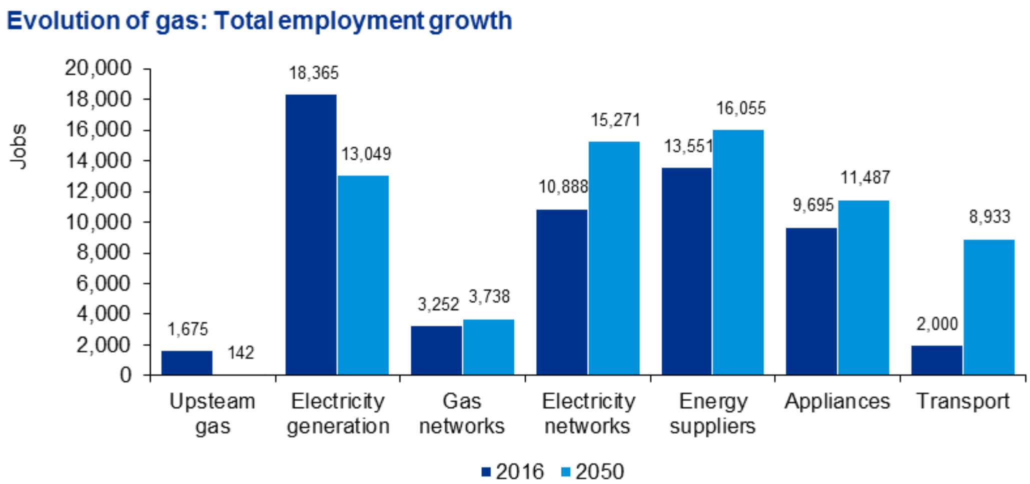
per annum on average. As the reduced demand for gas appliances is offset by the take-up in hydrogen appliances, we assume that growth in jobs will follow projected growth in the number of households out to 2050 i.e. 0.5% per annum.

The transport sector is mostly decarbonised by 2050. In this scenario, we assume that ultra-low emission vehicles (ULEVs) represent 80% of road transport by 2050, of which three quarters is hydrogen fuel cells vehicles and one quarter is Electric Vehicles. The remaining 20% are petrol vehicles. GVA and employment for transport increases over time by 9% and 4.5% respectively, as some components of EVs are produced in the North.

Figure 6.3 Economic growth by sub-sector – Evolution of gas





6.3.3 Scenario 2: Diversified energy sources

Figure 6.4 Energy sector growth to 2050: Diversified energy sources

2016-2050

- GVA growth (y-o-y): 1.4%
- Job growth (y-o-y): 1.0%

Here we set out the key assumptions in this illustrative scenario.

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Different areas of the North use different energy delivery methods and fuels depending on the characteristics of the area, such as population density and proximity to fuel sources and facilities. Demand for heat is met by heat networks (25%), hydrogen networks (25%), natural gas heating (25%) and electric heating (25%)[133].

In this scenario, unlike Scenario 1, demand for natural gas decreases over time at the retail level. GVA and jobs in the upstream gas sector decrease over time as per the Oil and Gas Authority's production forecast (-5% and -7% respectively). Although some additional natural gas is required for hydrogen production for the 25% of the regions gas connections that convert to hydrogen, this is more than counter balanced by the fact that 50% of customers are no longer connected to the gas network.

There is an increase in electricity demand due to heat conversions and a large number of EVs, from 68TWh in 2016 to 98TWh in 2050[134]. Ageing power generation assets are refurbished or replaced or new ones are built. This increase in demand results in the North only meeting Northern demand and therefore the region is no longer a net exporter of electricity. The Siemens factory at Hull continues to play a key role in the deployment of UK offshore wind, alongside the growth in distributed energy. As a result of these factors, there is an increase in GVA of 0.8% year-on-year to 2050 while jobs remain constant as employees move from legacy jobs to new jobs. The growth in manufacturing and supply chain activities (e.g. Siemens) will be an important driver for this growth.

As customers in the North use four different sources of heat, half of the gas distribution network is less heavily utilised and the other half is converted to hydrogen. The value of the gas distribution network increases by 1% year-on-year to 2021 to reflect partial investment in the iron mains programme, then decreases to 0.5% to 2030 followed by a decrease to -3% from 2031 onwards to reflect that the network is less heavily utilised. The drop in GVA is compensated by hydrogen with an associated GVA growth rate of 2.4% annually to 2050. As in Scenario 1, the Northern economy would respond to business opportunities to develop hydrogen technologies but only to a lesser extent. Heat networks are also built in the densely populated inner cities of the region sourced from small local biomass plants fed by waste material. We estimate that the heat sector grows by 9.0% annually to 2050. As in Scenario 1 we have not attempted to quantity the number of hydrogen/heat jobs.

The gas transmission network remains largely as it is today, continuing to supply industry with a GVA growth rate of 2% to 2021 and 0.3% thereafter to reflect the ongoing investment in SMRs. Gas networks jobs follow the same trend as gas distribution GVA.

The electricity distribution network becomes a 'smart grid' and networks expand to meet higher demand as more local sources of energy are developed and EVs are adopted networks resulting in a GVA growth rate of 1% to 2023 and reaches 3% by 2030 and decreases to 1% by 2050. As electricity demand is met more locally, there is a decrease in the need for large transmission. These activities require considerable expenditure and thus contribute to increasing GVA in the North by 4% annually to 2021 and decreases to 0% by 2040 and remains constant thereafter. Electricity network jobs increase over time to meet additional demand at the distribution level and follows electricity distribution GVA growth rate.

Energy suppliers become energy service companies (ESCOs) and take a greater role in managing their customers' energy through smart meters and smart grids. By 2050 a lot more energy is supplied via these small local suppliers which, when combined, become at least equivalent to the market share of one of the Big Six today (circa 15% of all customers in the UK). As a result the activity of managing energy, supply is brought into the North rather than being managed elsewhere. In addition there is a greater amount of distributed generation and energy companies play a role in managing these

[133] Based on KPMG analysis from 2050 Energy Scenarios report (KPMG 2016). https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

[134] Based on KPMG analysis from 2050 Energy Scenarios report (KPMG 2016). https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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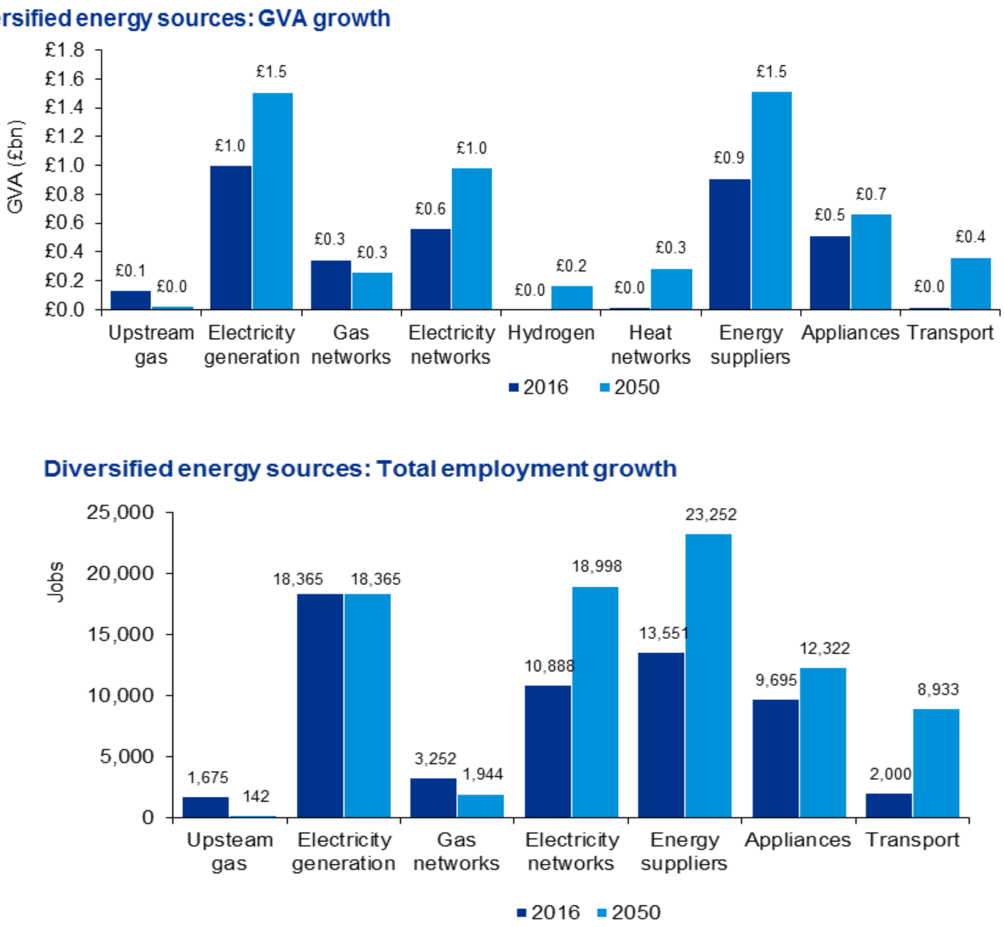
systems for their customers. As a result, GVA increases by 1.5% annually to 2050 while jobs increase by 0.5% year-on-year to 2025 and increases by 2.0% annually from 2026 onwards.

As grids become ‘smarter’ and consumers adapt to technological changes, there is a high take up of smart appliances (e.g. smart meters and smart thermostats) in the North. The increase in adoption of new technology and fuel mix offer considerable opportunities for growth in the North. Customer on electric heating use heat pumps for space heating and electric boilers for hot water. As a result, both GVA and jobs increase over time by 0.7% year-on-year to 2050.

Smaller cars and vehicles that make shorter urban journeys are electric (35% by 2050). Hydrogen fuel cells are used for larger vehicles including HGVs, buses, commercial vans etc. (35% by 2050). A hydrogen fuel cell network is developed, supplied by the local hydrogen network, but unlike Scenario 1 it is relatively limited as hydrogen is not developed at scale. Petrol/diesel/electric hybrid vehicles plug the gap between the smaller urban electric only vehicles that are able to charge regularly and the larger hydrogen commercial vehicles. Overall the role of petrol and diesel decreases over time as the transport sector decarbonises to some extent and makes up a much reduced level of transport fuel compared to today (30% by 2050)[135]. The local spend in the manufacture of EVs combined with the opportunities in the manufacture of component parts of hydrogen fuel cells vehicles result in an increase in GVA and jobs over time of 9% and 4.5% annually respectively.

Figure 6.5 Economic growth – Diversified energy sources



135 Based on KPMG analysis from 2050 Energy Scenarios report (KPMG 2016). https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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6.3.4 Scenario 3: No progression

Figure 6.6 Energy sector growth to 2050: No progression

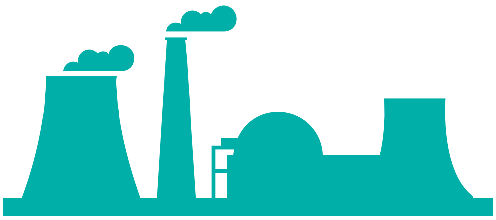
2016-2050

- GVA growth (y-o-y): Approximately ~0.0%
- Job growth (y-o-y): Approximately 0.3%

In this scenario, the current state carries on to 2050 and the climate change targets would not be met.

Although demand for gas remains at current levels, North Sea production declines, meaning less demand for supply chain and workers in the North and future activity likely to focus on decommissioning rather than extracting. This results in lower GVA and jobs in the sector, alike Scenarios 1 and 2.

There is a decrease in electricity generation in the North as current thermal assets (coal, nuclear) reach the end of their useful life and are only partially replaced. Over the period, the North shifts towards a more 'export' neutral position, where regional demand is equivalent to regional supply so that the region is no longer a net exporter of electricity. This implies a decrease in both GVA and employment for this sector of -1% annually to 2050.



The gas distribution network continues to be used as it is today, with natural gas providing heat to homes and businesses, and being used in industrial processes. Gas distribution GVA grows by 1.0% annually to 2030 and 0% thereafter. The gas transmission system may be reinforced to cater for more import facilities as North Sea production declines which results in a marginal increase in GVA of 1% annually to 2030. Beyond 2030 we assume a lower GVA growth at 0.3% a year to account for network reinforcement around new import facilities. Jobs are assumed to grow at the same rate as GVA for gas distribution.

Electricity demand remains constant over time. The electricity distribution network in the North continues to operate in the same way as today and the transmission network does not require substantial investment to meet constant demand. Overall the growth in networks slows down which results in a marginal increase in GVA and jobs. The GVA associated with the electricity distribution network grows by 1% to 2023 and 0% thereafter while the transmission networks grows by 4% to 2021 and 0% thereafter. Jobs are assumed to grow at the same rate as GVA for electricity distribution.

Some suppliers offer smart home energy management solutions but there is no growth in services to 'prosumers', households and businesses which produce their own energy for consumption and export to the grid e.g. aggregation services. Demand for energy supplier services continues to grow slowly, driven by increases in the number of households and businesses resulting in GVA and jobs to grow by 0.5% annually.

Households and businesses continue to spend on energy efficiency for appliances and buildings but at a lower rate than in Scenarios 1 and 2. Associated GVA growth rate for appliances and buildings is 0.3% annually to 2050 mainly due to the cost reduction related to distributed generation technologies and renewable heat. Jobs grow by 0.5% year-on-year to 2050 in line with estimated household growth projections.

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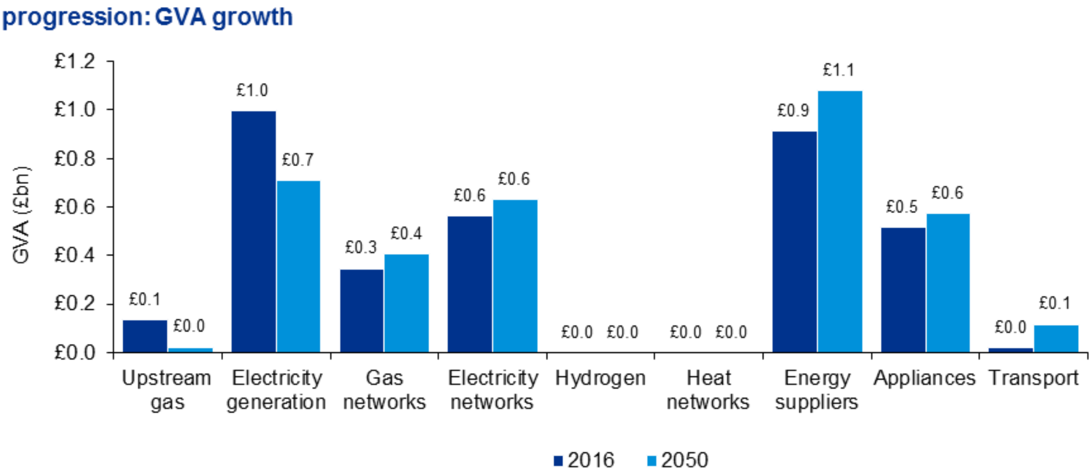
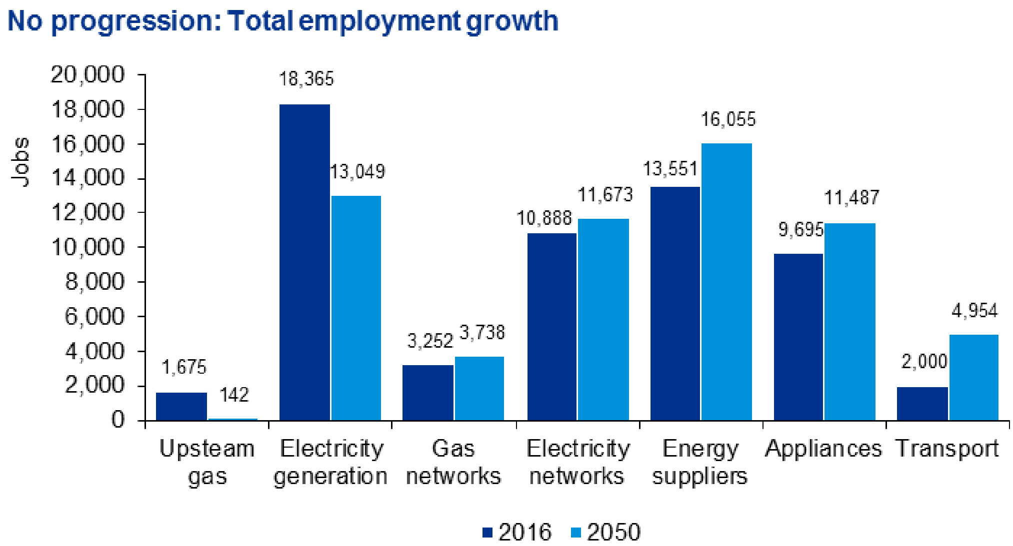
Petrol and diesel only cars account for the majority of vehicles on the road in 2050, with only 35% of EVs[136]. We estimate a GVA growth rate of 5.4% while jobs grow by 2.7% annually by 2050.

Figure 6.7 Economic growth – No progression





6.4 Results: comparing scenarios

The three scenarios presented in Section 6.3 generate different economic benefits for the North of England. In this section we compare and contrast our scenarios and provide a short discussion on the results. Figure 6.8 provide a summary of GVA and jobs for each scenario.

[136] Based on EVs uptakes from 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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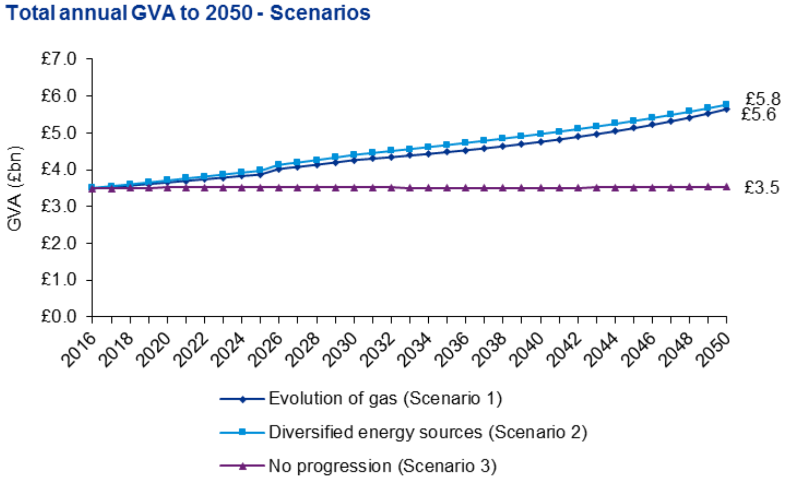
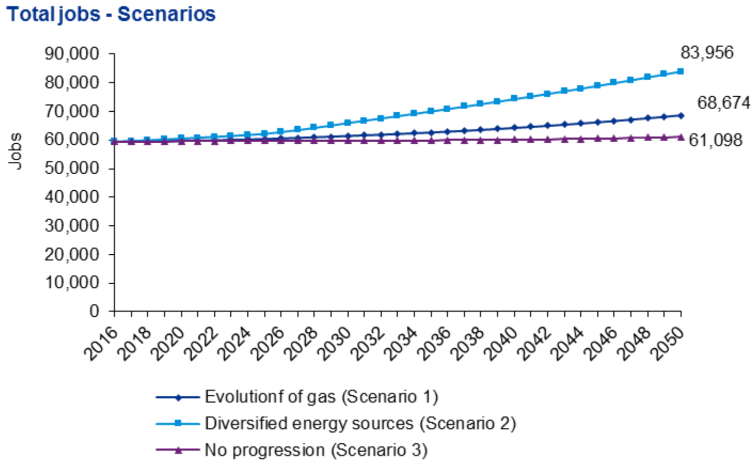
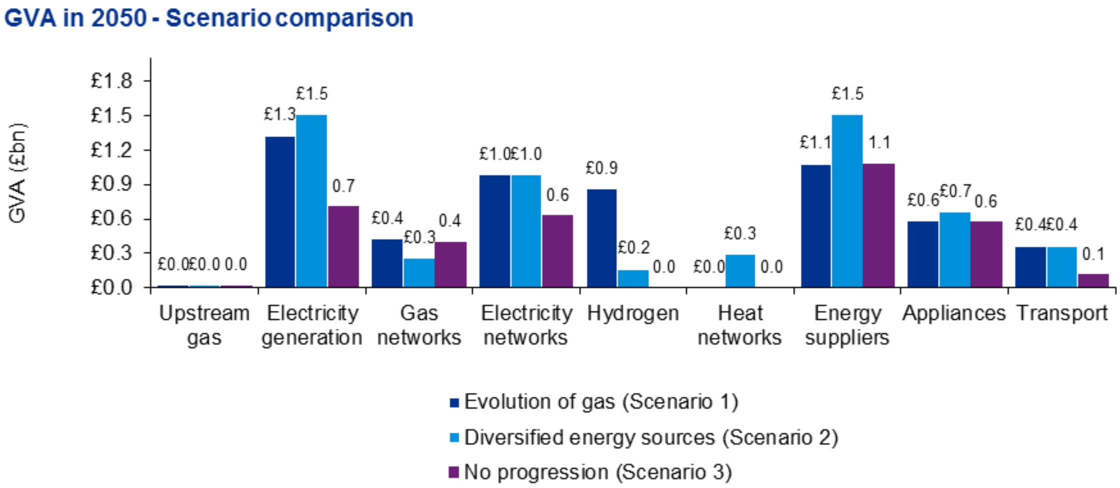
Figure 6.8 Summary of scenarios







It is worth noting that the difference in employment between Scenarios 1 and 2 can be attributed to the fact that we have not included jobs related to hydrogen due to the lack of evidence.

Meeting 2050 decarbonisation targets will be challenging. It will require changes to heat and transport energy supplies alongside decarbonisation of power. Scenario 1 (Evolution of gas) assumes that gas provided to homes and businesses is decarbonised through the substitution of hydrogen for natural gas. Scenario 2 (Diversified energy sources) assumes that a mixture of hydrogen, heat networks and

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additional electrification substitutes for natural gas and liquid fuels. Scenario 2 shows a slightly higher economic activity than Scenario 1 because a diversified decarbonisation is likely to involve greater changes to existing infrastructure than the hydrogen solution in Scenario 1. Scenario 3 (No Progression) assumes that decarbonisation targets are not met, but existing energy assets are replaced with equivalent resources.

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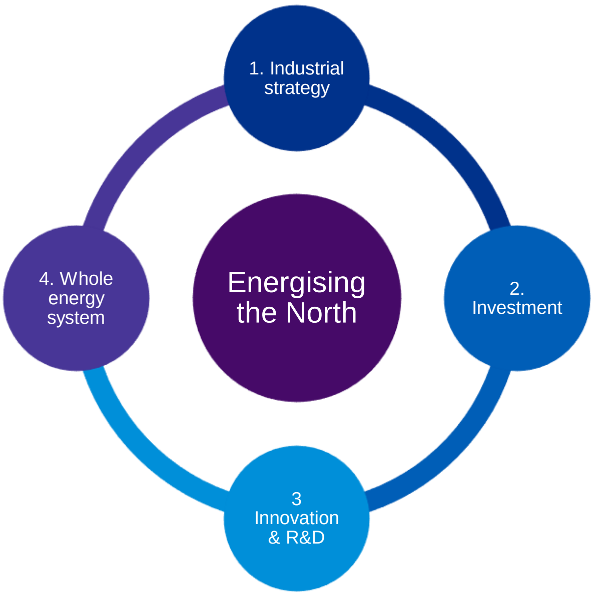
7 Energising the North: making it happen

7.1 How can the benefits be realised?

Scenarios 1 and 2 could potentially deliver important economic benefits to the North. The realisation of these benefits will depend on how the region exploits its current capabilities and the opportunities for growing these in the future. This will require a long-term strategy supported by business, customers and Government (central and local).

In the chapter, we map out four potential elements of such a strategy:

Figure 7.1 Energising the North: making it happen



1 **Industrial strategy:** The Government is prioritising industrial strategy. We suggest that energy should play a key role in an industrial strategy for the North. It could embrace resourcing, training and skills provision that a growing and evolving energy sector requires, together with infrastructure (e.g. digital, transport) improvements that could drive increased productivity and enable growth.

2 **Investment:** Continuing investment should ensure that the Northern energy economy is able to meet the demand of the region and develop the low-carbon, decentralised, energy systems of the future. Investor confidence is vital in attracting the required investment to the North.

3 **Innovation & R&D:** Changing energy systems may offer considerable opportunities for innovation that can create new goods and services. The North already has capabilities in energy-related R&D, for example in relation to smart networks. It would be important that this focus is maintained (and even strengthened) in the future.

4 **Whole energy system:** Different parts of the energy system are becoming increasingly interlinked. Solutions developed in one sector can have implications elsewhere. For example, increased penetration of electric vehicles may have implications for the energy demand profile of

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households. By looking across customer needs for energy, the Northern energy economy could deliver the powerful synergies and efficiencies that benefit customers and businesses.

The following sub-sections provide more detail on these themes.

7.1.1 Industrial strategy

To deliver benefits at both regional and national levels, it would be important to have a clear strategy and action plan to maximise the economic opportunities emerging in the energy sector across the entire supply chain, spanning from manufacturing of pipes and turbines through asset provision to customer services.

This would require training and skills development for people in the region, alongside the social and business infrastructure necessary to enable such regional development.

A sound and supportive industrial strategy could ensure markets are favourable and attract investment in the energy sector. Following an initial assessment of capabilities and opportunities, the following measures could be identified as priorities to maximise the contribution of the energy sector in the North:

- Developing regional strategies for key initiatives, including:
  - Developing whole energy solutions, covering power, heat and transport that exploit existing investment in electricity and gas networks.
  - Developing hydrogen technologies, including the exploitation of carbon capture and storage potential as well as the development of steam methane reformer plants.
  - Ensuring such developments can help address fuel poverty and economic development in the region.
- Ongoing funding for innovation projects to trial and test prior to full scale implementation.
- A coordinating group to ‘champion’ regional energy innovation and development, bringing parties with complementary objectives and expertise together, especially business interests.
- Advising relevant authorities on incentives or actions to drive new ‘regional energy innovation hubs’ e.g. locations such as Sunderland, Hull.
- Reflecting the new Government’s emphasis on the need for industrial strategy to reflect the particular needs and realities of local areas, it would be important for plans to be developed with local stakeholders at the forefront. This could include bodies such as Local Enterprise Partnerships, regional and city councils, local chambers of commerce as well as other national and local bodies such as the Department for Communities and Local Government, the Department for International Development, the Department for International Trade, Innovate UK, the Economic and Social Research Council, and the Science and Technology Facilities Council, amongst others.

7.1.2 Investment

Continuing ongoing investment in the sector and having a positive climate for investment would be important to ensure the North replaces its ageing infrastructure.

A sound industrial strategy that fosters market confidence would contribute to capitalising on what is currently available in terms of infrastructure and developing opportunities to grow. Working with partners like the Department for International Trade, the Confederation of British Industry, the British Chambers of Commerce and local enterprise partnerships would inform investors and businesses of the opportunities available in the North of England. A transparent regulatory system and business environment would provide certainty for investors.

7.1.3 Innovation and R&D

Economic growth and investment opportunities could come through gaining greater market share in the power, heat and transport sectors. This could be driven by innovation as energy systems evolve rapidly driven by the energy trilemma, technological change and customer demand.

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The 'north-south divide' is not as pronounced in energy as it is in other sectors, as this report has demonstrated. Analysis such as that conducted by SQW has identified the energy sector as one of the growth opportunities in the North, based on the region's expertise around generation, storage and low carbon technologies and processes, especially in nuclear, offshore wind[137] and hydrogen. Other areas of growth opportunities outside the energy sector include advanced manufacturing and digital which have positive impacts on the supply chain of the energy sector. Northern energy companies are already providing a strong source of innovation and investment, contributing to areas such as customer service, renewable deployment and electric vehicles.

The case studies presented in Chapter 4 show that there are a large number of innovation projects already taking place in the North. It would be important to maintain R&D and innovation in the sector to trial projects at a small scale first, to demonstrate technologies can also be deployed at scale and provide good value for money for the end consumer. Leveraging current expertise and experience and developing a 'centre of excellence' in the growth areas identified in this report would not only contribute to the North's economic growth but also to other regions.

7.1.4 Whole energy system

Energy policy has traditionally been centrally planned in the UK, with policy decisions taken in Whitehall or by Ofgem/DECC (now BEIS). However, rapid technological advances have made decentralised energy technologies such as solar PV, distributed generation and energy storage increasingly important, giving local communities more power to take control of how they use and produce energy. This has been recognised by DECC's Community Energy Strategy, with initiatives such as Bristol Energy, a municipal energy company wholly owned by Bristol Council created in 2015 which invest its profits back into Bristol supporting council services to citizens and community projects. These trends mean cities in the North of England could start taking more of a role in local energy policy for the benefit of their inhabitants. This is also true in generation where a recent study by the University of Bath on 'Realising Transition Pathways' argues that 50% of energy generation could be devolved to regions by 2050[138] via distributed generation with emerging technologies, new infrastructures and institutions. This also offers the prospect of closer matching of local energy supply and demand, as well as the appropriate usage of local energy assets. Local authorities could work with the energy sector in the North to drive the decentralised energy systems of the future, driving the efficient use of local assets, developing local expertise, and providing a blueprint for the rest of the country.

There are many ways in which stakeholders in the energy sector in the North could work together to meet energy challenges in innovative ways that would benefit the region. Yet, for this to happen, clear accountability, governance and leadership should be in place from the outset through existing or new institutions. This presents an opportunity to ensure cross-sector collaboration for joined up planning and decision making. An integrated energy system would bring benefits through improved investment models and a cohesive energy strategy. This could foster the development of partnerships between electricity and gas network companies and encourage them to collaborate to deliver the best outcomes for customers, communities and the environment.

Going forwards, different energy market players may need to develop complementary market offerings. Additionally, bringing new skills and know-how from one sector to another could also promote and speed up development. The North's current market positioning offers an opportunity to join up power, heat and transport to develop businesses and skilled workforce in the North that can add value to other parts of GB. This also involves exploring the options that are available to solve the energy trilemma and select the ones that provide the most value for customers – these trade-offs would help get the best integrated solution.

137 The Northern Powerhouse Independent Economic Review: Final Executive Summary Report, SQW, 24 June 2016. Available at: http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf

138 'Realising Transition Pathways' Consortium, EPSR. Available at: http://www.realisingtransitionpathways.org.uk/realisingtransitionpathways/publications/RTP_Achievements_One_Pager_Final.pdf

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Appendix A GVA methodology

A.1 Estimating GVA – Methodology

GVA, measures the contribution to the economy each individual producer, industry or sector in the UK. It is used in the estimation of GDP which is a key indicator of the state of the whole economy. The ONS uses three theoretical approaches to estimate GDP. These are: i) production, ii) income and iii) expenditure. When using the production or income approaches, the contribution to the economy of each industry or sector is measured using GVA[139].

There are a number of ways to measure GVA. The preferred methodology is a bottom-up approach where GVA is calculated using company data including company accounts as well as sector/industry wide surveys. There can be considerable methodological and data challenges to estimating the economic activity associated with a particular sector or region using a 'bottom up' method. One of the main challenges is the need to gather large amounts of public and non-public information. When data is not always available, alternative approaches are used.

Our review of available data for the North has shown that there limited regional data coded to the energy sector, making it difficult to account for the full supply chain and conduct a 'bottom-up' analysis. As such, although a 'bottom up approach' approach can provide a more accurate picture of economic activity in a particular sector, we have employed a 'top down' approach to estimating the GVA of the energy sector in the North due to the lack of data availability.

The benefit of a 'top down' approach is that GVA can be estimated using publicly available information, but the downside is that it provides a less granular picture of the sector's GVA composition. This is the reason why our estimates of the economic activity associated with the Northern energy economy are subject to considerable uncertainty.

Using a top-down approach, it is possible to estimate GVA at the firm level using two different methods:

Method 1: GVA = Operating profit (before tax) + Employee costs + Depreciation + Amortisation

Method 2: GVA = Turnover (or sales) – Cost of goods sold (excluding employee costs)

Where:

139 ONS. Available at: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/national-accounts/gva/index.html

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— Employee costs are the total costs to the employer of employing someone – That includes wages, pension and National Insurance contributions and any other costs directly associated with employment such as bonuses and overtime[140]; and
— Cost of goods sold includes the costs of raw materials and energy.

The approach we have adopted in building up our GVA estimates is as follows:

1 We have built on recent existing analysis to identify a current overall GVA figure for the Northern energy sector (in 2014 prices);
2 We have broken down this current overall energy sector GVA into its key constituent segments based on BEIS/Ofgem's analysis of the breakdown of the fuel bill and have adjusted this using Method 2 described above; and
3 We have then made assumptions for each of these segments to create our future economic growth scenarios to 2050 (for GVA and employment).

Section 1.2 below explains this approach in further details.

A.2 Estimating current GVA for the energy sector in Northern England

The SQW study introduced in Section 5.1 compiled 'top down' data on Northern GVA by sector. The study found that GVA for electricity and gas was £3.644 billion[141] in 2013[142]. We have updated SQW's 'top down' GVA of £3.644 billion[143] to account for sectoral growth since 2013.

The ONS publish annual estimates of regional GVA by sector[144]. The data shows that GVA for the electricity and gas sector decreased by 11.3%[145] from 2013 to 2014. To take account of growth in 2015 and 2016, we use UK-wide total GDP as a proxy for Northern GVA for electricity and gas as we would expect the sector to have grown in similar proportions. From 2015 to Q2 2016, GDP grew by 2.8%[146]. These data adjustments result in an adjusted GVA baseline of £3.51 billion in £2014 prices.

To look at the future economic contribution of the energy sector in the North in Chapter 6, we developed three economic growth scenarios to estimate GVA and employment out to 2050 in each of the component parts of the energy sector. As a starting point, we broke down our estimate of current GVA for the energy sector into component parts based on BEIS/Ofgem's analysis of the breakdown of the fuel bill. The breakdown provides an estimate of the proportion of different costs in the dual fuel bill of an average domestic customer of the large suppliers ('Big Six') in 2014/15[147] [148]. Ofgem/BEIS estimate the share of the energy bill for each constituent part as follows:

140 Scottish Enterprise Economic Impact Guidance, January 2014. Available at: http://www.evaluationsonline.org.uk/evaluations/Documents.do?action=download&id=683
141 2011 prices
142 Table B-4, Page B-7, Workstream 3, Northern Powerhouse Independent Economic Review, SQW, June 2016.
143 2011 prices
144 2014 is the latest year.
145 Regional Gross Value Added (Income Approach) reference tables, ONS. Available at: http://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach
146 Gross Domestic Product, ONS. Available at: https://www.ons.gov.uk/economy/grossdomesticproductgdp
147 Understanding your gas and electricity bills, Ofgem. Available at: https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills
148 Policy impacts on prices and bills, BEIS. Available at: https://www.gov.uk/guidance/policy-impacts-on-prices-and-bills

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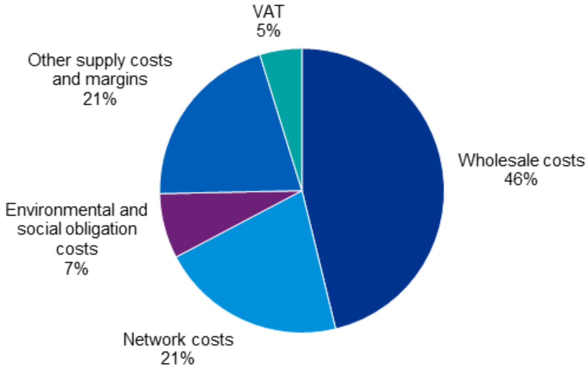
Figure A.2 Breakdown of a typical dual fuel bill



Source: https://www.ofgem.gov.uk/information-consumers/domestic-consumers/understanding-energy-bills
https://www.gov.uk/guidance/policy-impacts-on-prices-and-bills

Our starting assumption is that a sub-sector's share of an energy bill can be used as a proxy to estimate its contribution to GVA, i.e. if energy networks made up 50% of the energy bill, we would work off the assumption that they also generated 50% of the total energy GVA figure for the North. We acknowledge that the Ofgem/BEIS analysis represents a snapshot of the bill breakdown in a particular year, and that shares may change over time, due to shifts in commodity prices in particular. Current industry projections for commodity costs are stable, therefore we have not factored future commodity cost changes into our analysis.

We then refined these figures to take account of:

— Parts of the bill that are not directly included in GVA, i.e. taxes such as VAT and subsidies to ensure environmental and social obligations are met, e.g. Feed in Tariffs, Renewables Obligation and Energy Company Obligation;

— Parts of the bill where activities associated with a component are not undertaken locally e.g. upstream gas (see below); and

— Parts of the energy sector not reflected in an energy bill, i.e. appliances, buildings and transport (see below).

1 Upstream gas

There is no gas extraction in the North of England, but workers from the region are involved in the sector elsewhere in the UK, either directly or in the supply chain. It is worth noting that although we acknowledge that shale gas/oil could contribute to Northern GVA should development go ahead, the economic impacts of the development of unconventional oil and gas are excluded from this Report due to the uncertainty regarding exploration and production of the resources in the North of England. Economic Impact Assessments on shale gas in Northern England[149] have demonstrated that there could be positive economic benefits from exploiting the resources.

While including the potential benefits of the shale gas sector would increase the GVA results presented in this study, we have excluded any potential benefits given the uncertainty about the scale and timing and economics of exploitation. For example, continued low international gas prices may make shale gas extraction in the North unviable.

[149] Such as: Amion Consulting. (2014, June). Potential Economic Impacts of Shale Gas in the Ocean Gateway. Retrieved from http://www.igasplc.com/media/10851/ocean-gateway-shale-gas-impact-study.pdf and Amion Consulting. (2015, April). Shale Gas – Creating a Supply Hib for the Bowland Shale. Retrieved from http://www.peelgasandoil.co.uk/media/Peel_Gas_and_Oil_Ltd_-_Shale_Gas_-_Creating_a_supply_hub_for_the_Bowland_Shale_FINAL_100415.pdf

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2 Energy appliances and buildings and transport

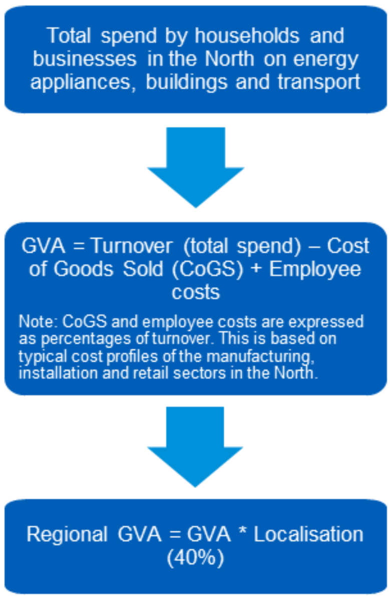
The energy bill reflects all of the upstream and downstream costs associated with the generation, supply and sale of electricity and gas, on the assumption that all of these costs are 'passed through' to consumers by companies. However, households and business face other costs associated with their use of energy which are not reflected in their energy bill. These chiefly relate to energy appliances and buildings and transport.

For the purpose of this report, we define energy appliances and buildings as the energy production technologies (i.e. small-scale distributed generation) and appliances used and home improvements made by households and commercial and industrial customers. See Section 1.3 for the breakdown of the distributed generation/appliances we have considered.

We made a bottom up estimate of regional GVA in the North of England associated with transport and energy appliances and buildings used in households and businesses. This is based on estimates of GVA at the firm level using Method 2 presented in Section 1.1 (Appendix 1).

For example, to calculate GVA for appliances and buildings, we have developed an estimate of total spend by households and businesses in the North of England on energy appliances (including maintenance, repair, alterations and improvements) as well as small-scale distributed generation technologies. This is used as a proxy for the turnover of Northern firms involved in this sector. This is a cautious approach because it excludes potential demand for the goods and services of Northern firms from outside the region. Figure A.3 provides a step by step demonstration of how these baselines were compiled.

Figure A.3 Estimation of regional GVA for transport and appliances and buildings



The GVA related to spend on appliances and buildings is calculated as the difference between the *Turnover* and the *Cost of Goods Sold (excluding employee costs)*. We assume that GVA for energy appliances and buildings comes from the manufacturing and installation of energy appliances as well as the retail sector. We have therefore calculated the Cost of Goods Sold (CoGS) and employee costs as percentages of turnover. This was done by a weighted average of turnover and costs for the manufacturing, installation and retail sectors in the North[150]. This data was taken from the ONS's Annual Business Survey[151]. Our analysis of the ONS data provides the estimated CoGS as 80% of turnover and employee costs as 18% of turnover. The GVA for appliances is calculated by adding turnover, subtracting the CoGS and adding back employee costs using the percentages above.

Finally, we took account of the localisation of the monies spent in the North of England. A localisation ratio is a percentage representing the amount of expenditure on a good or service that remains within the region in question. For instance, some component parts are manufactured in the North while others are bought elsewhere. The component parts manufactured in the North are thus 'local' and contribute to the local economy. The localisation assumption attempts to take account of leakage, i.e. how much expenditure is with economic agents in the North versus in other UK regions and the rest of the world. Leakage is also defined as the proportion of outputs that benefit those outside of the

150 SIC codes 32, 33 and 47.

151 Annual Business Survey, ONS, July 2016. Available at: http://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveyregionalresultsqualitymeasures

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intervention target area of group. For the purpose of this report, we have used a localisation of 40%[152][153].

We assumed that economic activity associated with the manufacture and sale of energy appliances in the North of England is covered by the SQW GVA estimate quoted above, and is not additional. We believe this is a cautious approach to prevent any overestimate of sectoral GVA.

The same methodology was used to calculate the GVA baseline for transport.

A.3 Estimating GVA for energy appliances & buildings

'Energy appliances and buildings' consist of the spend by households and businesses on energy related maintenance (e.g. boiler repairs, insulation and other home improvements), spend on heating systems (e.g. boiler, ASHP, GSHP etc.) and distributed generations (e.g. PV, hydro, wind, etc.). Table A.1 shows what we included in small-scale distributed generation, appliances and home improvements.

Table A.1 Small-scale distributed generation, appliances and home improvements

Type of technology considered	Domestic	I&C
Air source heat pumps	✓	✓
Water/ground source heat pumps	✓	✓
Biomass systems	✓	✓
Solar thermal	✓	
Solar PV	✓	✓
Hydro		✓
Wind	✓	✓
Anaerobic digestion		✓
CHP	✓	✓
Biomethane		✓
Biogas		✓
Deep geothermal		✓
Low carbon heating (repairs/installations)	✓	✓
DIY improvements – Double glazing, kitchen units, sheds, etc.	✓	
Home improvements – Contracted out	✓	

152 This is in line with the UK content in totex for offshore wind farms and for the UK nuclear supply chain. See next footnote for source.

153 The Nuclear Supply Chain Action Plan, HM Government, December 2012. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65658/7176-nuclear-supply-chain-action-plan.pdf

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Type of technology considered	Domestic	I&C
Purchase of materials for capital improvements	✓	✓
Equipment hire, small materials	✓	✓
Electric vehicles	✓	
Hydrogen vehicles	✓	

Source: KPMG

The total installed capacity for renewable heat and distributed generation is based on BEIS's RHI deployment data[154] and BEIS's Feed-in Tariff statistics[155]. Total spend on these technologies is calculated based on capex cost per kW installed. Table A.2 sets out our cost assumptions:

Table A.2 Summary of cost assumptions

Technology	Unit cost (£/kw)	Source
Solid Biomass Boiler (Non-domestic)	£500 – £1,000	Table 8, Industrial Sweett capex assumptions (DECC)
Ground Source Heat Pumps (Non-domestic)	£1,593	Table 8, Industrial Sweett capex assumptions (DECC)
Air Source Heat Pumps (Non-domestic)	£1,017	Table 8, Industrial Sweett capex assumptions (DECC)
Air Source Heat Pumps (Domestic)	£9,000[(a)]	Energy Saving Trust
Ground Source Heat Pumps (Domestic)	£13,000[(a)]	Centre for Sustainable Energy
Biomass system	£4,300[(a)]	Energy Saving Trust
Solar thermal	£4,500[(a)]	Renewable Energy Hub
PV	£941	Small scale generation costs (DECC)
Hydro	£1,840	Small scale generation costs (DECC)
Wind	£1,115	Small scale generation costs (DECC)
Anaerobic Digestion	£3,283	Small scale generation costs (DECC)
Micro-CHP	£9,415	Small scale generation costs (DECC)

Note: (a) Cost per unit of technology installed.

We assumed that the costs of the renewable heat technologies decrease over time. For domestic users, the cost reduction is 33% by 2025 and 10% by 2045, based on DELTA's estimation for ASHP[156]. For I&C, the cost reduction is 13% by 2025 and 20% by 2045, based on DELTA's estimation for biomass plant[157]. We also assumed that 90% of the households and businesses with gas boilers will need to replace their boilers once in the period.

[154] RHI deployment data, BEIS, August 2016. Available at: https://www.gov.uk/government/statistics/rhi-deployment-data-august-2016

[155] Feed-in Tariff Statistics, BEIS. Available at: https://www.gov.uk/government/collections/feed-in-tariff-statistics

[156] 2050 Pathways for Domestic Heat, DELTA, September 2012. Available at: http://www.energynetworks.org/assets/files/gas/futures/Delta-ee_ENA%20Final%20Report%20OCT.pdf.pdf

[157] 2050 Pathways for Domestic Heat, DELTA, September 2012. Available at: http://www.energynetworks.org/assets/files/gas/futures/Delta-ee_ENA%20Final%20Report%20OCT.pdf.pdf

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The GVA for energy appliances and buildings was calculated using Method 2 as outlined in Section 1.1 (Appendix 1) above. The underlying assumptions for the calculation of GVA are outlined in Table A.3.

Table A.3 Summary of assumptions for GVA calculation

Cost type	Assumption	Source
Employee costs as a % of gross profit	18%	Based on ONS's Annual Business Survey data on Manufacturing in the North.
Localisation factor	40%	Based on totex for UK offshore wind farms[158] and for the UK nuclear supply chain[159]
Cost of inputs as a % of gross profit	80%	Based on ONS's Annual Business Survey data on Manufacturing in the North.

Source: KPMG analysis.

A.4 Estimating GVA for transport

Our baseline for total spend in the North on transport is based on the sales of Nissan Leaf in the UK in 2015 (over 5,000 cars[160]) at £24,500 per unit[161]. The projected spend on transport is based on the price of a typical ULEV and the assumption of ULEV take-up in each scenario. Nissan's production of the Nissan Leaf accounts for 17%[162] of EVs sold in 2015 in the UK. To estimate the sales of EVs vehicles that can be attributed to the North of England, we use the number of ULEVs in the UK as a proportion of cars on the road in 2015 multiplied by the sales of Nissan Leaf (i.e. 17%). This gives us our baseline sales for the calculation of GVA associated with the transport sector.

The GVA for the transport sector was calculated using Method 2 described in Section 1.1 (Appendix 1). The underlying assumptions for the calculation of GVA are the same as for appliances and buildings (see Table A.3 above).

It is worth noting that there is uncertainty with regards to the production of hydrogen fuel cells vehicles in the UK. Based on the North's advance in production of EVs and R&D facilities in hydrogen fuel cells, we estimate that the North will produce 8.5% of hydrogen fuel cells sold in the UK.

We assume that the cost of ULEVs will be competitive compared to conventional vehicles by 2020. The price of a typical ULEV is set out in Figure A.4 below.

158 The UK content of operating offshore wind farms, Offshore Wind Program Board, November 2015. Available at: https://c.ymcdn.com/sites/www.renewableuk.com/resource/resmgr/publications/reports/uk_offshore_content_report_n.pdf

159 The Nuclear Supply Chain Action Plan, HM Government, December 2012. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65658/7176-nuclear-supply-chain-action-plan.pdf

160 'Nissan LEAF Sales Rose 29% In UK In 2015', CleanTechnica, January 2016. Available at: https://cleantechnica.com/2016/01/26/nissan-leaf-sales-rose-29-in-uk-in-2015/

161 Nissan Leaf prices and specifications, Nissan. Available at: https://www.nissan.co.uk/vehicles/new-vehicles/leaf/prices-specifications.html

162 5,000 Nissan sold out of 30,000 EVs sold in 2015. Number of EVs sold in the UK in 2015 is available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516429/vehicle-licensing-statistics-2015.pdf

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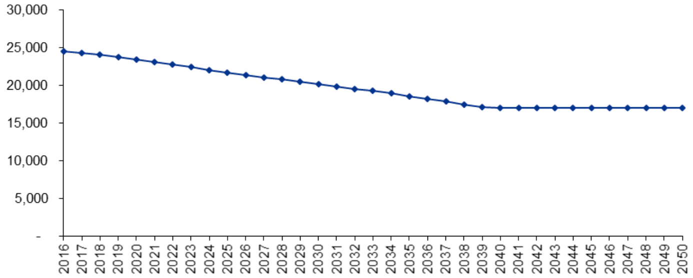
Figure A.4 Price of ULEVs over time (£)



Source: KPMG

A.5 GVA baseline

Table A.4 depicts the adjusted baseline in both percentage and monetary terms.

Table A.4 GVA breakdown assumptions to calculate our GVA baseline for 2016

Components	BEIS bill breakdown	Notes	Adjusted % breakdown of Northern GVA	2016 – GVA breakdown in the North (electricity & gas)
Wholesale costs	**46%**		**32%**	**£1.13bn**
Upstream gas	23%	No gas extraction in the North, but some workers are accounted for	4%	£0.14bn
Electricity generation	23%		28%	£1.00bn
Network costs	**21%**		**26%**	
Gas transmission	2%		2%	£0.09bn
Electricity transmission	4%		5%	£0.17bn
Gas distribution	6%		7%	£0.26bn
Electricity distribution	9%		11%	£0.39bn
Hydrogen networks	NA		0%	-
Heat networks	NA		~0%	£0.02bn
Other supply costs and margins	**21%**		**26%**	**£0.91bn**
Environmental and social obligations costs	**7%**	Subsidies – Not included in GVA	**0%**	**-**
Domestic appliances	**NA**		**7%**	**£0.23bn**
Non-domestic appliances	**NA**		**8%**	**£0.29bn**
Transport	**NA**		**1%**	**£0.02bn**
VAT	**5%**	Tax – Not included in GVA	**0%**	**-**
Total	**100%**		**100%**	**£3.51bn**

Source: KPMG.

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Appendix B Employment methodology

B.1 Employment baseline

To estimate the number of direct energy sector jobs and supply chain jobs in the North, we used FAME, a database of companies in the UK. We filtered for active companies based on Government regions (North East, North West and Yorkshire and The Humber) and UK Standard Industry Classification (SIC) Codes 2007 (a list of the SIC codes used is provided in Section 2.2 below) to identify the companies that operate in the North, and are involved in the energy economy. The SIC codes are based on sectors directly involved in the electricity and gas industry as well as indirectly through the supply chain.

Based on the SIC codes we classified jobs as: i) direct jobs or ii) supply chain jobs and adjusted these to approximate the number of jobs in the electricity and gas sectors only. Table B.5 shows how we have adjusted the job numbers.

Table B.5 Number of jobs in FAME – Adjusted

Segment	Number of jobs – Adjusted			
	Direct	Supply chain	Total	Notes
Upstream gas	-	1,675	**1,675**	Adjusted from 6,699 to reflect the supply chain jobs related to upstream gas, i.e. 30%.
Electricity generation	7,296	11,069	**18,365**	Includes all jobs in FAME in the electricity generation sector.
Gas networks	2,673	579	**3,252**	Includes all jobs in FAME in the gas networks sector. Excludes hydrogen/hear jobs.
Electricity networks	3,878	7,010	**10,888**	Includes all jobs in FAME in the electricity networks sector. Excludes half the jobs in installation of industrial machinery and equipment (1,132) as the other half is likely to be metering jobs which are included in energy supply.
Energy supply	12,261	1,290	**13,551**	Includes all jobs in FAME in energy supply, but adjusted for take account of only 5% of call centre jobs, i.e. 2,484. Includes half the jobs in installation of industrial machinery and equipment (1,132 jobs are likely related to metering). The other half is likely to be part of DNOs.
Appliances	4,980	4,715	**9,695**	Adjusted to only account for heating jobs, i.e. 45% direct jobs (i.e. 4,160) and 60% of supply chain jobs (4,715) – This adjustment was made to exclude plumbing jobs. This number may also excludes self-employed.
Transport	1,000	1,000	**2,000**	Adjusted to account for jobs related to the manufacturing of EV components only.

We note that there are a number of companies that do not provide employee numbers which may underreport jobs in the North. Additionally, our estimates do not include self-employed workers (i.e. sole traders) in the energy sector which would not be accounted for in the FAME database. It is also worth noting that we have included sectors in the supply chain where activities are not solely confined to the energy sector e.g. roofers' work will involve roof repairs as well as energy-related insulation activities. This might therefore lead to an overestimation of the number of indirect Full Time Employee (FTE) jobs in the energy sector.

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B.2 Employment breakdown

Table B.6 below shows the SIC codes used to estimate the number of jobs in the North of England. This was used as our jobs baseline in 2016.

Table B.6 SIC codes used to estimate jobs in the North of England

SIC	Description	Link to study	Type of jobs
6200	Extraction of natural gas	Gas extraction	Direct
9100	Support activities for petroleum and natural gas extraction	Gas extraction	Supply chain
27110	Manufacture of electric motors, generators and transformers	Electricity generation	Supply chain
27120	Manufacture of electricity distribution and control apparatus	Electricity networks – Distribution	Supply chain
27200	Manufacture of batteries and accumulators	Appliances – Transport	Direct
27400	Manufacture of electric lighting equipment	Appliances	Supply chain
27510	Manufacture of electric domestic appliances	Appliances	Supply chain
27900	Manufacture of other electrical equipment	Appliances	Supply chain
28110	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	Electricity generation	Supply chain
28120	Manufacture of fluid power equipment	Electricity generation	Supply chain
28131	Manufacture of pumps	Electricity generation	Supply chain
28132	Manufacture of compressors	Electricity generation	Supply chain
29100	Manufacture of motor vehicles	Appliances – Transport	Direct
29310	Manufacture of electrical and electronic equipment for motor vehicles and their engines	Appliances – Transport	Direct
32990	Other manufacturing n.e.c.	Appliances	Supply chain
33140	Repair of electrical equipment	Appliances	Direct
33190	Repair of other equipment	Appliances	Direct
35110	Production of electricity	Electricity generation	Direct
35120	Transmission of electricity	Electricity networks – Transmission	Direct
35130	Distribution of electricity	Electricity networks – Distribution	Direct
35140	Trade of electricity	Supply – Electricity	Direct
35210	Manufacture of gas	Gas extraction	Supply chain

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SIC	Description	Link to study	Type of jobs
35220	Distribution of gaseous fuels through mains	Gas networks – Distribution & transmission	Direct
35230	Trade of gas through mains	Supply – Gas	Direct
38110	Collection of non-hazardous waste	Electricity generation (e.g. biomass)	Supply chain
38210	Treatment and disposal of non-hazardous waste	Electricity generation (e.g. biomass)	Supply chain
39000	Remediation activities and other waste management services	Electricity generation (e.g. biomass)	Supply chain
41100	Development of building projects	Networks	Supply chain
42220	Construction of utility projects for electricity and telecommunications	Networks	Supply chain
43210	Electrical installation	Appliances	Direct
43220	Plumbing, heat and air-conditioning installation	Appliances	Direct
43390	Other building completion and finishing	Appliances	Supply chain
43910	Roofing activities	Appliances	Supply chain
43999	Other specialised construction activities n.e.c.	Appliances	Supply chain
45111	Sale of new cars and light motor vehicles	Appliances – Transport	Supply chain
45200	Maintenance and repair of motor vehicles	Appliances – Transport	Supply chain
45310	Wholesale trade of motor vehicle parts and accessories	Appliances – Transport	Supply chain
46120	Agents involved in the sale of fuels, ores, metals and industrial chemicals	Electricity generation	Supply chain
46160	Agents involved in the sale of textiles, clothing, fur, footwear and leather goods	Appliances – Transport	Supply chain
46439	Wholesale of radio, television goods & electrical household appliances (other than records, tapes, CD's & video tapes and the equipment used for playing them)	Appliances	Direct
46719	Wholesale of other fuels and related products	Electricity generation	Supply chain
46740	Wholesale of hardware, plumbing and heating equipment and supplies	Appliances	Direct
47540	Retail sale of electrical household appliances in specialised stores	Appliances	Direct
63110	Data processing, hosting and related activities	Supply	Direct
73110	Advertising agencies	Supply	Supply chain

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SIC	Description	Link to study	Type of jobs
82200	Activities of call centres	Supply	Direct
82990	Other business support service activities n.e.c. (gas/water meter reading)	Supply	Supply chain
95220	Repair of household appliances and home and garden equipment	Appliances	Direct
95290	Repair of personal and household goods n.e.c.	Appliances	Direct

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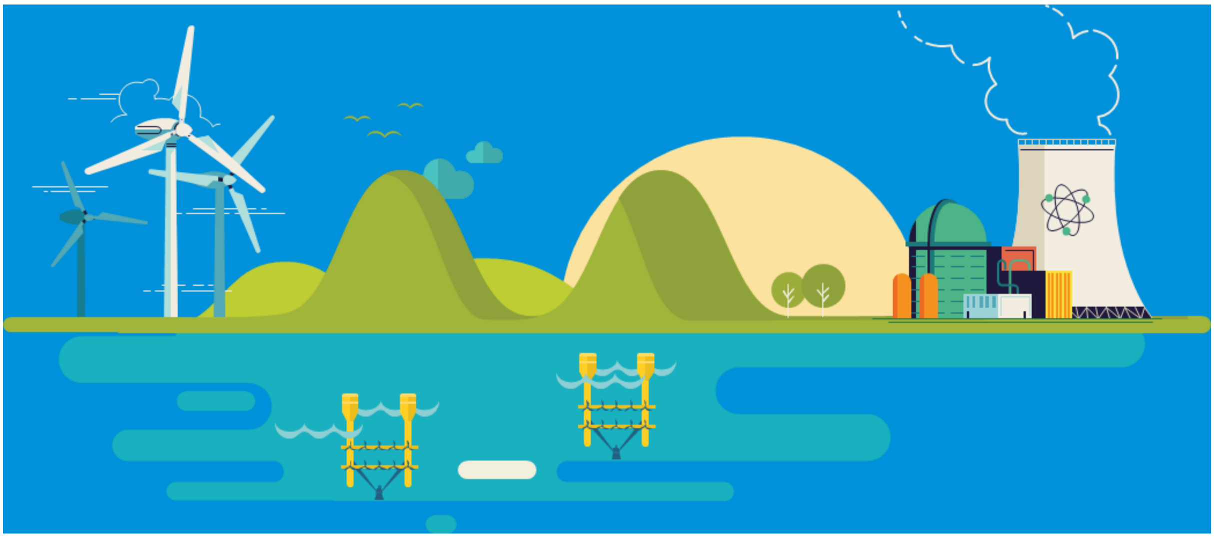
Appendix C The scenarios considered



C.1 Scenario 1: Evolution of gas

Table C.7 summarises our detailed assessment of the prospects for growth in each sector of the Northern energy economy, and our resulting assumption of average annual growth in GVA and jobs out to 2050:

Table C.7 Summary of Scenario 1

Component	What will the sector look like?	What will markets participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
Upstream gas	— Although demand for gas remains at current levels, North Sea production declines, meaning less demand for supply chain and workers in the North — LNG imports needed to meet gas demand — At the wholesale level, more demand for gas to meet hydrogen needs	— Investment in LNG facilities — Use of gas interconnectors to meet gas demand — Future activity likely to focus on decommissioning rather than extraction	-5.0%	-7.0%
Electricity generation	— Decrease in electricity generation in the North as current thermal assets reach the end of their useful life and are only partially replaced so that the region is no longer a net exporter of electricity	— Some investment in power plants — Some investment in wind between 2016 and 2030	1.9% to 2030, 0% thereafter	-1.0%
Gas networks	— Gas distribution network in urban areas is converted to hydrogen — Gas transmission network provides the methane to gas-fired power plants and SMRs	— Investment in the IMRP — Investment in CCS and SMR plants	**Distribution** 1.0% to 2030 and 0% thereafter **Transmission** 2.0% to 2021 and 1.0% thereafter	1.0% to 2030 and 0% thereafter

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Component	What will the sector look like?	What will markets participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
Hydrogen	— Urban areas in the North convert to use hydrogen gas for heating and transport. — The heat sector is completely decarbonised by 2050;all customers in the North convert to hydrogen gas	— Investment in CCS, SMRs, networks and appliances conversions	9.7% from 2026 onwards	n/a
Electricity networks	— The distribution network becomes a 'smart grid; — Electricity transmission is reinforced until 2030 to adapt to large amounts of renewable power coming from Scotland	— DNOs invest in smart grids	**Distribution** 1.0% to 2050 **Transmission** 4.0% to 2030 and decreases to 0% by 2050	1.0%
Energy supply	— Suppliers become 'energy service companies' and offer products and services such as Hive and Nest	— Some investment in 'smart home solutions'	0.5%	0.5%
Appliances & buildings	— Buildings become more energy efficient and appliances in urban households are converted to hydrogen — No conversions to electric heating — Some consumers take up distributed generation	— Investment in energy efficient buildings/applianc es — Spend in appliances conversion and manufacturing	0.3%	0.5%
Transport	— Transport is mostly decarbonised with many hydrogen and EV on the road — Hydrogen is transported to fuel stations via lorries	— Investment in hydrogen vehicles and hydrogen fuelling stations — Investment in EV/storage/ULEV components	9.0%	4.5%

1. Upstream gas

How will the sector evolve?

The main features of the upstream gas sector in the North are as follows:

— Supply chain firms and workers supporting extraction activities in the North Sea;

— LNG terminal infrastructure at Teesside – Teesside GasPort (TGP), a dockside floating regasification facility, was in operation for eight years until 2015; and

— UK-Norway interconnector (Langeled) at Easington.

In future, gas extraction in the North Sea, and related supply chain activities, will decrease over time as high cost production combined with the collapse in crude prices to 12-year lows put pressure on operators' balance sheet. This will negatively affect demand for the goods and services of workers and firms based in the North which supply the North Sea industry.

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A recent report published by the OGA[163] shows that the rate of production of UK gas from 1998 to 2015 was -5%. The OGA believes this trend will continue until 2035 resulting in a negative impact on both GVA and jobs.

In this scenario, natural gas will be increasingly used to derive hydrogen to heat homes and businesses. This implies increased demand for natural gas (both in the region and nationally) as methane is the principal input into the Steam Methane Reform (SMR) process to produce hydrogen[164]. Given the decline in North Sea production, meeting demand for natural gas will require greater gas imports, either through gas interconnectors or through LNG terminals.

It is currently uncertain how existing infrastructure could meet gas demand in the future. In this scenario we assume that there is investment in the North in LNG facilities similar to TGP, and that the existing gas interconnector at Easington (Langeled) continues to be used. The capital expenditure in an LNG terminal infrastructure such as TGP would cost approximately £40 million[165], which would not be significant enough to offset the negative GVA trend caused by lower extraction activities in the North Sea.

How will the Northern energy economy respond to opportunities?

As production in the North Sea declines, we would expect to see less investment by supply chain firms in the Northern energy economy which are involved in extraction activities. Some firms may be able to shift their focus to decommissioning activities, although these will not fully replace the activity associated with extraction over the course of an oil/gas field's life.

Gas extraction and import is a mature sector with limited scope for further innovation, or for significant changes in the nature of work and required employee skills levels.

Growth assumptions

Even though North Sea production is now falling, the sector remains a major driver of economic activity in the UK[166]. As a result, the economic impacts from a reduction in North Sea production are unlikely to be offset by investment in new gas storage facilities, which are less capital intensive[167].

We therefore estimate that GVA associated with upstream gas will fall by an average of 5% a year out to 2050 in line with than the average reduction in North Sea production.

Interconnectors and LNG facilities are significantly less labour-intensive than oil and gas extraction[168]. We, therefore, estimate that the increase in local LNG jobs would not significantly offset jobs losses in the gas extraction sector resulting in an average employment growth rate of -7% to 2050[169], in line with the OGA's employment estimates.

163 OGA production projection, Oil and Gas Authority, February 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503852/OGA_production_projections_-_February_2016.pdf

164 We assume that Steam Methane Reformers (SMRs) are used to produce hydrogen rather than the alternative technique of electrolysis. SMR efficiency losses are c30%, i.e. 1 unit of methane produce 0.7 unit of hydrogen. Available at: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

165 Teesside GasPort project, Technica. Available at: https://www.technicaltd.com/projects/Murphy%20-%20Teesside.pdf

166 In 2015, capital investment in the UK oil and gas industry was estimated at £11.6bn

167 As explained above, a single LNG site is estimated to cost £40m to build.

168 Data from FAME shows that the O&M subcontractor for Teeside GasPort employed 243 people. National Grid Grain LNG Limited employs 145 people while South Hook LNG Terminal Company Ltd employs 94 people. This is significantly lower than employment in the UK offshore oil and gas industry with 34,000 direct jobs in 2016. Available at: http://oilandgasuk.co.uk/oil-gas-uk-figures-show-impact-of-oil-price-downturn-on-jobs/

169 http://oilandgasuk.co.uk/oil-gas-uk-figures-show-impact-of-oil-price-downturn-on-jobs/

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2. Electricity generation

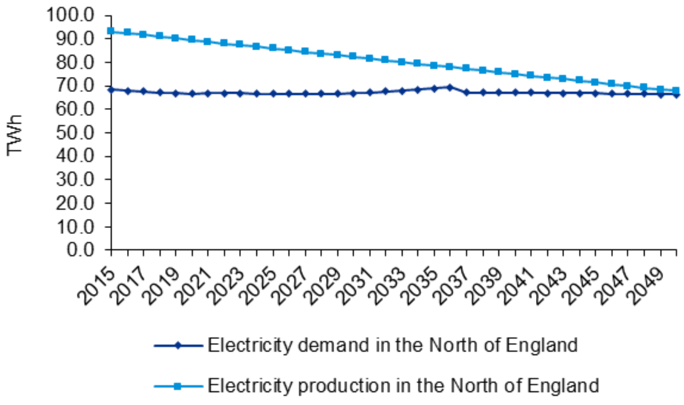
How will the sector evolve?

The North is a net exporter of electricity to the rest of the UK as it hosts a significant proportion of the UK's largest thermal power stations. There is 9,466MW of nuclear and coal capacity in the region, which represents a little less than half of total installed capacity (20,853 MW)[170]. The North West, the North East and Yorkshire and The Humber generate c93TWh of electricity a year[171] versus demand in the region of 68TWh per year[172].

The energy pathway for this scenario assumes that demand for electricity decreases marginally overtime from c68TWh a year in 2016 to c66TWh a year in 2050 as energy efficiency improvements cancel out the effects of population growth.

Thermal power stations in the North are generally ageing, and coal power stations face limits on their running hours due to environmental legislation. In addition, the UK Government has pledged to phase out unabated coal generation by 2025. We assume that these assets are only partially replaced, such that the North no longer 'exports' power to other regions of the UK by 2050, i.e. output equals regional demand in 2050. Figure C.5 below shows electricity production to 2050 versus electricity demand in the North. The average annual reduction in output is 0.8%.

Figure C.5 Electricity production versus electricity demand in the North



Source: KPMG analysis based on sub-national electricity consumption statistics and DUKES Chapters 5 & 6.

How will the Northern energy economy respond to opportunities?

Although electricity output in the region will decline over time in this scenario, it will become increasingly low-carbon through technologies such as wind, solar and biomass. For example, a major dedicated biomass project is due to be commissioned on Teesside in 2020[173]. Furthermore, the location of the Siemens offshore wind turbine manufacturing facility in the region (at Hull) will present opportunities for supply chain firms in the region.

170 DUKES, BEIS. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540948/DUKES_5.10.xls

171 KPMG estimate based on DECC load factors and DUKES Table 5.10. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540948/DUKES_5.10.xls

172 Regional and local authority electricity consumption statistics 2005 to 2011, DECC, 2016. Available at: https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics-2005-to-2011

173 'MGT Power: Work on Tees Renewable Energy Plant creating 600 jobs to start 'within weeks'', Gazettelive, August 2016. Available at: http://www.gazettelive.co.uk/business/business-news/mgt-power-work-tees-renewable-11738899

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The move to low-carbon generation presents significant opportunities for firms in the region to produce innovative new products and services, and for workers to upskill in order to work with the new technologies.

Growth assumptions

Despite a decrease in installed capacity, there is still a degree of innovation and value increase whereby more established technologies are replaced by ones that incur equivalent levels of GVA through construction and operation activity through to 2050. Separate to this, growth in distributed energy solutions will take place within the region – This has been included in the 'Appliances and buildings' section below. We therefore assume an average GVA growth rate of 1.9% year-on-year out to 2030 as reduced volumes are offset by replacement in construction and operation activity and to account for GVA related to the manufacture of wind turbines in Hull.

The decrease in installed capacity results in a decrease of the total workforce in the sector as assets are only partially replaced. Our analysis suggests that the closure of three large thermal plants could result in a decrease of 25% of direct jobs[174] in the sector. We have annuitized this figure out to 2050, giving an annual reduction of 1.0%. However some additional jobs are likely to be created in distributed energy solutions and these are captured elsewhere in our analysis.

3. Gas networks

How will the sector evolve?

Transmission

In this scenario, the gas transmission system exists largely in the same form as today except a large proportion of the natural gas it currently carries is used to feed the SMR plants for hydrogen production.

In addition, some further investment in the network may be required to meet increased import needs as North Sea production declines, and gas demand for hydrogen production increases.

In terms of ongoing investment, for the price control period 2014-2021, National Grid Gas Transmission expects an average growth rate of 2% year-on-year for its Regulatory Asset Value (RAV).

Distribution

At the distribution level, the iron mains replacement programme (IMRP) is completed which paves the way for hydrogen to be distributed through pipes with minimum additional conversion. The GDNs business plans for the current price control (2013-2021) suggest that network investment would result in a 1% growth in RAV year-on-year and includes the expenditure related to the IMRP programme.

Based on the assumption that the North represents c20% of total GB gas demand, average peak demand for gas in the North is 32 GW with a peak of 40GW in 2016-2017[175]. The current gas networks in the UK, and especially in Leeds, is large enough to convert to hydrogen and would not require additional investment in network capacity.

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[174] Based on data for three large thermal plants expected to be decommissioned in 2017, 2024 and 2025

[175] KPMG analysis based on 2050 Energy Scenarios report. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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How will the Northern energy economy respond to opportunities?

Gas transportation is a mature sector with limited additional scope for innovation, at both distribution and transmission level.

We expect that market structure will not change significantly in the period i.e. the gas transmission network will remain a national asset owned by a single company with its headquarters outside of the North of England. We also assume that the ownership of gas distribution networks will continue as today i.e. one network based in the region transporting gas to households and businesses in Yorkshire and the North East as Northern Gas Networks does today, and another network transporting gas in the North West as National Grid does today. These firms will remain regulated monopoly businesses as they are today[176].

Growth assumptions

A network's RAV is a good indication of the level of investment made on a yearly basis. We therefore use the RAV as a proxy to estimating GVA growth associated with gas networks in the North of England for the rest of the current RIIO price control period, with additional growth assumptions for the longer term out to 2050.

For the **transmission** network in the North, we expect that ongoing investment will be required after the end of the current price control period to ensure the network can cater for increased imports. As such, we expect GVA associated with the gas transmission network to grow by 2% year-on-year until 2021 in line with RAV[177] and 1% thereafter.

We assume that GVA growth associated with **distribution** networks grow by 1% year-on-year until 2030[178], i.e. 1% growth during the current price control period will continue until 2030, reflecting the completion of IMRP that is a necessary precursor to converting the network in urban areas to hydrogen. From 2030 to 2050 GVA for the gas distribution network in the North remains constant (i.e. 0% growth) as they are converted to hydrogen.

Gas network enhancements and replacements require skilled labour such as engineers, architects, legal and financial services, construction workers, etc. We assume that jobs would grow in line with GVA for gas distribution.

4. Hydrogen

How will the sector evolve?

Plans for hydrogen networks are in their early stages, and detailed evidence around how the sector will evolve is limited. Much of the evidence around the potential for hydrogen networks in the UK comes from NGN's H21 City Gate Project[179], which foresees hydrogen playing a major role in the energy system of the North of England over the coming decades. We therefore assume that the hydrogen sector in the North of England will develop along the lines of the roll-out presented in NGN's analysis. This suggests a city-by-city roll-out whereby Leeds gets converted from 2026 to 2029 and other major cities in the North of England are subsequently converted in the period to 2038. We

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176 Ofgem has indicated that it will consult in 2018 on strategy for RIIO-GD2, the price control agreement for gas distribution networks that will cover the 2023-30 period. https://www.ofgem.gov.uk/system/files/docs/2016/03/forward_work_programme_2016-17.pdf

177 Based on projected RAV growth in NGT RIIO business plan. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gt1-price-control-financial-model-following-annual-iteration-process-2015

178 RIIO-GD1 Price Control Financial Model following the Annual Iteration Process 2015, Ofgem, November 2015. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

179 H21, Leeds City Gate, July 2016. Available at: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

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assume that other cities and urban areas are also converted by 2050, so that scale economies from using a single fuel across existing networks in urban areas in the North are exploited to the full.

The conversion process will require substantial capital expenditure, and means that all gas appliances, boilers, hot water tanks, cookers, are either replaced or converted to run on hydrogen. Other technologies will also be required to support the conversion, such as CCS, salt caverns and Steam Methane Reformers (SMRs).

Based on data from the Leeds City Gate report and KPMG analysis, we estimate that total cumulative spend on the hydrogen conversion process is around £100 billion to 2050[180].

How will the Northern energy economy respond to the opportunities?

The Northern energy economy is well placed to respond to the challenges and opportunities presented by the hydrogen conversion. NGN are taking the lead among UK networks in developing conversion plans through its H21 City Gate Project. The conversion to hydrogen offers significant opportunities for innovation in supply chain firms in the North, and for major upskilling of the gas workforce. Firms in the region will also have the opportunity to export their expertise to other regions of the UK and the rest of the world as hydrogen networks are adopted more widely. By 2050, the North of England plays host to a ‘centre of excellence’ for the hydrogen economy which increases the region’s economic contribution through higher direct spend and spend related to the supply chain.

Growth assumptions

Hydrogen is a novel sector, and there is currently significant uncertainty over the costs and employment associated with large-scale hydrogen conversion. Our assumption for GVA growth in hydrogen is based on cost information presented in NGN’s H21 Leeds City Gate report. Total costs associated with the project include hydrogen infrastructure costs, conversion costs and ongoing operating expenditure costs[181]. The phased roll-out shown in Table C.8 would result in an average annual GVA growth of 9.7% year-on-year over a period of around 25 years, i.e. to 2050.

Table C.8 Hydrogen rollout profile by city

City	Conversion years	Source/Assumption
Leeds	2026 – 2029	H21 Leeds City Gate
Teesside (Greater Area)	2029 – 2032	H21 Leeds City Gate
Kingston-Upon Hull (City)	2029 – 2032	H21 Leeds City Gate
Newcastle (Greater Area)	2032 – 2035	H21 Leeds City Gate
Manchester (Greater Area)	2032 – 2035	H21 Leeds City Gate
Sheffield (City)	2035 – 2038	H21 Leeds City Gate
Liverpool (Greater Area)	2035 – 2038	H21 Leeds City Gate
Other cities in the North	2039 – 2050	KPMG assumption

180 Based on data from H21 Leeds City Gas Project for main cities and KPMG estimates for smaller cities, towns and sub-urban areas.

181 SMR costs, intraday salt caverns, inter-seasonal salt caverns, appliance conversion, hydrogen transmission system (HTS), CCS, SMR/salt cavern/HTS management and SMR efficiency loss.

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In terms of jobs, the H21 Leeds City Gate report stipulates that 'a conversion programme would create significant numbers of jobs associated with the physical work and wider supply chain. These jobs would be across England and, initially the north'[182].

As with other industries, a new sector generates hundreds of direct jobs and thousands of supply chain jobs. Because there are no estimates available on the potential employment opportunities in the hydrogen sector, we have not sought to quantify these. The nature of jobs remain unclear but would likely span across the entire supply chain – Hydrogen production via SMRs, CCS, hydrogen transport system, gas distribution network conversion, appliances conversions and installations and manufacturing of hydrogen appliances.

5. Electricity networks

How will the sector evolve?

As explained in the 'Electricity generation' section above, the demand for electricity decreases marginally over time from c68TWh a year in 2016 to c66TWh a year in 2050.

Transmission

In this scenario, the electricity transmission network exists largely in the same form as today at a national level. Because the UK electricity generation mix evolves over time with fewer thermal power plants and more offshore wind farms, there is an increase in transmission capacity as more power flows generated in Scotland flows through the North. The current price control for National Grid Transmission suggests an average of 4% growth in RAV to 2021[183].

Distribution

Smart grids are thought to fuel economic growth, deliver cost-saving efficiencies, give customers greater control over their energy use, support jobs and growth whilst increasing energy security and enabling integration of low carbon technologies[184]. As DNOs are at the heart of the transition to smart grids, they are well placed to lead and invest in smart grid technologies to facilitate the transition. This creates additional GVA contribution as a result of further investment in R&D and innovation to upgrade and modernise the network to ensure it supports deployment in renewable technologies as well as meet changing customer needs. Such innovation projects include the Newcastle Smart Grid project which has already invested £2 million[185].

The DNOs' business plans for the current price control (2015-2023) suggest that network investment would increase their RAV by 1% year-on-year to 2023[186]. This growth rate includes the current expenditure in innovation projects in smart grids.

How will the Northern energy economy respond to opportunities?

As with gas networks, we assume that the structure of networks in the North of England will continue on the same basis as today, i.e. a single transmission network at a national level, one distribution

182 H21, Leeds City Gate, July 2016. Available at: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

183 RIIO-GD1 Price Control Financial Model following the Annual Iteration Process 2015, Ofgem, November 2015. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

184 'Great Britain's smart grid to revolutionise energy sector', DECC, 2014. Available at: https://www.gov.uk/government/news/great-britains-smart-grid-to-revolutionise-energy-sector

185 See p17 for more details of this project

186 RIIO-GD1 Price Control Financial Model following the Annual Iteration Process 2015, Ofgem, November 2015. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

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network for Yorkshire and the North East, one for North West England and another covering Merseyside and Cheshire[187].

Whereas the transmission network is mature, as outlined above Smart Grids offer significant opportunities for distribution networks to innovate and develop new business models. This offers opportunities for players in the Northern economy. The Newcastle Smart Grids project indicates that the region could become a leader in the emerging field of Smart Grids. Smarter networks will in turn offer opportunities for networks and their supply chains in the North to upskill their workers.

Growth assumptions

As with gas networks, we use RAV growth projections in networks' RIIO business plans as a proxy for GVA growth over the rest of the current price control period. We therefore assume a GVA growth rate of 1% year-on-year to 2023 for electricity distribution networks, Beyond 2023, we assume that investment in creating a 'smart' distribution network will continue, such that GVA will continue to grow at 1% a year to 2050.

For transmission networks, we assume that GVA grows by 4% to 2021 (end of GT1) in line with the price control RAV growth and follows the same trend 2030, as more Scottish offshore wind farms connect to the grid. From 2030 onwards we estimate that growth will slow down reaching 0% by 2050, reflecting the assumption that the deployment of offshore wind will be largely complete by 2030[188], with efforts shifting to decarbonise heat and transport.

Electricity transmission and distribution jobs are similar in nature. As with gas networks, we assume that jobs growth in electricity networks follows the growth trend of GVA for electricity distribution.

6. Energy suppliers

How will the sector evolve?

Even though electricity demand remains largely constant over time in this scenario, demand for the services of energy suppliers will continue to grow, driven by increases in the number of households and businesses.

In addition, technological change will allow energy suppliers to become 'energy service companies'. This is already underway with offers such as Hive or Nest, which offer households the chance to control heating in their home from mobile communications devices. As more households invest in distributed energy and storage, suppliers could potentially offer energy management and aggregation services to households and businesses looking to sell energy back into the grid. However, uptake of distributed energy is limited in this scenario compared to Scenario 2.

How will the Northern energy economy respond to opportunities?

None of the major energy suppliers have their headquarters in the North of England (although EDF has a large call centre in Sunderland). We assume that this will remain the case under this scenario. There will continue to be significant activity by suppliers in the North in the near term, in particular with regard to implementing Government schemes such as Smart Meters and the Energy Company Obligation (ECO).

[187] As part of a wider network also covering North Wales and North Shropshire

[188] National Grid Future Energy Scenarios do not project the deployment of significant amounts of new offshore wind beyond 2030. http://fes.nationalgrid.com/fes-document/

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Growth assumptions

Given the assumption that no major energy supplier will emerge in the North of England, we adopt a cautious approach to estimating future GVA and jobs growth, and assume that both will follow projected growth in the number of households out to 2050, i.e. 0.5% per annum.

7. Appliances & buildings

How will the sector evolve?

In this scenario, all urban and sub-urban areas are connected to the hydrogen network by 2050. The switch from methane to hydrogen requires appliances to be converted or replaced. Households and businesses therefore spend on converting or replacing their appliances[189]. As a consequence, there is less spend on gas (methane) appliances and their maintenance. The costs of conversion to hydrogen are not covered in this category, however the costs of maintenance and replacement of hydrogen appliances are included. As part of the on-going maintenance costs, we assume that 90% of the gas appliances will be replaced once between 2016 and 2030 while hydrogen appliances will be replaced once between 2030 and 2050. As suggested by the Leeds City Gate's report, low-cost range of hydrogen appliances is possible if there is significant demand[190]. We therefore assume that the cost of replacing a gas boiler and hydrogen boiler is the same by 2045, when the first wave of replacement of hydrogen appliances will occur.

Based on the latest Feed-in Tariffs statistics, 0.6% of households in the North installed small-scale renewable electricity generation technologies in 2015[191], of which over 90% are solar panel electricity systems for domestic users. Taking into account the adoption of hydrogen and heat networks, we assume that the growth rate for distributed generations would remain at 0.6% until 2019 and reduce by half from 2020 onwards as households and businesses use hydrogen and heat networks instead.

In addition, we also consider expenditure on maintenance and energy-related building improvements. These include costs such as central heating repairs, insulation and energy efficient appliances. We assume a high take up of smart appliances (e.g. smart meters and smart thermostats) in the North. The penetration of 'smart home' technology is projected to rise from 11% to 27% in the UK by 2020[192]. We therefore assume a 60% penetration of smart thermostats by 2050 in the North.

How will the Northern energy economy respond to opportunities?

The conversion to hydrogen offers considerable opportunities to firms in the North, as households and businesses require hydrogen appliances to be retrofitted on existing properties, and fitted as part of new developments. These conversions are likely to be done by local workers, and can be carried out by SMEs based in the region, in the same way that many home improvement and maintenance services are today.

The scope for Northern firms to gain a strong position in relation to the manufacture of hydrogen appliances depends on wider global trends. If hydrogen is adopted as a fuel for heating in many countries, a global market in hydrogen appliances is likely to develop, as manufacturers of gas appliances introduce new lines. This is likely to be a competitive marketplace. On the other hand, if the uptake of hydrogen networks is limited, the market for appliances may remain relatively specialised. This would offer Northern firms a better opportunity to gain significant market share, given that much of their demand would be local, but the 'size of the prize' would be less.

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189 These switching costs were included in the Hydrogen segment of the analysis.

190 H21, Leeds City Gate, July 2016. Available at: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

191 KPMG analysis and FiT statistics. Available at: https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics

192 Smart Technology and Living, Raconteur, 2015. Available at: http://raconteur.net/smart-technology-and-living

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Growth assumptions

The majority of jobs and GVA contribution in this sector is assumed to come from installations of appliances. In this scenario, the number of households and businesses on gas appliances decrease each year. This results in a reduction in spend on gas appliances and by 2050 all gas appliances in urban households are replaced by hydrogen appliances. The costs of conversion to hydrogen are not covered in this category, however the costs of maintenance and replacement of hydrogen appliances are included. We have calculated the expected spend for households and businesses to carry out the maintenance and take up of different technologies (gas and electricity appliances, distributed generations etc.).

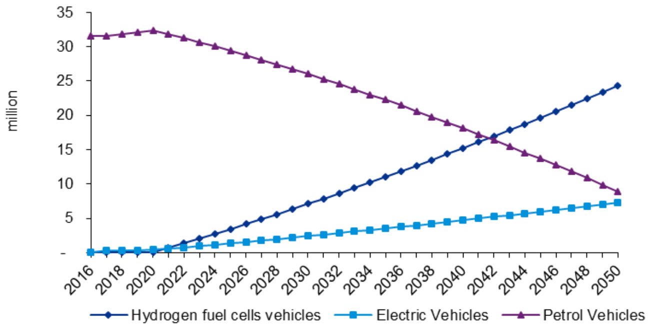
Our analysis shows a decrease in GVA for buildings (hydrogen and heat networks conversions are accounted for separately) of 0.3% per annum on average. We therefore assume that GVA for buildings will follow the same trend. As the reduced demand for gas appliances is off-set by the take-up in hydrogen appliances, we assume that growth in jobs will follow projected growth in the number of households out to 2050, i.e. 0.5% per annum[193].

8. Transport

How will the sector evolve?

In this scenario, we assume that ULEVs represent 80% of road transport by 2050, of which three quarters are hydrogen fuel cells vehicles and one quarter are EVs. The remaining 20% are petrol vehicles[194]. There is an extensive hydrogen vehicle refuelling network by 2050. In areas where the refuelling network is near the hydrogen distribution network, the latter can supply these hydrogen refuelling stations, otherwise hydrogen is transported via lorry to existing petrol stations.

Figure C.6 Number of vehicles on the road by type



Low emission vehicles currently cost at a premium compared to conventional vehicles. It costs around £25,000[195] to purchase an Electric Vehicle (Nissan Leaf) and £60,000[196] to purchase a hydrogen fuel cells vehicle (TOYOTA Mirai). A study by UKH2Mobility, a partnership of UK industry leaders and government, has suggested that low emission vehicles will be cost-competitive by 2030[197]. It was

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193 More workers are needed to meet demand coming from new households and businesses.

194 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

195 Nissan, 2016. Available at: https://www.nissan.co.uk/vehicles/new-vehicles/leaf/prices-specifications.html

196 2015 Toyota Mirai – price information, specs and UK arrival, Autocar, 2015. Available at: http://www.autocar.co.uk/car-news/motor-shows/hydrogen-powered-toyota-mirai-unveiled-ahead-2015-launch

197 UK H2 Mobility Phase 1 Results, UK H2 Mobility, April 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/192440/13-799-uk-h2-mobility-phase-1-results.pdf

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suggested that long-range electric cars will cost less than $22,000 by 2040[198]. We therefore assume that the cost of low emission vehicles will decrease to £17,000 by 2040[199].

How will the Northern energy economy respond to opportunities?

There are currently over 80,000 electric vehicles registered in the UK[200]. The North is already in a strong position with regards to the manufacture of low emission vehicles components. In effect, the North East is host to the Nissan manufacturing plant in Sunderland which has built over 50,000 Nissan Leaf electric cars since production began in 2013[201]. The Sunderland plant is one of three Nissan EV production sites globally and the largest of its type in Europe[202].

According to UKH2Mobility, there will be 1.6 million hydrogen fuel cell vehicles on the road by 2030[203]. There are currently only two models of hydrogen fuel cells vehicles on the market and neither of them are produced in the UK[204]. With its skilled workforce and know-how in low emission vehicles manufacturing, the North could be a potential manufacturing hub for hydrogen fuel cells vehicles in the future if the region decides to use hydrogen gas at scale.

Growth assumptions

The UK currently has a market share of 1% of ULEVs[205]. Based on a recent KPMG report[206], we assume that 80% of cars will be ULEVs by 2050, of which 60% are hydrogen fuel cells vehicles and 20% are EVs. We assume that the North will continue to produce 17% of EVs sold in the UK and 8.5% of hydrogen fuel cells sold in the UK. Using the methodology set out in Appendix 1, we estimate an annual spend of £2.3 billion in 2050 on ULEVs in the North. Based on the expected annual spend on ULEVs, we were able to estimate GVA (see Appendix 1 for our methodology and assumptions for GVA calculation). Our calculations suggest a GVA growth rate of 9% per annum on average.

Employment in the low-carbon transport sector would be in the manufacture of EVs, hydrogen fuel cells and ULEVs component-parts for low emission vehicles. We assume that the North will be able to maintain its current market share in manufacturing of ULEVs and expand it in the future. Nissan Motor Manufacturing currently employs around 7,200 people[207]. Estimates suggest that the Nissan jobs related to the manufacture of batteries is approximately 2,000[208] (direct and supply chain). Based on current trends and expected growth in the sector and its supply chain, we assume that sectorial employment in the North grows by 4.5% per annum which is half of the GVA growth rate, based on estimates of productivity improvement.

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198 'Here's How Electric Cars Will Cause the Next Oil Crisis', Bloomberg, February 2016. Available at: http://www.bloomberg.com/features/2016-ev-oil-crisis/

199 'Here's How Electric Cars Will Cause the Next Oil Crisis', Bloomberg, February 2016. Available at: http://www.bloomberg.com/features/2016-ev-oil-crisis/

200 EV registrations, SMMT, 2016. Available at: http://www.smmt.co.uk/2016/09/august-2016-ev-registrations/

201 'Nissan's Sunderland plant hits 50,000 Leaf milestone', Sunderland Echo, 2016. Available at: http://www.sunderlandecho.com/news/business/nissan-s-sunderland-plant-hits-50-000-leaf-milestone-1-7903582

202 Nissan. Available at: http://newsroom.nissan-europe.com/eu/en-gb/media/pressreleases/141566

203 UK H2 Mobility Phase 1 Results, UK H2 Mobility, April 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/192440/13-799-uk-h2-mobility-phase-1-results.pdf

204 Fuel Cell Electric Vehicle Fleet Support Scheme, Office for Low Emission Vehicles, 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/521147/supporting-fleet-uptake-of-hydrogen-fuel-cell-vehicles-guidance-note.pdf

205 Uptake of Ultra Low Emission Vehicles in the UK, Office for Low Emission Vehicles, 2015. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464763/uptake-of-ulev-uk.pdf

206 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

207 Fame database.

208 Nissan. Available at: http://newsroom.nissan-europe.com/eu/en-gb/media/pressreleases/141566

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C.2 Scenario 2: Diversified energy sources

In this scenario, different areas of the North use different energy delivery methods and fuels depending on the characteristics of the area, such as population density and proximity to fuel sources and facilities. Building on KPMG's study into national energy scenarios published in July 2016[209] we have applied the 'Diversified energy sources' scenario to the North. In this scenario four main sources of energy for domestic and commercial heating emerge in different areas of the region:

… Conversion to heat networks – 25% of current gas connections

What: Customers pay for hot water generated at a central source primarily from biomass. A connection to the gas network could be maintained with large gas boilers used at peak times to provide a steady level of heat.

Where: Developed in the most densely populated areas of the region where the benefits of installing heat networks are greatest, this could include the inner cities of the largest cities in the region.

… Conversion to hydrogen networks – 25% of current gas connections

What: A quarter of the existing gas network in urban areas is converted to using hydrogen, which is produced by removing hydrogen from methane with CO_2 stored in CCS facilities.

Where: Cities and other urban areas which are nearer to carbon capture and storage facilities where the CO_2 bi-product of hydrogen can be stored. These could include areas in the east of the region nearer to the North Sea

… Remain as a methane – 25% of current gas connections

What: A quarter of the networks continues to use methane gas (combination of natural gas and biomethane).

Where: The suburbs and larger towns in the region that are not as close to potential carbon storage facilities. This could mainly include areas in the west of the regions.

… Conversion to electric heating – 25% of current gas connections

What: Electric heating methods primarily heat pump technologies replace gas boilers. The gas network is much less heavily utilised in these areas.

Where: The smaller towns and rural areas (where there is currently a gas network) and are further away from gas sources. Where heat networks have the space to be effective and the benefits of being connected to gas or heat networks are not as great.

209 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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An assessment of the drivers of economic growth allows us to estimate the GVA and employment growth trends for each component part. Table C.9 indicates the direction of travel that GVA follows to 2050.

Table C.9 Summary of Scenario 2

Component	What will the sector look like?	What will markets participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
Upstream gas	— North Sea production declines by 5% year on year, meaning less demand for supply chain and workers in the North	— No major investment in the sector — Jobs decrease	-5.0%	-7.0%
Electricity generation	— Increase in electricity demand from some heat conversion and EVs, from 68TWh in 2016 to 98TWh in 2050 — Ageing assets are refurbished/replaced. — The North meets its own demand but is no longer a net exporter of power	— Investment in power plants — Some investment in wind between 2016 and 2030	1.7% to 2030 and 0.8% thereafter	0%
Gas networks	— Customers in the North use four different sources of heat — Half of the distribution network is less heavily utilised, with one quarter of households converting to electricity and the other quarter using heat networks — A quarter continues to use gas (methane)	— Some investment in CCS and SMR plants, but lower than in Scenario 1 — Investment and production of electric heat pump equipment.	**Distribution** 1.0% to 2021, 0.5% to 2030 and -3.0% thereafter **Transmission** 2.0% to 2021 and 0.3% thereafter	1.0% to 2021, 0.5% to 2030 and -1.5%
Hydrogen	— A quarter of the gas network is converted to run on hydrogen	— Some investment in hydrogen appliances, but lower than in Scenario 1	2.4% from 2026 onwards	n/a
Heat	— A quarter of the gas network is converted to heat networks	— Some investment in installing heat networks (district heating)	9.0%	n/a
Electricity networks	— Development of smart grids — Networks expand to meet higher demand (geographically) — More local sources of energy – Decrease in the need for large networks (no big Scottish wind farms)	— DNOs invest in smart grids — Investment in grid capacity	**Distribution** 1.0% to 2023, reaches 3.0% by 2030 and decreases to 1.0% by 2050 **Transmission** 4.0% to 2021, declines to 0% by 2040 and 0% thereafter	1.0% to 2023, reaches 3.0% by 2030 and decreases to 1.0% by 2050
Energy supply	— Suppliers become 'energy service companies'	— Investment in 'smart home solutions' — Suppliers offer products and	1.5%	0.5% to 2025 and 2.0% thereafter

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Component	What will the sector look like?	What will markets participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
		services such as Hive and Nest		
Appliances & buildings	— Buildings become more energy efficient and convert to hydrogen, heat, and electric appliances	— Households and I&C invest in energy efficient buildings/appliances	0.7%	0.7%
Transport	— Transport is mostly decarbonised through a combination of electric vehicles (EVs) and hydrogen fuel cell vehicles.	— Investment in EV, storage and batteries and charging stations — Some production of hydrogen fuel cells vehicles in the North	9.0%	4.5%

1. Upstream gas

How will the sector evolve?

In this scenario, unlike Scenario 1 there is not an overall increase in the volume of natural gas required. Although some additional natural gas is required for hydrogen production for the 25% of the region's gas connections that convert to hydrogen, this is more than counter balanced by the fact that 50% of customers are no longer connected to the gas network. Therefore no additional economic activity is generated by LNG or other natural gas imports.

How will the Northern energy economy respond to opportunities?

As in Scenario 1, production in the North Sea declines so we would expect to see less investment by supply chain firms in the Northern energy economy which are involved in extraction activities.

Growth assumptions

In this scenario, the gas extraction sector shrinks by -5% per annum in line with the OGA's UKCS gas production projections. Unlike in scenario 1 natural gas use falls therefore there is no offsetting from gas importing.

The workforce involved in upstream gas decreases over time by -7% due to lower gas extraction activities in the North Sea depressing related supply chain activities in the North. This is in line with the trend observed in the UK offshore oil and gas industry from 2013 to 2016[210] where the workforce declined by an average of -7% year-on-year. We assume this trend is maintained to 2050.

2. Electricity generation

How will the sector evolve?

As in all scenarios fossil-fuel power plants are decommissioned or converted into greener generation (such as biomass, wind, etc.). In this this scenario electricity demand increases from the 25% switching from gas to electric heating and from the switch to electric vehicles.

The North of England is currently a net exporter of electricity to the rest of the UK as host to a number of nuclear, large coal-fired and biomass power plants. As in all scenarios we assume that older particularly coal-fired power stations are shut down. In this scenario we assume this generation is

[210] 'Oil & Gas UK figures show impact of oil price downturn on jobs', Oil and Gas UK, June 2016. Available at: http://oilandgasuk.co.uk/oil-gas-uk-figures-show-impact-of-oil-price-downturn-on-jobs/

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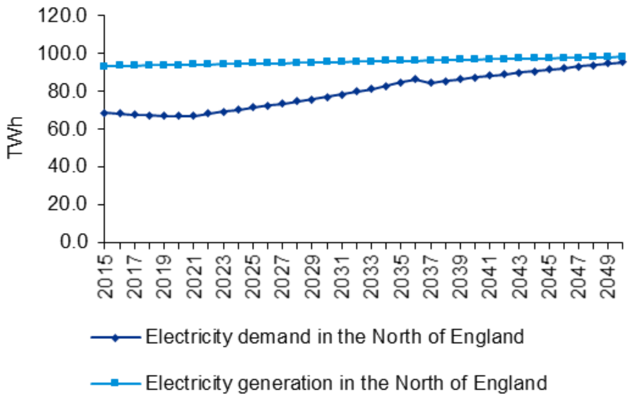
replaced largely by more local low carbon distributed energy sources. This generation only meets the increasing demand and therefore the North is no longer is a net exporter of electricity. See Figure C.7 below:

Figure C.7 Electricity production versus electricity demand in the North



Source: KPMG analysis

How will the Northern energy economy respond to opportunities?

In this scenario electricity demand increases driven by electric vehicle growth and the electrification of heat in 25% of the region. This demand is met by more distributed low/zero carbon generation rather than the larger thermal power plants of today. This drives a greater degree of investment and innovation in the northern electricity sector compared to our other scenarios with the North playing a key role in the development of innovative and green generation technologies.

Growth assumptions

As a result of new technologies being developed and the investment in new generation and the manufacture of wind turbines in Hull, GVA growth is 1.7% year-on-year on average to 2030 and lowers to 0.8% thereafter, reflecting the growth in electricity demand.

As older power plants are decommissioned in the next decade, employment in the sector would decrease. At the same time, because capacity is replaced over time, new jobs are created to respond to the use of different technologies to generate power, such as local renewable generation. The new jobs created would thus likely substitute for the jobs lost resulting in the same number of overall jobs in the industry. Our assumption is that the employment level in the electricity sector will remain the same as it is today, i.e. 0% growth.

3. Gas networks

How will the sector evolve?

Transmission

In this scenario the gas transmission network remains largely as it is today, continuing to supply industry for gas-fired electricity generation as well as those areas that continue to use methane.

Distribution

Half the gas distribution network is less heavily utilised in the areas where household and commercial heating is provided by heat networks or electric heating. One quarter of the gas network converts to transporting hydrogen while the remaining quarter remains a methane network as it is today, though with an increased number of distributed connections injecting local sources of biomethane.

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The iron mains replacement programme is only completed in the half of the gas network that remains by 2030. In the other half iron mains upgrades are not carried out in preparation for decommissioning.

How will the Northern energy economy respond to opportunities?

As in Scenario 1 we do not expect the gas transmission network to change significantly in this scenario although it will carry less gas. It will remain a national asset owned by a single company with its headquarters outside of the North of England.

We also assume that the ownership of gas distribution networks will continue as today, i.e. one network based in the region transporting gas to households and businesses in Yorkshire and the North East as Northern Gas Networks does today, and another network transporting gas in the North West as National Grid does today. These firms will remain regulated monopoly businesses as they are today. However they will be significantly smaller as they only carry gas (either hydrogen or methane) to 50% of the customers that they have today.

Growth assumptions

As in Scenario 1, the GVA growth rate follows NGGT's RAV, i.e. 2% to 2021. Further investment is limited from 2021 onwards falling to 0.3% thereafter. Future investment includes the value added from connecting SMRs. We assume that the number of people employed in gas transmission remains steady.

We assume that the 1% growth in distribution networks' GVA over the current price control period is a result of the iron mains replacement programme in this scenario. The gas distribution network will be less heavily utilised meaning that less investment in iron mains replacement will be required beyond 2021, so we assume that GVA growth halves to 0.5% until 2030. From 2030 to 2050, overall GVA shrinks to -1.5% per annum as a result of the gas distribution network being less heavily utilised. This represents a GVA decline of 50% over 20 years. The number of jobs follow the same trend as the GVA trend for gas distribution.

4. Hydrogen

How will the sector evolve?

In this scenario a quarter of existing gas connections in urban areas are converted to hydrogen starting in 2026. In these areas the conversion is as described in Scenario 1. In total, the spend is approximately a quarter of that in Scenario 1, i.e. £25 billion.

Hydrogen is also used in the transport sector. The gas network that is converted to hydrogen network is used to help supply the transport sector.

How will the Northern energy economy respond to opportunities?

Like Scenario 1, the Northern economy would respond to business opportunities to develop hydrogen technologies but to a lesser extent as only a quarter of the network is converted to hydrogen.

Growth assumptions

As in Scenario 1 the creation of a hydrogen network would contribute to GVA. In this scenario only a quarter of connections are converted to hydrogen, therefore we assume that GVA growth is a quarter of the GVA in Scenario 1. Additionally, we have not attempted to quantify employment in the hydrogen sector due data unavailability.

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5. Heat networks

How will the sector evolve?

In this scenario we assume that heat networks are built in the densely populated inner cities of the region where the benefits of heat networks are greatest. Currently heat networks supply approximately 2%[211] of properties in the UK (and these are not connected to the gas networks). In this scenario 25% of properties are connected to heat networks, requiring significant investment in heat network infrastructure.

We assume that the heat is largely sourced from small local biomass plants fed by waste material. Heat networks maintain a connection to the gas network and at peak times large back-up gas boilers are used to ensure a steady level of heat.

New hot water pipes are laid in urban areas. A proportion of properties connected to heat networks are new build apartment buildings and office blocks, but to connect 25% of properties to heat networks necessitates a large degree of 'retrofitting' i.e. removing old gas boilers and replacing with a heat network connection.

How will the Northern energy economy respond to opportunities?

The significant growth of heat networks in this scenario opens up a significant new sector. New networks will need to be created in urban areas almost from scratch (some limited amount of district heating systems currently in place). This will create significant opportunities in the short term as these networks are constructed and in the longer term as a new workforce is needed to run these networks. The northern manufacturing sector could be in a good position to benefit from the growth in the heat network supply chain, manufacturing the appropriate pipes and heating units etc.

Using biomass as the main source of the heat would also present significant opportunities. A significant amount of waste would need to be sourced locally to feed the biomass plants as well as other biomass materials. This would create a local supply chain which would create a number of jobs in the region.

Growth assumptions

Based on KPMG's Diversified energy sources scenario included in a recent report[212] and adjusted for the North, heat networks would see GVA growth of 9.0% per annum from 2017 to 2050 driven by the investment needed to lay down new pipe networks, investment in biomass plants and other potential heat sources and installing equipment into homes and businesses.

As with other industries, a new sector generates hundreds of direct jobs and thousands of supply chain jobs during. Because of the limited evidence on employment in the heat sector, we have not sought to quantify how many jobs would be created in the future. The nature of jobs remain unclear but would likely span across networks, buildings and appliances.

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[211] 2050 Energy Scenarios, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

[212] 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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6. Electricity networks

How will the sector evolve?

Transmission

The electricity transmission network will remain largely as it is today. We do not envisage that the development of more localised energy systems will require the decommissioning of significant parts of the transmission network.

Distribution

In this scenario overall peak electricity usage remains constant although there is an increase in demand from additional consumers using electric heating technologies. This is balanced by the overall fall in energy demand which means that investment in the remaining electricity network is lower than the current trend. We assume that although electric vehicles result in an overall increase in demand this does not increase peak demand as they would not typically be charged at peak times. Indeed at the highest peak times they could 're-supply' the local grid to help balance the system.

There is more local renewable generation connected to the grid to replace the large thermal power plants. Connection of renewables electricity is already under way and reflected in current trend[213]. This scenario envisages a greater increase in connections of distributed renewable generation.

How will the Northern energy economy respond to opportunities?

As in Scenario 1 the structure of electricity networks would remain largely unchanged. In some areas the network may need reinforcement but we would expect this to be limited as greater utilisation is made of the existing network through customers switching their consumption away from expensive peak periods. There will also be growth in the supply sector as homes are converted to different fuel sources, the northern manufacturing sector may be well placed to benefit from this.

Growth assumptions

Growth of GVA associated with the electricity transmission network follows NGET's RAV growth rate to 2021, i.e. 4%. The move to more local energy production to replace large thermal power stations reduces the role of the electricity transmission network so GVA declines to 0% growth by 2040 and remains constant thereafter.

Unlike Scenario 1, we assume that GVA for electricity distribution increases by 1% to 2023, reaches 3% by 2030 and decreases to 1% by 2050. This is driven by a significantly increased amount of local distributed energy connections.

Electricity network jobs follow the same pattern as GVA electricity distribution. This is driven by the investment needed in the network and the increased workforce needed to manage local renewable distribution.

7. Energy suppliers

How will the sector evolve?

As per Scenario 1, energy suppliers become energy service companies (ESCOs) and take a greater role in managing their customers' energy through smart meters and smart grids. Reflecting the growth in distributed generation and localised energy networks, there is a much increased role for local energy suppliers such as local co-operative groups, municipal councils, local trade groups etc.

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213 The contribution of all renewables to UK electricity generation was 24.6 per cent in 2015, 5.5 percentage points higher than in 2014.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/547977/Chapter_6_web.pdf

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By 2050 a lot more energy is supplied via these small local suppliers. Due to limited supply activities currently performed in the region, we assume that the North makes a net supply activity gain equivalent to about 15% of all UK customers, which when combined, becomes at least equivalent to the market share of one of the Big Six today. As a result the activity of managing energy, supply is brought into the North rather than being managed elsewhere. In addition there is a greater amount of self- generation and energy companies play a role in managing these systems for their customers.

How will the Northern energy economy respond to opportunities?

Although the growth in storage and distributed energy offers considerable opportunities to firms which are able to offer energy management services, there is no evidence that the Northern energy economy is in a particularly strong position to benefit from this. This market is likely to be very competitive, with major IT players such as Apple and Google potentially in a position to offer synergies with computers and mobile devices and capture market share.

Growth assumptions

As more energy is supplied locally, we assume a growth of 1.5% in GVA year-on-year based on household growth of 0.5% per year and 1% growth related to suppliers taking an enhanced role as energy service companies.

Employment in the energy supply follows the trend in household growth, but due to new local suppliers, jobs increase by an extra 1.5% per annum, totalling to c10,500 jobs by 2050, representing the current number of employees in the sector as well as the equivalent number of workers employed by one Big Six energy supplier. We therefore assume that employment grows by 0.5% to 2025 and by 2.0% thereafter.

8. Appliances & buildings

How will the sector evolve?

In this scenario, we assume that a quarter of Northern households and businesses (1.9 million) switch to electricity as their main fuel for heating by 2050. For these households and businesses, heat pumps are used for space heating and electric boilers for hot water. This means that households and businesses incur switching costs (conversions, installations, etc.) of approximately £7,500[214] for an average household and £35,000[215] for an average business. The costs are based on the current weighted average spend on renewable heat in the North for the domestic and the non-domestic sectors. Appendix 1 sets out our assumptions on costs for individual technologies.

Hydrogen and heat network switching costs are covered separately in this scenario. The remaining households continue to use natural gas (methane) as heating fuel and therefore only incur an annual maintenance cost for their boilers and other appliances.

As grids become ‘smarter’ and consumers adapt to technological changes, we assume there is a high take up of smart appliances (e.g. smart meters and smart thermostats) in the North. We assume around 60% of households will have a smart thermostat by 2050. This is below Accenture’s projection of over 65% adoption rate for Smart Thermostat[216] in the next decade, as we assume a lower take up due to a continued level of ‘disengaged’ customers.

[214] KPMG analysis of the weighted average costs based on RHI deployment data. Available at: https://www.gov.uk/government/statistics/rhi-deployment-data-december-2015

[215] KPMG analysis of the weighted average costs based on RHI deployment data. Available at: https://www.gov.uk/government/statistics/rhi-deployment-data-december-2015

[216] The Internet of Things, Accenture, 2015. Available at: https://www.accenture.com/t20150624T211456__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology_9/Accenture-Internet-Things.pdf

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How will the Northern energy economy respond to opportunities?

The increase in adoption of new technology and fuel mix offer considerable opportunities for growth in the North. This includes opportunities in manufacturing and installation of appliances. The North can capture this growth by building on its manufacturing base and skilled workforce.

Growth assumptions

Based on the latest Feed-in Tariffs statistics, 0.6% of domestic and 0.5% of non-domestic users in the North installed small-scale renewable electricity generation technologies in 2015[217]. In the future, we assume that households and businesses in the North will continue to set up distributed generation on their premises at this rate at a cost of approximately £7,900[218] per household and approximately £244,500[219] per commercial property. These costs are based on the current weighted average spend on distributed generation in the North for the domestic and non-domestic sectors (see Appendix 1 for the technology costs).

We have calculated the expected spend on maintenance and different technologies (gas and electricity appliances, distributed generations, etc.) for households and businesses. Our analysis shows an increase in GVA for building energy of 0.7% per annum on average. We therefore estimate that GVA and employment grows by 0.7% per annum on average.

9. Transport

How will the sector evolve?

In this scenario road transport is diverse with different fuels used for different purposes.

Smaller cars and vehicles that make shorter urban journeys are electric. Hydrogen fuel cells are used for larger vehicles including HGVs, buses, commercial vans etc. A hydrogen fuel cell network is developed, supplied by the local hydrogen network, but unlike Scenario 1 it is relatively limited as hydrogen is not developed at scale. Petrol/electric hybrid vehicles plug the gap between the smaller urban electric only vehicles that are able to charge regularly and the larger hydrogen commercial vehicles. Overall the role of petrol decreases over time as the transport sector decarbonises to some extent and makes up a much reduced proportion of transport fuel compared to today. Table C.10 below shows the breakdown of fuel mix for transport by 2050.

Table C.10 Breakdown of fuel mix of the transport sector in 2050

Fuel type	Assumed % of energy consumption
Hydrogen fuel cells	35%
Electricity	35%
Petrol	30%

Source: Based on KPMG analysis from 2050 Energy Scenarios report (KPMG 2016).

217 KPMG analysis and FiT statistics. Available at: https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics

218 KPMG analysis of the weighted average costs based on the Central Feed-in Tariff Register.

219 KPMG analysis of the weighted average costs based on the Central Feed-in Tariff Register.

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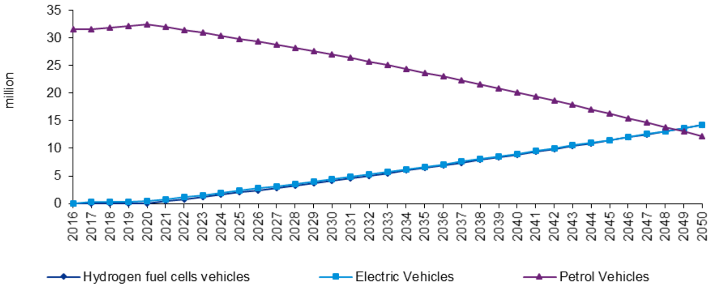
Figure C.8 Number of vehicles on the road by type



Source: KPMG analysis

How will the Northern energy economy respond to opportunities?

The North has an advantage in manufacturing low emission vehicles considering that the Nissan Sunderland factory is at the forefront of ULEV. The Sunderland plant currently produces 60,000 batteries per year[220] and the Nissan LEAF sales increased by 30% in 2015[221]. In January 2016, Nissan announced plan to invest £26.5 million in manufacturing, maintenance and engineering at its Sunderland plant[222]. This will provide the North with the skilled workforce and research facility to continue to play a key role in the development and production of ultra-low emission vehicles.

As demand for EVs increases in the future, we would expect Nissan to respond accordingly and expand its activities at its Sunderland base. This would enable it to meet UK demand as well as from other parts of Western Europe. This would generate more employment in the sector which would likely be filled by local workers in the region.

Growth assumptions

In this scenario, we assume that the North maintains its competitive advantage in EV manufacturing. There is a higher penetration of EVs in this scenario which results in higher spend in the North compared to Scenario 1.

We assume that the North will continue to produce 17% of EVs sold in the UK and 8.5% of hydrogen fuel cells sold in the UK (see Section 1.4 in Appendix 1 for more details). Using the methodology set out in Appendix 1, we estimate an annual spend of £2.5 billion in 2050 on ULEVs in the North. Based on the expected annual spend on ULEVs, we were able to estimate GVA (see Appendix 1 for our methodology and assumptions for GVA calculation). Our calculations suggest a GVA growth rate of 9% per annum on average.

Employment in the transport sector would be in the manufacture of EVs and related components. As demand for EVs is high in this scenario, we would expect employment to grow by half of GVA growth rate, i.e. 4.5% year-on-year, to reflect expected productivity improvements in a rapidly growing technology sector.

C.3 Scenario 3: No progression

An assessment of the drivers of economic growth allows us to estimate the GVA growth trend for each component part. Table C.11 below indicates the direction of travel that GVA follows to 2050.

220 ‘Nissan Leaf £26.5m battery investment secures 300 jobs’, BBC, January 2016. Available at: http://www.bbc.co.uk/news/uk-england-tyne-35363356

221 Nissan LEAF Sales Rose 29% In UK In 2015’, CleanTechnica, January 2016. Available at: https://cleantechnica.com/2016/01/26/nissan-leaf-sales-rose-29-in-uk-in-2015/

222 ‘Nissan invests £26.5 million in EV battery production’, AutoExpress, January 2016. Available at: http://www.autoexpress.co.uk/nissan/94127/nissan-invests-265-million-in-ev-battery-production

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Table C.11 Summary of Scenario 3

Component	What will the sector look like in the North of England?	What will Northern market participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
Upstream gas	— Although demand for gas remains at current levels, North Sea production declines, meaning less demand for supply chain and workers in the North — Future activity likely to focus on decommissioning rather than extracting	— Increased focus on decommissioning going forward, given reduced demand for extraction activities	-5.0%	-7.0%
Electricity generation	— Decrease in electricity generation in the North as current thermal assets (coal, nuclear) reach the end of their useful life and are only partially replaced so that the region is no longer a net exporter of electricity — Same as Scenario 1	— Some investment in generation capacity, mainly at a larger scale, with less investment in distributed generation — Limited innovation, as current technologies continue to be used	-1.0%	-1.0%
Gas networks	— Network continues to be used as it is today, with natural gas providing heating to homes and businesses, and being used in industrial processes — Gas transmission system is reinforced to cater for more import facilities as North Sea production declines	— Continued investment in the IMRP and to ensure that winter demand is met — Less focus on innovative network management or low-carbon solutions: existing networks are 'mature' technologies	**Distribution** 1% to 2030, 0% thereafter **Transmission** 1% to 2030 and 0.3% thereafter	1% to 2030, 0% thereafter
Electricity networks	— Electricity distribution networks in the North continue to operate in the same way as today, with less distributed energy than in other scenarios — There is less deployment of renewable electricity at a national level, and therefore there is reduced reinforcement of the transmission network in the North to allow north-south flow of Scottish renewable electricity. In addition, there is less generation from Northern power stations as the region is no longer a net exporter of power — Growth in networks slows	— No significant investment in innovation, as networks continue to be used as they are today.	**Distribution** 1% to 2023 and 0% thereafter. **Transmission**4% to 2021 and 0% by 2050	1% to 2023 and 0% thereafter

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Component	What will the sector look like in the North of England?	What will Northern market participants do?	Estimated GVA growth rate (%)	Estimated employment growth rate (%)
Energy supply	— Some suppliers offer smart home energy management solutions — There is no growth in services to 'prosumers', households and businesses which produce their own energy for consumption and export to the grid e.g. aggregation services — Market volumes continue to grow as the number of households increases	— No significant investment in 'smart home solutions' — Suppliers continue to provide goods and services nationally, and local energy companies/ESCOs do not develop in the North. — Energy company 'head office' activities therefore located outside the region, although there are jobs related to customer service and metering.	0.5%	0.5%
Appliances & buildings	— Households and I&C continue to invest in energy efficient dwellings/appliances.	— Northern firms remain active in the installation and maintenance of energy efficiency products, reflecting the localised nature of this work.	0.3%	0.5%
Transport	— Petrol remains the main fuel. — Some deployment of EVs.	— Some investment in EV. — Some investments in EV components and charging stations.	5.4%	2.7%

1. Upstream gas

In this scenario gas extraction follows the same trend as in Scenario 2, and the same growth assumptions are used.

2. Electricity generation

How will the sector evolve?

In this scenario, electricity demand in the North remains roughly constant over time, reflecting national trends. However, while the region is currently a net exporter of electricity, due in part to the significant number of large thermal generators in the region (coal and nuclear) over the period, it shifts towards a more neutral position, where regional demand is equivalent to regional supply (see Figure C.5 in Section 3.1 – Appendix 3 above). This reflects the assumption that the large thermal generators close, and are not fully replaced by other sources of generation.

How will the Northern energy economy respond to opportunities?

There is much slower progress towards decarbonisation than other scenarios at a national level. As a result, there are fewer opportunities for firms in the North to develop innovative low-carbon approaches and technologies.

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Growth assumptions

Given that electricity generation is likely to use similar technologies to today, GVA growth in the North is likely to be linked to volumes of electricity produced by Northern generators. We estimate that Northern generators currently produce about 93TWh of energy a year, compared to regional demand of 68TWh. If the North ceases to be a net exporter, and given that regional demand remains constant, this implies that the output of Northern generators will also be c68TWh in 2050. This in turn implies an annual reduction in generation in the region -1.0% on average. We assume that both GVA and employment in the generation sector decline at this rate.

3. Gas networks

How will the sector evolve?

Gas continues to be the major source of heating for homes and businesses, both in the UK as a whole and in the North. Peak winter demand increases under this scenario, meaning investment in the network is required to ensure network capacity remains adequate. In addition, we assume networks would continue with the Iron Mains Replacement Programme until completion (expected to be in around 2030) given the continued importance of the gas network in this scenario.

North Sea gas production declines over the coming decades, while gas demand in the UK remains high. This may require investment in gas importing facilities (either LNG storage or interconnectors) in the North to ensure that supply meets demand. New gas storage and interconnectors would require reinforcement of the gas transmission network.

How will the Northern energy economy respond to opportunities?

As with Scenarios 1 and 2, we assume that market structure in relation to networks will be largely unchanged from today, i.e. a national transmission network, and two distribution networks transporting gas, one in the North East and Yorkshire and the other in the North West. Given that gas networks continue to transport natural gas under this scenario (rather than transitioning to alternative low carbon fuels such as hydrogen), there are limited opportunities for innovation on the part of network companies and their supply chains given the mature nature of technologies.

Growth assumptions

We therefore assume that GVA growth in the North is driven by ongoing network investment to deliver the Iron Mains Replacement Programme, ensure peak demand is met, and reinforce the transmission network around new import facilities. In the near term, the proxy for GVA growth is the increase in the RAV for the gas distribution network in the North over the current price control period out to 2023 – This is 1%[223]. Beyond 2023, we assume that RAV and GVA continue to grow at this rate until 2030, reflecting the ongoing Iron Mains Replacement Programme. GVA remains constant from 2031 onwards, i.e. 0% growth rate.

As with distribution, GVA in transmission also grows by 1% to 2030 because of investments to ensure that higher peak demand can be met. Beyond 2030 we assume a lower GVA growth at 0.3% a year to account for network reinforcement around new import facilities.

Jobs are assumed to grow at the same rate as GVA for distribution.

4. Electricity networks

How will the sector evolve?

Electricity networks in the North continue to function in much the same way as they do today. There is limited additional deployment of distributed generation. With regard to the transmission network, there

[223] Price control financial calculator, Ofgem. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-price-control-financial-model-following-annual-iteration-process-2015

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is limited future deployment of low-carbon electricity. This means that there is be less need to reinforce the network in the North to accommodate the North-South flow of electricity from Scottish renewable projects to sources of demand in southern England.

How will the Northern energy economy respond to opportunities?

Limited additional deployment of distributed generation and storage means that there is less scope for innovative approaches to network management/local system operation.

As with Scenarios 1 and 2, we assume the market structure relating to electricity networks retains the same form as today, i.e. a single national transmission network, and separate DNOs for the North West and Yorkshire/North East.

Growth assumptions

As with gas networks, we have used the growth in network companies' RAV as a proxy for GVA growth over the rest of the current price control period. For electricity distribution, this implies GVA growth of 1% until 2023 and for electricity transmission 4%[224] until 2021. After the current price control period, given the lack of major changes to the way networks operate, we assume that GVA remains constant over the rest of the period. Jobs growth is also assumed to follow the same pattern as GVA for electricity distribution.

5. Energy suppliers

How will the sector evolve?

Even though electricity demand remains largely constant over time in this scenario, demand for the services of energy suppliers will continue to grow, driven by increases in the number of households and businesses.

There will be limited moves by suppliers to take advantage of technological change to offer additional energy management services such as Hive or Nest, which offer households the chance to control heating in their home from mobile communications devices. Given limited investment in distributed generation and storage, there will be limited scope for suppliers to offer energy management and aggregation services to households and businesses looking to sell energy back into the grid.

How will the Northern energy economy respond to opportunities?

We assume that market structure will remain largely as today, i.e. no major energy suppliers will be located in the North during the period out to 2050. There will continue to be significant activity by suppliers in the North in the near term, in particular with regard to implementing Government schemes such as Smart Meters and the Energy Company Obligation (ECO). Given the limited penetration of distributed energy and storage, energy companies are unlikely to develop innovative business models around energy management, and local energy supply companies are unlikely to develop.

Growth assumptions

As with Scenario 1, we assume that GVA and jobs growth will reflect growth in the number of households, i.e. 0.5% per year.

[224] Based on RAV growth for NGET as a whole. Available at: https://www.ofgem.gov.uk/publications-and-updates/riio-et1-price-control-financial-model-following-annual-iteration-process-2015

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6. Appliances and buildings

How will the sector evolve?

As the energy mix used in this scenario stays the same as it is today, the majority of households and businesses carry on using gas appliances while a small proportion switch to electric appliances. Based on the latest Feed-in Tariffs statistics, 0.6% of domestic and 0.5% of non-domestic users in the North installed small-scale renewable electricity generation technologies in 2015[225]. We assume that households and businesses in the North will continue to set up distributed generation in the same rate until 2020 and then grow at 0% onwards.

According to Accenture, over 60% of household would have a Smart Thermostat in the next 10 years[226]. Based on this evidence, and unlike Scenario 1, we adopt a more conservative estimate and assume that 30% of households in the North install smart appliances in their homes (e.g. smart thermostats) by 2050. This assumes that the majority of consumers continue to be disengaged from the energy market and do not take advantage of energy cost reduction measures such as switching supplier or energy efficiency measures.

How will the Northern energy economy respond to opportunities?

As the energy mix remains the same over time, no significant innovation and investment takes places.

Growth assumptions

We have calculated the expected households and businesses spend to carry out appliances maintenance and take up of different energy technologies. Our analysis shows an increase in GVA for buildings of 0.3% per annum on average. We therefore estimate that GVA will increase by 0.3% per annum on average. Employment growth in this sector is mainly based on installing and manufacturing appliances. As such, we estimate that employment will grow by 0.5% year-on-year to 2050 in line with household growth projections from the ONS.

7. Transport

How will the sector evolve?

In this scenario, we assume that 30% of vehicles are EVs by 2050[227]. This is based on the decreasing prices of EVs and increasing numbers of charging points in the North. Petrol only cars still remain the majority of vehicles on the road in 2050. Figure C.9 shows the trajectory in number of vehicles on the road by type.

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225 KPMG analysis and FiT statistics. Available at: https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics

226 The Internet of Things, Accenture, 2015. Available at: https://www.accenture.com/t20150624T211456__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology_9/Accenture-Internet-Things.pdf

227 Based on KPMG analysis from FES 2016 – No Progression scenario. Available at: http://fes.nationalgrid.com/fes-document/

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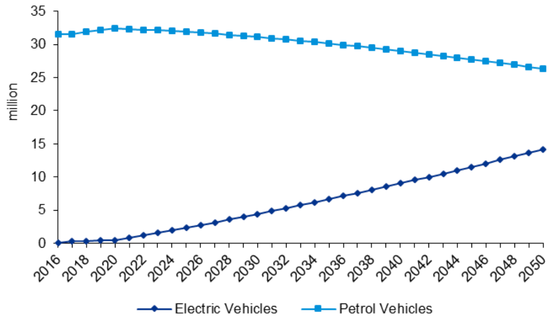
Figure C.9 Number of vehicles on the road by type



Source: KPMG analysis.

How will the Northern energy economy respond to opportunities?

Currently the Sunderland Nissan plant produces 60,000 lithium-ion batteries for its EVs[228]. The North is in a strong position to develop an advantage in manufacturing low emission vehicles. With its skilled workforce and experience in ULEVs manufacturing, the North is well placed to take advantage of the increasing demand in low emission vehicles. As with Scenario 2, the North East could play an important role in EV manufacturing at a global level should other countries adopt this technology.

Growth assumptions

We assume that 35% of cars will be EVs by 2050. The EV penetration rate is based on KPMG's recent report on the future of gas in the UK[229]. We assume that the North's share of EVs production will decrease from 17% to 9% by 2050. Using the methodology set out in Appendix 1 we estimate an annual spend of £0.8 billion in 2050 on ULEVs in the North. Based on the expected annual spend on ULEVs, we were able to estimate GVA (see Appendix 1 for our methodology and assumptions for GVA calculation). Our calculations suggest a GVA growth rate of 5.4% per annum on average.

Employment in the transport sector for the North will be in the manufacture of ULEVs and related components. On that basis, we assume that employment growth rate will follow the GVA growth rate of 2.7% per annum for direct jobs and supply chain jobs.

[228] Nissan Leaf £26.5m battery investment secures 300 jobs', BBC, January 2016. Available at: http://www.bbc.co.uk/news/uk-england-tyne-35363356

[229] 2050 Energy Scenarios – Scenario 3, KPMG, July 2016. Available at: http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

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