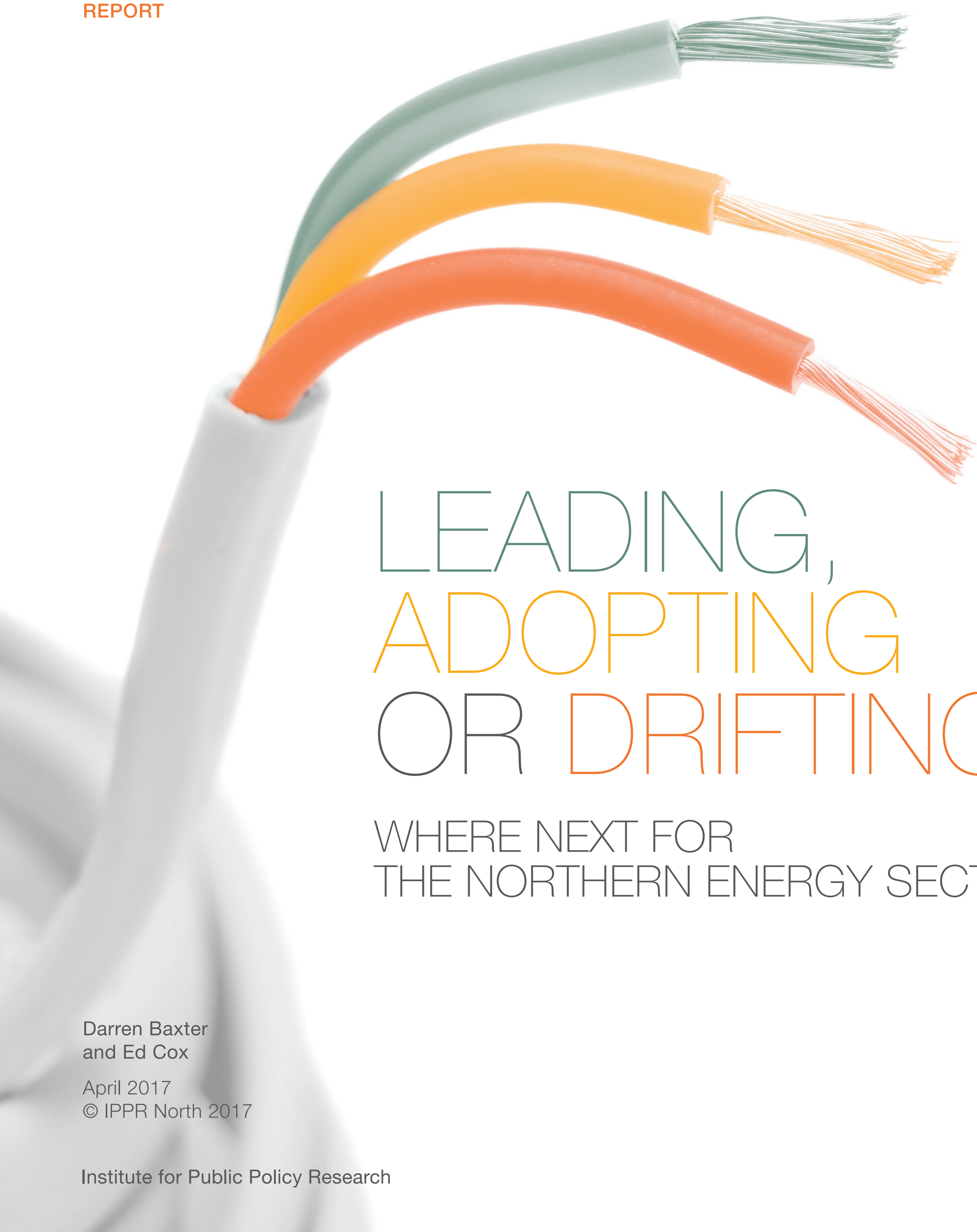
NORTHERN ENERGY TASKFORCE

IPPR NORTH

REPORT



LEADING, ADOPTING OR DRIFTING?

WHERE NEXT FOR THE NORTHERN ENERGY SECTOR?

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and Ed Cox

April 2017

Institute for Public Policy Research

NORTHERN ENERGY TASKFORCE

ABOUT THE NORTHERN ENERGY TASKFORCE

The Northern Energy Taskforce has been established to oversee an ambitious programme of work over the next 18 months that will develop an energy strategy for the northern powerhouse. The Taskforce is chaired by Sir John Harman, who will be supported by a number of high-profile figures with expertise across infrastructure, engineering, finance, academia and local government. It is supported by IPPR staff in a research and secretariat capacity.

The taskforce has three central objectives.

- Develop a plan for the northern energy system to 2030, addressing the key needs and challenges facing energy consumers and businesses in the North.
- Create an economic vision for the northern energy sector in 2030 and a practical roadmap for how to get there, addressing the opportunities for businesses, higher education institutions and the public sector in the energy sector.
- Set out a plan for 'energy devolution' that will consider whether and how various powers and responsibilities for energy issues should be devolved to different pan-northern, sub-regional and local levels.

ABOUT IPPR NORTH

IPPR North is IPPR's dedicated thinktank for the North of England. With its head office in Manchester and representatives in Newcastle, IPPR North's research, together with our stimulating and varied events programme, seeks to produce innovative policy ideas for fair, democratic and sustainable communities across the North of England.

IPPR's purpose is to conduct and promote research into, and the education of the public in, the economic, social and political sciences, science and technology, the voluntary sector and social enterprise, public services, and industry and commerce.

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SUMMARY

60-SECOND SUMMARY

This report argues that, with the appropriate support and strategic oversight, the north of England could do the following.

1. Act as a pathfinder for **unlocking the energy trilemma** for the UK: ensuring security of supply, managing the cost of and access to energy, while decarbonising the energy system in a 'no regrets' way, in the context of the policy and investment uncertainty created by Brexit.
2. Generate significant **economic benefits** for the North and the nation more widely, and in doing so narrow the regional productivity gap.
3. Successfully demonstrate a new **whole systems approach** to the UK energy sector and pioneer its implementation at a regional level.

Realising these propositions will naturally unlock great potential in the north of England, but will also be of national significance: ensuring energy security and resilient economic prosperity, while meeting the legally binding emissions reductions targets needed to mitigate – and adapt to – the effects of a changing climate.

A NORTHERN ENERGY STRATEGY

The northern energy sector is well equipped to deliver on these propositions, given its abundance of sites for new power and heat generation, and its ability to maximise these using its economic assets and legacy of skills in energy, energy efficiency and other related fields. The technologies which will deliver a national energy future are presented here as the 'ingredients' of a Northern Energy Strategy. In this report, each of these ingredients is analysed to assess its potential capacity, its relative cost, its ability to create jobs, and its contribution to meeting our carbon reduction obligations. It is argued that the North is particularly well placed, given its geography and geology, to develop those 'ingredients' which will create most social and economic value.

The combination of technologies that ultimately creates the energy mix will rest on the behaviour and decisions of a small number of key actors and institutions, globally, nationally and regionally, and in relation to four key variables.

1. Their level of support for decarbonisation.
2. Their approach to industrial strategy.
3. The extent and nature of coordination.
4. The availability of finance and investment.

POSSIBLE ENERGY FUTURES IN THE NORTH

Together, these ingredients and variables are likely to lead to one of three possible energy futures.

Future 1: The North as an energy leader

As an 'energy leader', the North would pioneer a new approach to national energy production, innovation and decarbonisation. The region would act on its comparative advantages in the energy sector and both develop and implement new low carbon technologies, such as tidal lagoon power and hydrogen for heat, which in turn will lead to the creation of new industries that export energy, goods and services to the rest of the country and the wider world.

Future 2: The North as a technological adopter

As a technological adopter, the north of England would take seriously its need to reduce carbon emissions and decarbonise much of its power and heat generation by 2050. It would generate energy from a range of old and new sources, such as offshore wind, nuclear power and a range of technologies for heating homes, depending to some extent on energy imports. While it may not become a driver of technological development, the North would adopt new technologies as necessary.

Future 3: The North as an energy drifter

As an 'energy drifter', the North would fail to make use of the opportunities currently available within its energy sector. It would not replace the capacity historically and currently created by fossil fuel plants, and would instead become increasingly dependent upon energy and technology imported from elsewhere.

The Northern Energy Taskforce is committed to developing a strategy to ensure that the north of England becomes a global energy leader. Based on the principles and broad parameters set out in this report, its work programme will now move to develop a strategy and route map to achieve this goal. This strategy, which will be published in autumn 2017, will consider a number of factors.

- The role of national and international policy in setting the framework for energy supply and demand and decarbonisation, and the need to manage the impact of Brexit on policy certainty.
- The added-value potential of northern energy assets and skills, and the role of subnational institutions and devolution in implementing and delivering a northern energy strategy in the context of a national and place-based industrial strategy.
- The ways in which energy projects of different scales are best funded and financed.
- Specific challenges relating to key 'ingredients' and how they will be implemented.

1. INTRODUCTION

The Northern Energy Taskforce has been convened to oversee an ambitious programme of work that will develop an energy strategy for the Northern Powerhouse. The taskforce is chaired by Sir John Harman, who is supported by a number of high-profile figures with expertise across infrastructure, engineering, finance, academia and local government.

The taskforce has three central objectives.

1. To develop a strategy for the northern energy system to 2030, addressing the key needs and challenges facing energy consumers and businesses in the North
2. To create an economic vision for the northern energy sector in 2030 and a practical roadmap for how to get there, addressing the opportunities in the energy sector for businesses, higher education institutions and the public sector
3. To set out a plan for 'energy devolution' that will consider whether and how various powers and responsibilities for energy issues should be devolved to different pan-northern, sub-regional and local levels.

This is the second report of the Northern Energy Taskforce. The first, *Who will power the powerhouse?* (Baxter and Cox 2017), took stock of the current landscape of the northern energy sector, assessing the key challenges it faces and opportunities it could grasp. In this interim report, we will consider some possible energy futures for the North.

The challenges identified in the first report are as follows.

A decline in the traditional energy economy

Traditional power generation is already in decline, with coal-fired power stations due to be phased out by 2025, and many combined cycle gas turbines reaching the end of their working lives. This also affects low carbon generation, given the finite life of nuclear plant and the absence of firm commitment for new plant. In economic terms, the North's share of energy GVA has fallen from a third to less than a quarter since 1997.

High-energy demand

Energy demand is disproportionately high in the North, due to the location of a number of energy-intensive commercial and industrial sectors in the region. This means that energy supply is critical to the wider health of the economy, and that projections show little scope for significant reductions in the demand for gas or power between now and 2030.

A reliance on national policy

The North's ability to exploit the potential sites for power generation is made more vulnerable due to its reliance on a national energy policy which tends to lack the granularity to exploit regional strengths and opportunities, and, in doing so, ends up undermining national goals.

These challenges represent a shift away from large fossil plant and towards new cleaner generation. But it is in these low carbon energy innovations that the key opportunities for the North lie. The region has the geological, geographic and historical assets to power and heat the nation, as well as the low carbon economy and assets needed to deliver new technologies and sources of generation. The region also has a strong skills base in deployment of energy efficiency technologies which can be drawn upon.

Bringing together these assets to address the challenges set out above represents a major industrial opportunity; not just for the North, but for the nation. Maximising the potential of the Northern energy sector will secure the nation's energy supply, develop a world-leading industry to help rebalance the economy, and help the nation achieve its carbon reduction obligations.

It is timely, then, that the UK government has released a green paper on industrial strategy that has recognised energy as a key element, both as vital infrastructure and as a cost to business (BEIS 2017a). Furthermore, the Industrial Strategy recognises the importance of place and the need to increase productivity in the regions outside London. This report shows that, with appropriate strategic planning and support, the energy sector in the North could be one of the world-leading industries that the government is seeking to support and promote.

A strong northern energy sector will be of national significance, ensuring energy security, economic prosperity and decarbonising a large amount the energy supply. This will be key in meeting the national and international goals for decarbonisation needed to adapt to and avoid further impacts of climate change.

STRUCTURE OF THE REPORT

This report is divided into three main sections.

1. **The propositions:** a vision of the North's capabilities.
2. **The ingredients:** the sources of energy and the technologies which could make up the future energy system.
3. **The variables:** the key factors which will determine the nature and shape of the future northern energy sector.

These will then be drawn together to present **three possible energy futures**. One in which the North is a 'leader', one in which the North is an 'adopter', and one in which the North is a 'drifter'. The report will then conclude by considering the next steps in developing a northern energy strategy which delivers both northern and national energy and economic prosperity.

2.
PROPOSITIONS ABOUT ENERGY IN THE NORTH

The energy sector in the north of England is well positioned to maximise the economic potential of a transition to a smart and cleaner energy system. Doing so will be both regionally and nationally advantageous. Realising this rests on three propositions which will be outlined in this chapter.

PROPOSITION 1: THE NORTH CAN ACT AS A PATHFINDER TO UNLOCK THE SO-CALLED 'ENERGY TRILEMMA' FOR THE UK AT A TIME OF DEEP UNCERTAINTY OVER BREXIT

The 'energy trilemma' refers to the need to balance three apparently competing aims of energy policy: to decarbonise the energy system, to ensure security of supply, and to manage the cost of and equitable access to energy (World Energy Council 2017). Meeting all three aims is challenging.

Decarbonisation is enshrined in law, but if reducing the reliance on fossil fuels to achieve it means increasing the amount of renewables on the grid, this may increase cost and diminish security, given the inherent intermittency of these technologies (ARUP 2017). This is made more challenging in the context of the UK's imminent departure from the EU which has the potential to disrupt the current and planned integration between UK and European energy systems. Similarly, continuing to exploit fossil fuels may represent short-term cost effectiveness and security of supply, but will do little to help us meet our carbon reduction obligations, nor will it improve resilience by diminishing our exposure to external supply shocks (ibid). Energy efficiency will be key to managing demand for energy services at least cost. However, the assets within the North position it well to contribute to each corner of the energy trilemma, avoid a potential investment hiatus, and enable the UK to stay on track with its carbon emission reduction programme.

Decarbonisation

The North is home to geographic, geological and historic assets that make it well placed to supply the nation with low carbon power. Northern regions already generate 48 per cent of the UK's renewable power (BEIS 2016b), and have clusters of expertise around offshore wind and nuclear power. Future developments could expand on this generation, and there is scope to develop new sources of clean energy such as tidal lagoons.

Finding a low carbon solution to heating is a key challenge in meeting commitments to reduce carbon emissions. The North is can offer the technologies and storage facilities that will enable its further development. It is home to plans to convert the gas grid to run on hydrogen, and could become a world leader in this field (Northern Gas Networks 2016). Many of the North's major cities are developing district-heating schemes (BEIS 2017b), and it is particularly well suited to the economically viable re-use of waste heat (Baxter and Cox 2017).

Security

Energy security has been managed in a number of ways. In respect to electricity, it has been maintained through ensuring sufficient capacity on the grid. As the UK's coal plant is closed, it will need to be replaced. In terms of raw capacity, the North is well equipped going forward. New offshore wind could bring 22.5GW onto the grid and new nuclear 5GW (see analysis in chapter 4). However, their intermittent generation and inability to 'peak' have meant that, until recently, replacing existing capacity with renewables and low carbon technologies has been considered too challenging (NIC 2016).

Moving forward, this intermittency will be managed through making the grid smarter and integrating new technologies, such as energy storage, energy efficiency and demand management (NIC 2016). The North is already leading in terms of technological innovation in this area. For example, the Centre for Energy Systems Integration (CESI) at the University of Newcastle is a national centre which is investigating the future of the energy network and ways of optimising it. Additionally, the customer-led network revolution run by Northern Powergrid and partners is at the forefront of trialling smart grid technologies on real customers. The North East is also pioneering batteries for electric vehicles, giving the region an edge in the manufacture of storage (SQW and CE 2016). Assets and projects such as this, and the expertise developed from them, will allow the region to become a test bed for the technologies that manage energy and ensure security for homes, businesses and industry.

The domestic production of energy, such as the extraction of domestic coal or North Sea oil and gas, has also historically contributed to energy security, through insulating against the potential for insecurity that importing energy exposes customers to, such as price volatility. As North Sea supplies run out and the UK imports more oil and gas, this mitigation will be lost (Bolton 2013). In its place, low carbon power and heat generation in the North can contribute to the region and the UK's energy security by increasing the level of domestic, low carbon production.

Costs and equity

With the right policy environment, and with a strong focus on energy efficiency and demand management, Northern energy assets represent a cost-effective and competitive approach for the nation. As will be presented in detail in chapter 3, the North is well suited to developing those technologies, such as offshore wind and nuclear power, which are becoming increasingly more cost-effective as they mature. A Committee on Climate Change-founded report recently identified offshore wind as one key sector in which the UK has an especially strong competitive advantage (CCC, 2017). Additionally, implementing the knowledge generated in northern institutions, such as CESI, around the future of the grid will reduce the 'whole systems' cost even further (Heptonstall et al 2017).

PROPOSITION 2: TAKING A STRATEGIC APPROACH TO THE ENERGY SECTOR IN THE NORTH WILL GENERATE SIGNIFICANT ECONOMIC BENEFITS FOR THE REGION AND THE NATION MORE WIDELY, AND WILL NARROW THE REGIONAL PRODUCTIVITY GAP

The North has a comparative advantage in the energy sector, and it is possible to turn this into a 'first mover' advantage. Decarbonising energy and reducing energy demand – for example through retrofit – is a global problem, and so those companies, clusters and regions who develop the technologies to meet these challenges will have significant opportunities to export their goods, services and expertise overseas.

The North has a strong low carbon economy, which will be key to developing this further (Baxter and Cox 2017). The region has more low carbon goods and services jobs per 1,000 employees than anywhere else in England, and the energy sector is worth £5.2 billion in GVA (Baxter and Cox 2017). Using Northern skills and assets to develop new technologies will bring substantial benefits through developing world-leading firms. Given that the low carbon potential of the region is as of yet largely untapped, the capacity for future growth is great. The energy sector can become a key industry in the North's economic future, as identified in the *Northern Powerhouse Independent Economic Review* (SWQ and CE 2016).

Expanding the energy sector in the North will contribute to rebalancing the economy between the North and the South, where a productivity gap has long been observed, but also between areas within the North. The energy sector is located largely outside of major cities (IPPR North 2016), and so expanding it will bring growth to those areas that often feel overlooked by the mainstream Northern Powerhouse agenda (Cox and Longlands 2016). Alongside offering productive growth, the energy sector requires highly skilled employees, and sites of generation can be hooked into programmes of local skills training, as has been the case in Hull and the Humber (Humber LEP 2015). Investing in these technologies in the North, given its already well-developed energy sector and supply chains (Baxter and Cox 2016), provides the best chance for investment in low carbon technologies to lead to jobs in the UK.

PROPOSITION 3: REALISING THE ENERGY POTENTIAL OF THE NORTH WILL REQUIRE A 'WHOLE SYSTEMS' APPROACH WHICH THE NORTH IS WELL PLACED TO DELIVER

Achieving the two propositions above will require a 'whole systems' approach (Energy UK 2016). This will mean two things. Firstly, that the transition to a low carbon energy system will require thinking about power, heat and transport together. Decisions about how we heat our homes, for example, will have significant implications for the electricity supply and the North's role in this. Bringing together these two parts of the energy system requires a focus on systems integration (Energy UK 2016). An integrated approach brings together generation, transmission and demand-response, which have historically been treated as separate technologies (NREL 2017).

Secondly, a 'whole systems' approach also means thinking about how energy is used, and not just how and where it is generated (CESI 2016). In the first report from the Northern Energy Taskforce, it was noted that the structure of the economy in the North means that the region is a heavy consumer of energy and emitter of carbon. Accordingly, a whole systems approach in the North can work to recognise the importance – and best means – of supporting industrial consumers.

While many places will need to grapple with a whole systems approach, the North is particularly well equipped to deliver this approach and implement it first. Already the region has several assets which will be key in developing the knowledge, skills and technologies necessary. As noted previously, it is pioneering smart grid technologies through the CESI, as well as Northern Powergrid and its partners' customer-led network revolution. These projects, while national in their focus, mean that the knowledge and skills associated with them are located in the region.

In addition, the wider economic strengths of the North position it well to deliver on these technologies. SQW and Cambridge Econometrics (CE) (2016) have noted that the digital sector is one of the North's key economic capabilities. Leeds, home to several data centres, is a good example of this. Such assets and skills will be key to delivering new, smarter energy systems (NIC 2016) while retaining the associated jobs in the UK.

Perhaps most importantly, northern regions also have a clear economic imperative to implement these technologies. This is because realising the previous two propositions, and driving the national benefit it will achieve, will create significant economic advantage for the north of England. That this relies on adopting such an approach, and investing in the relevant technologies and infrastructure, could and should be a necessary driver of technological innovation and implementation.

In order to deliver this, there is a need for coordination and collaboration. Work has already been undertaken in the North to establish regional institutions through devolution, such as through the City Deals. Additionally, Transport for the North, a pan-northern transport institution, demonstrates that the region is already home to strategic bodies at a regional level. These and new institutions, combined with municipal leadership and collaboration, can be exploited to deliver the coordination necessary for a regional energy strategy, demonstrating a particular advantage for the North.

3.
THE ‘INGREDIENTS’ OF A NORTHERN ENERGY SYSTEM

The landscape report of the Northern Energy Taskforce, *Who will power the powerhouse?*, identified the broad opportunities presented by the northern energy system. In this chapter, these technologies are examined in detail. The following sections address power generation on the transmission network and at the city level, future heat infrastructure, energy efficiency, and the export and import of energy through interconnectors.

This speaks to two parallel aims. First, the region should seek to be an exporter of energy to the rest of the UK, through building large power plant and looking at heat options. Second, and of equal importance, the North should drive efforts to reduce and better manage its energy use. A focus on energy efficiency will be key to delivering this.

To examine how far different technologies can meet these aims, we have looked at four key considerations.

- **Cost:** The cost for each technology. For power plant, this is the levelised cost per GWh, which collates the cost of building and running the plant and which is then standardised by output. For heat infrastructure, this is the total cost of changing the UK’s heating systems (space and water) to accommodate each approach. This includes the costs of energy commodity, capital, network conversion, and end user conversion. Costs are set out for 2016 and 2030 to reflect that prices of certain technologies will drop and others will increase.
- **Job creation:** The average number of jobs created in the construction and operation of different technologies, both directly and indirectly, are included. This is represented as jobs per GWh for power plant and for heat. Data is drawn from analysis conducted on the likely economic impact of different technologies by KPMG (2017).
- **Potential capacity in the North:** The potential capacity of different technologies is presented for power plant. For heat, this refers to the total replacement of the UK’s existing demand. Using available data, plant on the transmission network is represented in terms of capacity (GWs) whereas distributed generation is shown in terms of generation (GWHs).
- **Carbon emissions:** The amount of carbon emitted in the life cycle of each technology is represented as g/KwH for power plant and is inferred from KPMG analysis for heat infrastructure.

The differing levels of detail concerning each technology reflect the stages that planning and analysis are at in understanding them, but the analysis here gives a good reflection of the relative strengths and opportunities relating to each of the options. A detailed list of the sources underpinning this work are outlined in the annex to this report.

POWER

TABLE 3.1

The technology options for power generation

The economic, technical and low carbon potential of different options for power generation

Technology	Cost (£/MWh)		Job creation (Gross jobs/ GWh)	Potential capacity in the North (GW)	Carbon emissions (g/KWh)
	2016	2030			
Coal with carbon capture & storage (CCS)	146	146	0.14	5.9	87
Combined cycle gas turbine (CCGT)	57	100	0.12	5.3	487
CCGT with CCS	-	117	0.12		49
Biomass conversion	87	87	0.46	2	435
Nuclear	95	78	..	5.0	16
Offshore wind	110	89	0.25	22.5	11
Onshore wind	67	60	0.42	-	11
Tidal	100	-		16	-
Smart grid systems	20				

Source: BEIS (2016), Poyry (2014), Blyth et al (2014), Postnote 383 (2011), Heptonstall et al 2017)

TABLE 3.2

The potential for distributed generation at the city level

The economic, technical and low carbon potential of distributed generation in Northern cities

Technology	Cost (£/MWh)		Job creation (Gross jobs/ GWh)	Potential capacity in the North (GWh)	Carbon emissions (g/GHh)
	2016	2030			
Distributed solar and wind	77.5	62.5	1.02*	1187.66	11

Source: BEIS (2016), Blyth et al (2014), Gooding (2016), Postnote 383 (2011)
*Note: this figure is for solar photovoltaic (PV) only.

The 'ingredients' examined in table 3.1 show that the future of power generation lies in low carbon sources. Aside from the environmental case for these forms of generation, they are reducing in cost, and will become much more cost-effective than fossil fuels by 2030, as demonstrated by wind, solar and nuclear in table 3.1. This is even after considering the 'whole systems' cost of integrating renewables onto the grid (highlighted as smart grid systems above). As shown in table 3.2, low carbon sources of generation also create more jobs per GWh than traditional fossil fuels.

The potential capacity of all forms of generation listed is high in the North, although this is greatest in regards to low carbon sources of generation. For example, there is five times the potential of capacity in offshore wind as there is in current CCGT plant. Similarly, the current capacity provided by coal plant could easily be replaced by offshore wind, tidal lagoons and nuclear plant; technologies for which the costs are decreasing.

The wind profile, tidal sites and expertise in nuclear power in the North can therefore be considered as a national asset ready to be tapped. As has been the case in the past, the region could be the powerhouse of the country. Failing to develop these assets will ultimately reduce the overall supply of clean, secure power available to the nation's homes and businesses, and drive up dependency on potentially more expensive and less secure sources. What this shows is that, even if sufficient capacity could be driven by fossil fuel generation, there remains still strong economic 'common sense' case for investing in low carbon technologies.

There is also the potential for a large amount of rooftop solar and, to a lesser degree, wind in northern cities. If ten cities were to reach their physical capacity, they would be able to generate 1187.66GWh of power. This is also one of the lowest cost forms of generation, and it provides the one of the greatest amount of jobs per GWh of generation. While the North is not necessarily any better placed to deliver the roll-out of such technologies, if its new metro mayors and other municipal leaders were to seize these opportunities and put in place the mechanisms necessary to support their roll-out, then northern cities could offer national leadership in this important field.

HEAT

TABLE 3.3

Potential options for decarbonising heat

The economic, technical and low carbon potential of different options for decarbonising heat

Technology	Cost	Infrastructure disruption	Job creation (total, UK)	Carbon emissions (g/GHh)
Converting the gas grid to run on hydrogen	£122bn	Low	68,679	19
Mixed approach to heating, inc, district heating, electrification, bio/syn-gas	£188bn	Medium	83,930	0
Electrifying domestic & commercial heating	£318bn	High	-	0

Source: KPMG (2016) and KPMG (2017)

TABLE 3.4

Shale gas in the North of England

The economic, technical and low carbon potential of shale gas extraction in the North of England

Technology	Cost	Job creation (gross jobs/GWh)	Capacity (BCM)	Carbon emissions (g/kwh)
Shale gas	-	0.43	80–200	462

Source: BEIS (2016), Poyry (2014), Blyth et al (2014), Andrews (2013), Postnote 374 (2011)

Progress towards decarbonising heat is at a much earlier stage than the decarbonisation of power, and as a result, data on different technologies is not as readily available. In response, the attempt made here towards understanding the 'ingredients' of the future heat mix are bundled together into three potential strategies for the future of low carbon heat. These are: the conversion of the existing gas grid to run on hydrogen; the adoption of a 'diversified' heat mix that incorporates district heating, electrification of heat and biogas depending on local needs and strategies; and the total electrification of domestic and commercial heating.

As with potential power technologies, these options vary in cost and the extent to which they are low carbon and economically advantageous, as presented in table 3.3. However, to a greater extent than new electricity generation, they may require changes to the infrastructure which delivers heat to, or generates it within homes, businesses or industrial sites.

The North would be able to deliver on many of these futures. It is home to most economically advantageous waste heat sites for district heating and sits on the Bowland Hodder Basin, and so could lead the UK in domestic gas extraction (Baxter and Cox 2017). A potential least cost, least disruption scenario for the UK is found in converting the gas grid to run on hydrogen. Northern Gas Networks (2016) in their work on the H21 project, a plan to begin a national conversion to hydrogen in Leeds, note that the North of England is particularly placed to deliver a hydrogen conversion.

Three key factors anchor hydrogen generation and transmission in the region.

- **Industrial assets and skills base:** The North is already manufacturing hydrogen and has a world class chemicals industry in the North East (Northern Gas Networks, 2016). It therefore already has the necessary industrial infrastructure to begin supplying the gas for heating.
- **CCS:** Decarbonising heat through hydrogen by manufacturing it in this way will require CCS. Northern regions are already well positioned to build CCS infrastructure; there are existing industrial sites with access to North Sea gas fields, and plans for locating it in the region have already been developed.
- **Storage:** Managing peaks and seasonal variations in demand for gas will require hydrogen to be stored, often for long periods of time. The North is home to salt caverns which are optimal for

doing so. While such storage exists elsewhere in the country, only the North has them of sufficient depth to be commercially viable (Northern Gas Networks 2016).

Table 3.4 highlights the potential associated with shale gas. As is the case with hydrogen, this fuel has a particularly northern potential, given the presence of the natural asset in the region: the Bowland Hodder Basin. Estimates of the potential for employment associated with shale gas extraction have been high. The Institute of Directors (2013) estimated that up to 74,000 jobs could be created, although the variability in projected amounts of recoverable gas means that this is potentially overstating the potential. Table 3.4, which shows the number of jobs per GWh from shale gas, demonstrates that the average jobs created in production are higher than many of other fuels and equivalent to some renewables. However, we can also see that shale gas is comparable with natural gas in terms of its emissions, and its extraction is contentious. Additionally, much of its potential is limited or driven by the amount of gas which could be extracted, of which no one is yet certain (Andrews 2013). The Northern Energy Taskforce will be producing a separate briefing paper on shale gas later in the Spring.

ENERGY EFFICIENCY

In addition to considering the potential for generation in the North, it is also important to understand how the region can reduce and better manage its energy consumption, and the economic potential associated with doing so.

TABLE 3.5

Potential for energy efficiency measures in the North of England.
The capacity for and jobs associated with rolling out energy efficiency measures in the North of England

Technology	Number of homes	Jobs
Loft insulation	1,142,000	
Cavity wall insulation	1,378,000	
Solid wall insulation	1,375,000	20,400
Improve the efficiency of heating systems	2,857,000	

Source: Matthews (2013)

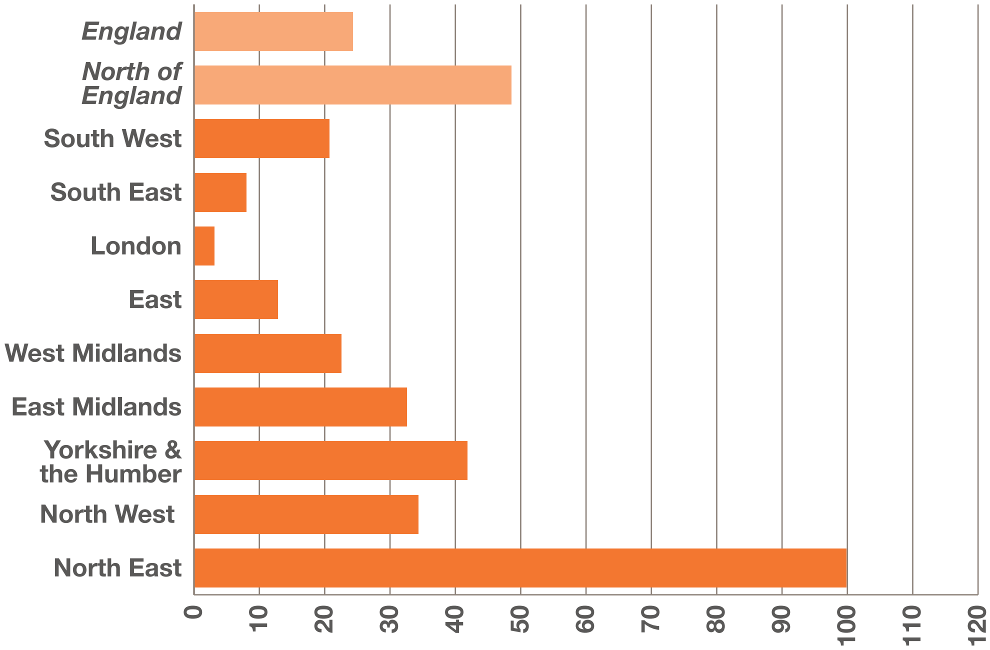
In line with Europe, energy demand in the UK has been fallen over the last decade (BEIS 2016b). There is significant potential to continue, and perhaps accelerate, this trend; this is a key way to manage the costs of decarbonisation, while delivering significant local job creation, air quality improvements and improved welfare.

There is much potential in the roll-out of energy efficiency measures in the north of England, with the region already leading the way in this area. Northern regions were well above the national average in terms of number of Green Deal plans per 1,000 households in 2015. This is particularly the case in the North East, where 1 in 10 households have an active Green Deal plan.

FIGURE 3.1

The North East has by far the highest number of active Green Deal plans, followed by the North of England, and Yorkshire and the Humber

Number of 'live' Green Deal plans by region, up to 30 June 2015



Source: DECC (2015)

Table 3.5 shows that there are 6.75 million instances where some energy efficiency measure could be rolled out. Delivering this could create 20,400 full time equivalent jobs per year over the fifteen years it would take to achieve this (Matthews, 2013. Therefore, as with rooftop solar and wind, there are significant opportunities for household and city level schemes.

INTERCONNECTION

A key part of managing energy in a smart system is through interconnection, where different regions and countries are linked by physical cables, through which energy can be traded at times of excess supply or demand. Currently, the UK has 4GW of installed interconnector capacity and more is planned, as listed below.

Of this new capacity, NSN – which connects the UK with Norway – will be built in the north of England, connecting from East Sleekburn in the North East and wider Blyth Estuary Renewable Energy Zone. This represents 1.4GW which could be used to balance demand, thereby improving resilience and providing a market into which the UK could export energy.

TABLE 3.6

Planned interconnectors between the UK and Europe

France: Eleclink (1GW, 2019); IFA2 (1GW, 2020); Acquind (2021; 2GW); FABLink (1.4GW, 2022)
Belgium: Nemo (1GW, 2019)
Ireland: GreenLink (0.5GW, 2021)
Denmark: Viking (1GW, 2022)
Norway: NSN (1.4GW, 2021); NorthConnect (1.4GW, 2022)
Iceland: IceLink (up to 1.2GW, 2024); Atlantic Superconnection (1.4GW, 2022+)
France: Gridlink (1.5GW, 2021)
Netherlands: New GB interconnector (1GW, 2030)
Belgium: 2nd Belgium interconnector (1GW, 2025)
Spain: Britib (1.8GW, 2022); ANAI (2GW, 2026)
Norway: Maali (600MW, 2023)
Ireland: ISLES (many GW potential; post-2030)

Source: INEA (2017)

4.
THE VARIABLES THAT UNDERPIN THE FUTURE OF THE NORTHERN ENERGY SECTOR

The future of the northern energy sector will depend on which of the ingredients laid out in the previous section ultimately form part of the North's energy system by 2050, but this energy mix will be determined by decisions about a series of 'variables'.

These variables include:

- the pace at which decarbonisation is pursued
- the approach to and ambition of the industrial strategy approaches
- the level and nature of coordination at a regional level
- the availability of finance.

Each of these variables is explored below.

VARIABLE 1: DECARBONISATION

In her book *The Entrepreneurial State*, Mariana Mazzucato argues that economies perform best, and develop great leaps forward in technology, when they are driven by innovative public institutions who are motivated by a broader mission. The Apollo spaceflight programme, and the myriad technological innovations which resulted from it, is presented as one of several examples of this (Mazzucato 2011).

The need to reduce carbon emissions globally to prevent further catastrophic damage from climate change could provide such a 'mission', as has been argued by the economist Carlota Perez (2016). The need to decarbonise is a national and international mission which will require different places and sectors to work together, and for decarbonisation to be weaved across the whole economy.

The propositions laid out in this report show that the north of England is well equipped, due to its disproportionate number of sites for future, low carbon power and heat generation, and its economic assets and skills base, to drive the decarbonisation of the UK's energy system. Additionally, we have demonstrated that there is an economic imperative to do so, given their reducing cost, and the potential for local and regional prosperity, as highlighted in the tables within the previous chapter.

If support for decarbonisation is low, the northern energy sector is likely to miss out on its most economically advantageous opportunities. If it is high, it is set to develop a large amount of secure, low carbon generation in both power and heat, which it could export to the rest of the country.

To do so, the region will require support across a number of areas.

The expansion and development of existing sites
Already, many low carbon technologies are planned or operational in the north of England. Expanding these will be a key part of increasing the amount of clean power which is generated. It will be necessary for national frameworks and local support to ensure these potentials are realised.

Putting in place the necessary infrastructure
As the nature of power generation shifts away from large conventional thermal plant towards increasing amounts of intermittent renewable generation, there will be a need for new infrastructure to manage this. Additionally, decarbonising heat and heavy industry will likely require systems to capture and sequester carbon emissions. Ensuring this infrastructure is in place will be a necessary facilitator of the expansion of new forms of generation.

Driving forward with a plan for heat
Decarbonising heat could be a mission in its own right. Currently, peak demand for domestic heat is four times that for power, and technologies for its decarbonisation are less widespread than in the power sector. In contrast to the decarbonisation of electricity supply, where new low carbon generation has been 'plugged' into the existing network, the low carbon heat transition will likely require a more substantial infrastructure change. Driving this transition will require making technology choices and then supporting their development, and will be key in the wider success of the 'mission' to decarbonise.

VARIABLE 2: INDUSTRIAL STRATEGY

Critics have suggested that energy policy has so far failed to effectively develop technologies early enough to truly capture their value in the UK (Wilson 2012). Offshore wind is often pointed to as a prime example of this. Research by IPPR has previously suggested that the UK has not always acted early enough or with a sufficient level of support to maximise the natural opportunity presented by its wind profile and shallow shores to develop its own world-leading offshore wind firms (McNeil, 2013). In its absence, the government and local actors have had to encourage and incentivise firms to locate in the UK, and, once there, to maximise UK content.

This is not to disparage the efforts of firms in regions such as Hull and the Humber, nor to suggest that offshore wind is the only industry that employs such techniques. This approach has been successful in attracting large numbers of jobs to the region, and contributed to a regenerative impact (see Siemens 2014 by way of example). This has particularly been the case in coastal communities, which have taken value in fabrication, supporting construction operations, and in ongoing operations and maintenance. However, if the North, and the UK, wants to develop a world-leading energy sector, delivering the mission of decarbonisation, it will also have to look at developing new technologies and take an early lead in the process.

An industrial strategy for the energy sector could therefore undertake the following.

Turn the North's comparative advantage into a first mover advantage
The region could utilise its comparative advantage in the energy sector to be a test-bed for new technologies, and develop goods, services and knowledge that could be traded globally, as other nations seek to meet the challenge of decarbonisation. A prime example of this could be converting the gas grid to run on hydrogen, as proposed by Northern Gas Networks (2016). Decarbonising heat is a global challenge, and the North is well suited to becoming the place that develops a solution. The appropriate support could unlock a key economic opportunity to develop the knowledge, skills and technologies necessary to implement this transition elsewhere.

Aim to attract investment and maximise UK content
The North could build on its successes in locating large firms in the regions who build technologies, extracting the value through their supply chains. A prime example of this method can be seen in the Green Port Hull, which has used direct investment, enterprise zones and skills training to present Hull and the Humber as an ideal location for renewable energy firms to locate their business (Green Port Hull 2017).

Aim to create jobs locally through programmes of energy efficiency and distributed generation delivery
Additionally, there are opportunities in the energy sector for local job creation, in both energy efficiency and distributed generation. Programmes of energy efficiency have often been justified by their potential to generate high levels of employment and feed cash into local economies. While the ambition of an energy strategy for the North should be grand, it is also worth considering that a plan may want to augment an industrial strategy approach with support closer to home. It is likely that there is significant 'social good' to be derived from the roll-out of domestic technologies, such as energy efficiency, rooftop solar and wind, which would also drive prosperity locally.

The choice and combination of these approaches will shape the technologies that make up the future northern energy mix, the pace at which they are rolled out, and the economic opportunities derived from them.

VARIABLE 3: COORDINATION

Delivering an energy strategy for the North will require coordination at the regional level. Structures already exist at the local level that are to some degree able to coordinate energy projects, in the form of local and combined authorities and local economic partnerships (LEPs). The strategic economic plans of LEPS in the North all highlight the energy sector or low carbon goods and services as a priority area for future growth (Baxter and Cox 2017). Additionally, many northern local authorities are working on projects to decarbonise the energy systems within their areas; for example, through district heating networks (BEIS 2017b).

In the landscape analysis of the Northern Energy Taskforce, it was recognised that LEPs, by their design, are well suited to encouraging the local benefits associated with generation. However, the extent to which these organisations represent the appropriate scale for managing large projects was challenged. It was argued that the pan-northern level would be more appropriate for coordination, which could provide the appropriate scale for large infrastructure projects to be managed, allow for cross-LEP working to occur on areas such as skills and innovation, and encourage large-scale investment.

Driving the ambitions outlined in this report will therefore require the identification or creation of the appropriate institutions to oversee and implement an energy strategy, with the appropriate roles and responsibilities at different spatial scales. These tiers and are outlined below.

The pan-northern level

- The management of large-scale infrastructure projects
- Spatial planning for energy infrastructure
- Developing pan-northern programmes; for example, to support innovation and develop skills
- Welcoming and supporting investment in the northern energy sector
- Technical assistance: providing an efficient, centralised resource to support the technical and commercial development of infrastructure

Combined, LEPS and local authorities

- Managing local schemes, such as the roll-out of energy efficiency or distributed generation
- Encouraging and facilitating community energy schemes
- Resource planning
- Maximising the economic opportunities associated with sites of generation locally
- Assessing and addressing local skills needs

VARIABLE 4: FINANCE

The availability of funding and finance to develop new energy infrastructure will be an essential variable in dictating the ambition of different energy futures. Already, many of the mechanisms used to fund energy projects, such as the Green Deal and feed-in tariff, have been reformed or removed due to criticism of their cost-effectiveness. In addition, the government's decision to press ahead with Hinkley Point C – the UK's first new nuclear power plant in two decades – has raised the issue of the cost of funding new energy infrastructure. In the North, challenges in finding appropriated funding and finance have meant that plans to develop CCS infrastructure have gone unrealised.

As IPPR North recently outlined in *Paying for our Progress: How will the Northern Powerhouse be financed and funded?* (Blakeley 2017), there are a number of different mechanisms available for financing large infrastructure projects – from negotiating Tax Increment Financing deals with local government, to setting up a national infrastructure bank, to leveraging investment from public pension funds – but these cannot be fully utilised until a number of issues with the UK's infrastructure financing system are resolved.

Funding is as critical as financing

Many infrastructure projects cannot be financed solely through private investment, as they do not have obvious revenue streams through which investors can recoup their capital. In these cases, if government wants the private sector to invest in the project, then it must recognise that funding is as critical as financing; if there is no obvious source of funding an infrastructure project, then the private sector is unlikely to finance it. The government therefore needs to provide certainty as to how investors will be repaid. This can take the form of the government paying investors back over the longer-term, or the provision of guarantees. This is clearly relevant in the energy sector, where a lack of policy certainty over recent years has had a negative impact on investors (House of Commons Energy and Climate Change Committee 2016).

Appraisal must be take into account the wider economic benefits of a scheme

Infrastructure schemes suffer from a lack of public investment because appraisal mechanisms do not take into account their wider economic benefits. If the long-term economic and social benefits of infrastructure projects were taken into account, it would be apparent that many projects pay for themselves over the long-run, and are clear cases for public investment. Therefore, infrastructure appraisal frameworks must be reformed in order to take these wider economic benefits of a project into account, including long-term increases in growth and reductions in public sector spend resulting from the initial investment. This may chime with the government's plans to focus on energy security and cost for businesses in their recent industrial strategy paper (BEIS 2017).

Subsidiarity, scale and trust are central to good governance

Funding and decision-making systems are too centralised, with local areas unable to borrow in order to finance growth-enhancing infrastructure projects. Local areas often have much greater knowledge than central government about the infrastructure projects they need, and are willing to take risks in order to ensure they go ahead.

Government should abide by the principle of subsidiarity; sufficient powers over taxation, spending and decision-making should be devolved to local government to allow them to finance and fund local infrastructure projects, while regional bodies such as Transport for the North should gain similar powers to Transport for London.

5.
NORTHERN ENERGY FUTURES

In this chapter, the 'variables' outlined in the previous chapter and the 'ingredients' of chapter 3 are brought together to construct three possible energy futures for the north of England. These are not scenarios or models – the data is simply unavailable to create these – but rather narrative descriptions of a series of possible outcomes that we describe as 'energy futures'. The technologies underpinning them may differ or change entirely as new approaches are developed, but for now, these are carefully considered opinions on what we can expect if different approaches are pursued.

The three possible futures are the following.

The North as an energy leader
As an energy leader, the North would be the driving force behind the national energy production, innovation and decarbonisation. The region would act on its comparative advantages in the energy sector and both develop and implement new low carbon technologies, which in turn would lead to the creation of new industries that export energy, goods and services to the rest of the country and the wider world.

The North as a technological adopter
As a technological adopter, the north of England would take seriously its need to reduce carbon emissions and decarbonise much of its power and heat generation by 2050, generating energy from a range of old and new sources, and depending to some extent on energy imports. While it may not become a driver of technological development, the North would adopt new technologies as necessary.

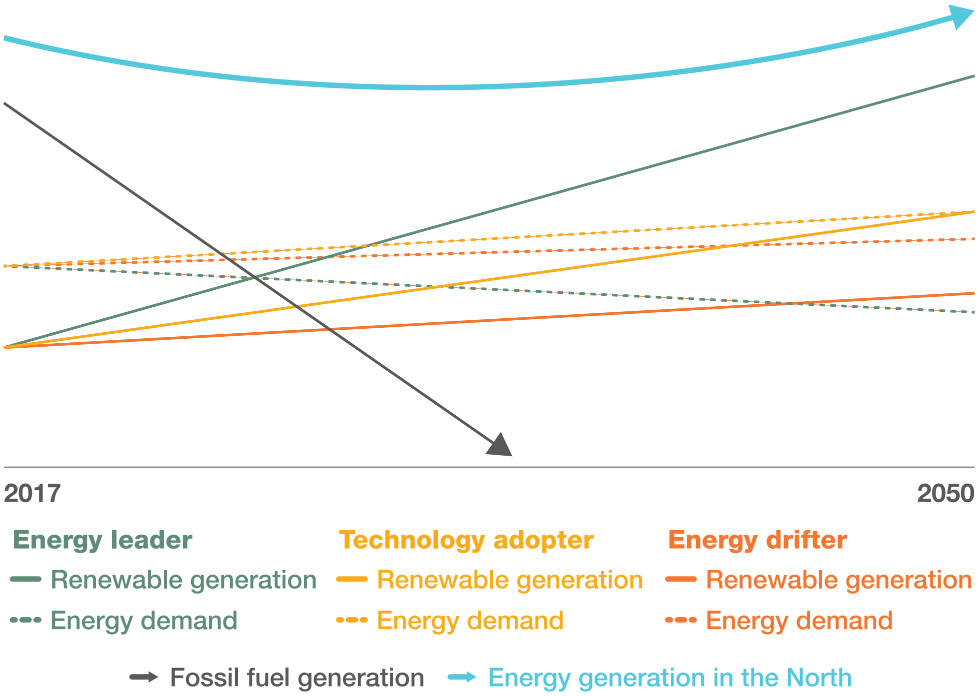
The North as an energy drifter
As an energy drifter, the North would fail to make use of the opportunities currently available within its energy sector. It would not replace the capacity historically and currently created by fossil fuel plants, and would instead become increasingly dependent upon energy and technology imported from elsewhere.

These different scenarios can be expressed graphically, as in figure 5.1 below. While it is by no means an accurate depiction of these scenarios, this diagram is useful in demonstrating each of the possible futures. It shows that, across each possible future, fossil fuel generation is set to fall, as large plant, particularly coal, closes. In its place, renewable generation increases in each possible future, but the level of generation varies between futures. This is described in greater detail in the sections below. Each scenario achieves varying levels of demand reduction through energy efficiency measures. This has an impact on the level of energy exported from the North. In the 'energy leader' future, the North is an exporter of clean energy; as an adopter it is energy self-sufficient; and as a drifter, it is an importer.

FIGURE 5.1

Energy generation and demand in the North differs in the three possible futures

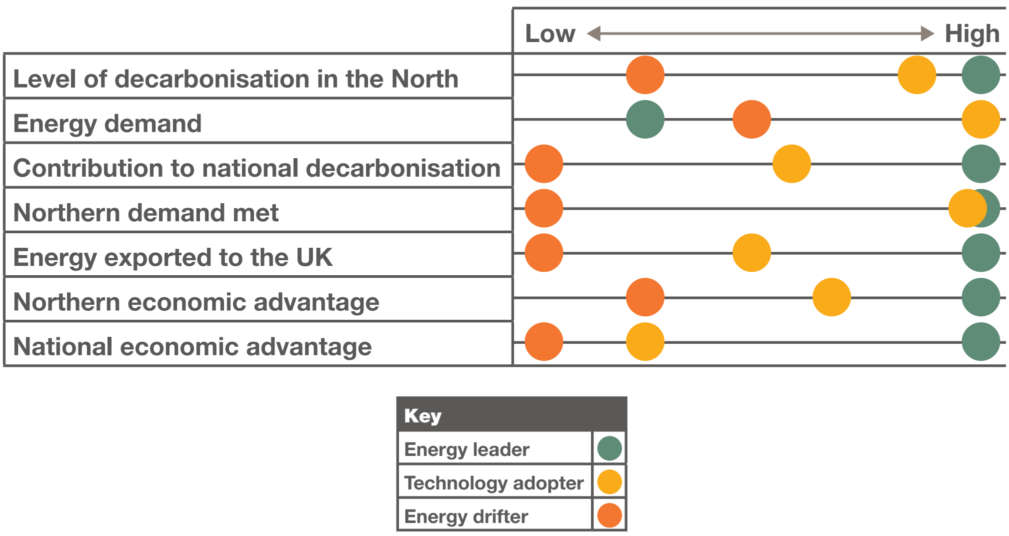
Illustrating the different trajectories for fossil fuel and for carbon generation and energy demand in different possible futures



Source: IPPR
Note: This graphic is illustrative only, no data is shown.

FIGURE 5.2

The contribution of different possible futures across various measurements



Source: IPPR

As shown in figure 5.2, the different approaches to the decarbonisation of heat lead to higher levels of energy demand, the highest being seen in the adopter scenario due to the electrification of heat. This similarly impacts on its ability, or lack of, to export energy to the rest of the UK.

The level of economic advantage also varies between the futures. Given the expansion of new technologies in the leader scenario, economic prosperity is high in both the North and nationally, whereas it is lower in the adopter scenario and lowest in the drifter scenario. Each of these scenarios will now be considered in detail in the rest of this chapter.

THE NORTH AS AN ENERGY LEADER

TABLE 5.1

The variables underpinning the North as an energy leader

Decarbonisation	Industrial strategy	Co-ordination	Finance
There is a strong drive from government to decarbonise the power supply and it is willing to be interventionist in its support	Support for innovative and scalable projects The maximisation of investment and UK content Job creation through energy efficiency and distributed generation at the local level	Pan-northern collaboration between industry, academic institutions, local government and civil society delivers the energy strategy.	Regional collaboration, strategic clarity and innovation leverages significant amounts of funding for energy projects

TABLE 5.2

The ingredients underpinning the North as an energy leader

5GW Nuclear 27.3GW Offshore wind 16GW Tidal	5353 GWhs of rooftop wind and solar energy	A large amount of the existing gas grid runs on hydrogen for heat

Overview

Underpinning this possible future is a clear and strong policy framework for decarbonisation. This is a strategy which would put in place sufficient continuity and support for existing generation, whilst supporting the development of new technologies. There would a high level of coordination at the regional level that would bring together economic assets and institutions to ensure the necessary energy infrastructure is in place. Policy certainty and business collaboration would ensure that there is sufficient funding and finance in place to develop innovative technologies and get them up and running, before exporting them overseas.

This drive and collaboration would provide the necessary ambition to deliver a significant project to decarbonise heat by converting the gas grid to run on hydrogen. This would be a national project, but one that would begin in the North.

Power would be decarbonised through the growth in renewables, nuclear and the application of CCS to gas plant. After 2030, gas plant would be decommissioned and new technologies brought onto distribution networks and the grid.

The development of large plant connected to the transmission network would be matched by support for renewables at the city level, and by 2050, a significant amount of rooftop solar and wind would have been connected to the distribution network in large cities and the roll out of energy efficiency measures.

Key milestones in delivering this future

2030

- By 2030, **three or four major northern cities would run on hydrogen**. Leeds would be the first to convert its gas grid and the appliances within its homes, followed shortly after by Hull, Newcastle and Teesside.
- **The North's offshore wind potential would be maximised**. Wind farms at Dogger Bank, Burbo Bank and Walney would be expanded, and Hornsea fully developed, bringing on shore large amounts of low carbon power.
- **A tidal lagoon is built in West Cumbria**. This would generate a large amount of dependable, clean energy.
- **Moorside power station in Cumbria would be consented and built by 2030**. It would be Europe's largest new nuclear power station (NuGen, 2010 and represent 3.4GW capacity.
- **A large roll-out of domestic and non-domestic energy efficiency measures would have been undertaken**.

2050

- By 2050, the whole of the North would be running on **100 per cent low carbon power** and heat and is exporting energy to the rest of the country.
- **Unabated gas plant would be phased out in the region.**
- The North's hydrogen economy would be booming. **Steam methane reformers, which produce hydrogen, would export the gas from Teesside and Hull**, as new manufacturing facilities are opened in the Liverpool region to keep pace with demand.
- **A new nuclear plant, a replacement for Hartlepool in the North East, would be constructed** and **cities would maximise their rooftop wind and solar potential**.

The necessary new infrastructure enabling this future

Moving to new sources of energy generation would require changes in how it is delivered to or used in homes. However, compared to other alternatives, converting the gas network requires relatively little infrastructure change. Work by Northern Gas Networks (2016) in assessing the feasibility of converting Leeds to run on hydrogen has shown that the existing gas pipes that supply homes and businesses can be converted. This avoids the need for a wholesale change in the way that heat is generated in or delivered to homes. The biggest form of intervention would come from converting appliances to run on hydrogen. While this is not easy, it is argued that it will require smaller amounts of disruption than that presented by alternative technologies, which, in some cases, will require significant alterations to customers' homes and the pipes that run underneath towns and cities (Northern Gas Networks (2016).

Northern Gas Networks (2016) estimate that converting the heat system to run on hydrogen across 80 per cent of the North would cost around £18.5 billion. This figure is broadly consistent with a national price tag estimated by KPMG at between £104 and £122 billion (KPMG 2016).

In order to deal with the carbon emitted in manufacturing hydrogen, CCS infrastructure would be constructed, overcoming the implicit financial and technological barriers. This takes the carbon and transports it to offshore, spent gas fields where it is stored, averting its release into the atmosphere. This would also allow other carbon emitters – namely resource intensive industries and gas power plants – to link into the systems and reduce their carbon emissions accordingly. This would drive significant benefit to the North's resource intensive industries, and reduce the carbon impact of extant gas plant. However, this does mean that the hydrogen conversion would be reliant on a technology which has not, as of yet, been implemented in the UK, adding a vulnerability to the project.

Managing a completely low carbon power system with a large amount of distributed generation would require the grid system to adapt and become 'smarter' (NIC 2016). The landscape analysis that proceeded this report (Baxter and Cox 2016) noted that the North has many of the research and development assets in the UK that are exploring this change. In this scenario, the North would become the nation's testbed for large-scale smart grid systems, adapting to this new infrastructure before other regions.

The costs of implementing a smarter grid system are harder to disaggregate to a regional level, but nationally it is estimated that between £23 billion (Easton and Byars 2012) and £32 billion (Owaineh et al 2015) would need to be spent between now and 2050 to implement this shift. Doing so should be cheaper than the alternative network reinforcements that would be necessary under the existing system (Owaineh et al 2015).

Economic opportunities for the North

If the 'energy leader' scenario is realised, the North will see an industrial renaissance in its energy sector, drawing together all three approaches to industrial strategy acknowledged in the previous section; support for innovative projects, the maximisation of UK content from generation, and job creation from energy efficiency and distributed generation delivery at the local level. Establishing home-grown technologies and industries will allow the region to have a 'first mover' advantage. Given that decarbonising heat is a major infrastructure challenge – recognised not just in the UK government, but also globally – this will give the region the opportunity to export technology, skills and knowledge globally. This will have the effect of the position the UK as a world leader in the energy sector.

Alongside creating new jobs, this plan would retain old ones. The landscape analysis of the Northern Energy Taskforce (Baxter and Cox 2017) noted that, since 2009, jobs in the northern energy sector have decline by 12 per cent. A key component of these are jobs lost to the gas industry, in transmission and offshore work (Baxter and Cox 2017). A hydrogen system would use much of the same assets and infrastructure as the existing gas networks, and so could re-purpose these skills. The ongoing nuclear decommissioning skill set in Cumbria – the birthplace of civil nuclear power – would continue to export its capability globally as international fleets reach end of life.

In the power sector, similar advantage would be felt in turning the region into a testbed for smart-grid technologies. As with the hydrogen conversion, this would be a necessary infrastructure change nationally and internationally, and position the region to export skills and technologies. Alongside this, the expansion of offshore wind and nuclear would add to the existing skills and job base in the region, creating new operations and management roles. As old sites reach re-fit stage, there would also be opportunities for innovation from northern companies.

At the local level, the push towards distributed generation would lead to the creation of large numbers of jobs in the installation and maintenance of solar panels and wind turbines. In the case of energy efficiency, this would create 20,400 jobs per year for 15 years (Matthews 2013).

THE NORTH AS A TECHNOLOGICAL ADOPTER

TABLE 5.3

The variables underpinning the North as an energy adopter

Decarbonisation	Industrial strategy	Co-ordination	Finance
Government is committed to meeting carbon emission reduction targets and sees itself as a 'rule setter'.	The maximisation of investment and UK content. Job creation through energy efficiency and distributed generation at the local level.	Energy projects are organised across the North but these are run locally, often by local authorities and LEPs.	Local actors adopt a 'fund chasing' approach.

TABLE 5.4

The ingredients underpinning the North as an energy adopter

22.5GW offshore wind 3.4GW Nuclear 2GW CCGT	1951GWhs of rooftop wind & solar energy	100% decarbonised heat. District heating in city centres, ground source heat pumps and bio gas elsewhere

Summary

Underpinning this possible future is a drive to meet the goal of decarbonising the energy supply, both at a national and regional level. A pan-northern approach is absent, and so most of the coordination of energy projects would be done at a local level, with local authorities and LEPs driving and supporting schemes. These local authorities would fund projects largely by 'chasing' funds as and when they become available. The industrial strategy approach adopted would be designed to encourage firms to locate plant in the region and to attempt to maximise UK content.

Rather than opting for one approach in the way that heat is decarbonised, heat would be reformed in several ways depending on the local context. In urban centres, district heating would be commonplace, whereas in suburban and rural areas it would be provided through electrification and the conversion of the gas grid to run on biogas.

Power would be largely decarbonised through the growth of new nuclear and renewables, but the region would retain some gas plant to keep up with the additional demand that electrifying elements of heat brings. This may utilise shale gas extracted in the north of England.

A number of cities would support the roll-out and adoption of distributed renewable generation, meaning that large numbers of households would have either roof mounted solar panels or small wind turbines, and there would be a high penetration of energy efficiency.

Key milestones in delivering this future

2030

- There would be progress towards decarbonising heat
  - The urban centres of major northern cities would have **joined-up commercial and municipal buildings to district heating** schemes.
  - Cities with existing schemes would expand outwards to take in wider areas, and **new build housing developments would increasingly have low carbon heating technologies as standard.**
  - Local residents who are able to pay would take up **electric solutions to heating**, particularly out of urban centres.
- **A large proportion of eligible houses would be retrofitted with insulation** and new technologies would be designed to reduce energy use and increase thermal efficiency.
- The region's offshore wind capacity would be maximised. Extensions would go ahead at Burbo Bank, and Walney and Hornsea would be fully developed.
- **Moorside nuclear plant in Cumbria would be built** and come live towards the end of the 2030s.

2050

- **By 2050, both power and heat supply in the region would be largely decarbonised.** A range of technologies would be used to heat homes, affected principally by the urban/suburban/rural

split. District heating schemes would become common features of urban areas.
  - Suburban, and particularly affluent, areas would be powered by electric solutions, such as ground source heat pumps.
  - In places, the gas grid would be converted to run on biogas, with rural areas producing much of this locally.
- **The region would meet its own demand with low carbon power** drawn from offshore wind and nuclear plant developed in the 2020s.
- **Some gas power plant would be retained** in order to meet the elevated demand brought about through the electrification of heat.

The necessary new infrastructure enabling this future

The move to a heating system that utilises a range of technologies would need a substantial change to heating infrastructure. Unlike the system that is common now, where gas is piped into the home and burned to produce heat and hot water in a boiler, heat or hot water would be pumped into the home. In all cases, this would require some change to the internal heating infrastructure of the home and the underground piping that takes the heat source into the home. The cost of implementing a system like this nationally is estimated at between £156–£188 billion (KPMG 2016).

Energy demand in this scenario would increase relative to where it is now given the electrification of heat. This would compound the need to ensure sufficient capacity to build new plant capable of keeping up with peak demand, which, in this scenario, is gas. It would therefore be the case that capacity mechanisms would seek the ensure not just new smart technologies, such as battery storage, but also traditional large plant. However, the need to manage demand, shifting peaks to accommodate the demand for heat, would require a smarter grid system like that in the 'energy leader' scenario. However, given the slower pace of the low carbon transition, these technologies could be adopted once commonplace elsewhere.

Economic opportunities for the North

In this future, the North would derive significant benefit from the decarbonisation of the energy supply. Sites of expanded generation, namely the Liverpool, the Humber and Cumbria, would expand local employment opportunities and supply chains associated with offshore wind and nuclear power. However, opportunities for exporting goods, services and knowledge would be low relative to the previous scenario. This would have a national advantage, but it would be limited in comparison to the leader future.

Delivering new heat technologies, rooftop solar and wind, and energy efficiency improvements would drive local employment. In the case of energy efficiency, this would 20,400 jobs per year for 15 years (Matthews 2013).

THE NORTH AS AN ENERGY DRIFTER

TABLE 5.5

The variables underpinning the North as an energy drifter

Decarbonisation	Industrial strategy	Co-ordination	Finance
The drive to decarbonise the energy supply is pursued weakly by government. Increasingly security supply and cost is prioritised	The maximisation of UK content	Co-ordination is non-existent or limited	Limited funding is available

TABLE 5.6

The ingredients underpinning the North as an energy drifter

1GW offshore wind 2GW CCGT	1,951GWhs of rooftop wind & solar energy	Slow progress on decarbonising heat

Overview

The lack of a clear framework or drive to decarbonisation, or any substantial regional coordination, would mean that the energy sector fails to maximise the opportunities presented by the North's geological, geographic and industrial assets. This would be compounded by mechanisms for financing and funding new technologies that are low in ambition and scope and insignificant to drive large infrastructure.

The region would continue to generate a significant amount of power from offshore wind, but its full capacity would not be realised, with investment not forthcoming for big opportunities. This would mean that gas-fired power stations built in the 2020s would represent the largest share of generation in 2050.

There would also be limited progress on decarbonising heat, and by 2050 most households would still be reliant on the traditional gas grid to heat their homes and businesses.

Key milestones in delivering this future

2030

- By 2030, progress on **decarbonising heat would be piecemeal**. The North **would continue to rely on natural gas** to meet the majority of its heating needs.
- The region would continue to have a **large amount of installed renewable capacity**, but other regions would take the lead in developing innovations.
- **Extensions would be built to the offshore wind sites at Burbo Bank and Walney**, but the full capacity of Hornsea would not be realised.
- **Some CCGT plant would be built in the 2020s.**
- A **small penetration of energy efficiency** measures would be achieved.

2050

- **By 2050, progress on heat would continue to be patchy with a limited and uncoordinated take up of new technologies**. This would mean that, with the exception of urban centres, the majority of heat would still be provided through the gas grid.
  - Some district heating schemes would be developed by local authorities, which would be typically small-scale and principally based on local centres.
  - There would be some adoption of electric heating technologies by highly motivated residents.
- The North would continue to have a **large share of the UK offshore wind** market.
- Some CCGT would be developed.

The necessary new infrastructure in enabling this future

The lack of new technologies to heat homes would mean that there is no need for a large-scale effort to change heating infrastructure. The gas grid would continue to operate as normal, and the need to manage intermittency would be a national rather than local problem, requiring the adoption of technologies as and when necessary. Infrastructure change would not be driven by the North, but rather imposed on it.

Economic opportunities for the North

This is a scenario marked not by the opportunities it would bring, but by those which would be lost. In this scenario, jobs would be retained in the offshore wind sector, and, as capacity grows, there would be some expansion in local supply chain opportunities.

6. TOWARDS AN ENERGY STRATEGY FOR THE NORTH

The Northern Energy Taskforce is committed to developing a strategy to ensure that the north of England becomes a global energy 'leader'. Developing the northern energy sector will drive national prosperity and energy security, economic prosperity, and will contribute heavily to decarbonising a large amount the energy supply. It will be businesses and other key stakeholder in the North that power the nation as it takes big strides to meet its targets for carbon reduction.

In order to achieve this situation, and based on the principles and broad parameters set out in this report, it is now necessary to move to develop a strategy and route map to achieve this goal. This strategy, which will be published in the autumn 2017, will consider a number of factors.

The role of national and international policy in setting the framework for decarbonisation and wider energy policy, and the need to manage the impact of Brexit on policy certainty

In order for the North to develop and deliver a Northern Energy Strategy, what is required from national and international actors will need to be considered. At a national level, this will most likely require the appropriate 'framework' for decarbonisation to be proposed. Internationally, as the UK withdraws from the European Union, a framework for the areas of energy policy areas which are re-patriated will need to be assured (DEI 2017).

The value-add opportunity the North creates in the context of devolution and the role of subnational institutions in implementing and delivering a Northern Energy Strategy

A Northern Energy Strategy will require appropriate institutions to deliver it. In the absence of pre-existing institutions at the pan-northern level capable of coordinating an energy strategy, it will be necessary to consider what this should look like. Considerations will need to be made as to the scale of the organisation, whether it should be a single institution or a partnership, whether it adapts or integrates existing institutions, and how it should be led and governed. A key point of this discussion should address which powers and policy levers can and should be devolved to regional and local levels in facilitating an energy strategy for the North.

The ways in which energy projects of different scales are best funded and financed

The availability of finance and funding will have a key impact on the ambition of a Northern Energy Strategy. The projects proposed in the different 'possible futures' vary in scale, from major infrastructure changes to local energy schemes. Financing mechanisms for each of these scales will need to be explored and proposed according to the different necessary scales.

Specific challenges relating to key 'ingredients' and technologies and how they will be implemented

Attention needs to be paid to the challenges specific to delivering individual 'key ingredients'. While it is important to consider the big picture, the economic potential of the northern energy sector requires all assets and opportunities coming together. In order to achieve this, the barriers need to be assessed, and strategies overcoming them developed.

The Northern Energy Taskforce will work to consider these areas and will present an energy strategy for the North in autumn 2017. This strategy will address these factors, drawing them together into a roadmap for the northern energy sector.

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ANNEX
DATA SOURCES FOR 'INGREDIENTS' SECTION

Data sources for table 3.1: The technology options for power transmission

Technology	Cost		Job creation	Potential capacity in the North (GW)	Carbon emissions
	2016	2030			
Coal with CCS	BEIS (2016c)		Blyth et al. (2014)	See table below*	Postnote 383 (2011)
CCGT					
CCGT with CCS					
Biomass conversion					
Nuclear					
Offshore wind					
Onshore wind					
Tidal	Poyry (2014)				
Smart grid systems	Heptonstall et al. (2017)				

***Data sources for potential power capacity in the North calculations**

Coal with CCS	Assume the continuation of 2016 levels
CCGT	Assume the continuation of 2016 levels
CCGT with CCS	
Biomass conversion	Based on current published conversion plans
Nuclear	Based on the completion of Moorside and the replacement of Hartlepool Nuclear power plant at the same capacity
Offshore wind	All published estimates for expansion and new sites
Onshore wind	no data

Data sources for table 3.2: The potential for distributed generation at the city level

Technology	Cost*		Job creation	Potential capacity in the North	Carbon emissions
	2016	2030			
Distributed solar & wind	BEIS (2016c)		Blyth et al. (2014)	Gooding (2016)**	Postnote 383 (2011)

** The analysis of Gooding (2016) refers to Leeds. This figure is used as a baseline which is applied for 10 other cities in the North of England after adjusted to relative amounts of dwelling stock. This creates a theoretical technical potential.

<table>
<tr><th colspan="5">Data sources for table 3.3: Potential options for decarbonising heat</th></tr>
<tr><th rowspan="2">Technology</th><th>Cost</th><th>Infrastructure disruption</th><th>Job creation</th><th>Carbon emissions</th></tr>
<tr><th>Total cost (£)</th><th></th><th>Total (UK)</th><th></th></tr>
<tr><td>Converting the gas grid to run on hydrogen</td><td colspan="2" rowspan="3">KPMG (2016)</td><td colspan="2" rowspan="3">KPMG (2017)</td></tr>
<tr><td>Mixed approach to heating, inc, district heating, electrification, bio/syn-gas</td></tr>
<tr><td>Electrifying domestic & commercial heating</td></tr>
</table>

Data sources for table 3.4: Shale gas				
Technology	Cost	Job creation	Capacity	Carbon emissions
Shale	BEIS (2016c)	Blyth et al. (2014)	Andrews (2013)	Postnote 374

<table>
<tr><th colspan="3">Data sources for table 3.5: Potential for energy efficiency measures</th></tr>
<tr><th>Technology</th><th>Number of homes</th><th>Jobs</th></tr>
<tr><td>Loft insulation</td><td colspan="2" rowspan="4">Matthews (2013)</td></tr>
<tr><td>Cavity wall insulation</td></tr>
<tr><td>Solid wall insulation</td></tr>
<tr><td>Improve the efficiency of heating systems</td></tr>
</table>