North Yorkshire & East Riding Local Enterprise Partnership

# A study on Low Carbon Value Chains and Economic Growth

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clarity from complexity

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# Authorisation and Version History

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| 2.0 | | Jon Stenning | Second draft incorporating Client comments |
| 3.0 | | Jon Stenning | Final draft with Executive Summary |

# Contents

# Executive Summary

The York, North Yorkshire and East Riding (YNYER) region of the UK is the location of many existing and planned low carbon energy assets, including Drax Power Station, the Allerton Park Waste Recovery Facility and the Humber Estuary. Furthermore, there is a substantial focus on developing bio-economy in the region, with ambitions to become a global leader in bio-renewables and bio-science, and to become a more circular economy.

While the YNYER region has many growing low carbon technology sectors, it is also one of the highest Greenhouse Gas (GHG) emitting regions in the UK. To meet UK targets for 2032, emissions in the YNYER region would need to fall by 33% from 2018 levels. An effective Local Energy Strategy is needed to ensure the region harnesses the potential of its low carbon assets, in order to meet emissions targets and to generate economic opportunities for residents. Low carbon sectors are expected to grow nationally at a faster pace than traditional economic sectors, and there is the potential for strong export opportunities. A thriving low carbon economy could therefore bring substantial growth in jobs and economic output to the YNYER region, and could help close productivity gaps between the region and other parts of the UK.

Presently, the YNYER Local Enterprise Partnership (LEP) has identified that the local area is not fully realising the low carbon opportunities that exist within YNYER and adjacent LEP areas. This study provides recommendations regarding the technologies that could offer the greatest potential to the YNYER region in terms of economic value, and makes suggestions of interventions that will be most effective at harnessing this potential.

Value chains have been identified for five technologies deemed to be priorities in the YNYER region, based on current and future prospects for deployment, cost effectiveness, policy incentives, local influence and potential economic value that could be accrued. The five technologies to prioritise in the region are: electric and plug-in hybrid vehicles, energy efficiency (fabric efficiency measures), anaerobic digestion, heat pumps and biomass for heat.

The key components and activities of the value chains for each of the five prioritised low carbon technologies have been identified, and the current and potential future economic value of each stage of each value chain determined. Value chains consist of economic activities that add value at each stage of the production of a technology. The value chain may begin at the research and development phase and end at the manufacture of a finished product or the maintenance and operation of a technology. Many individual sectors may feed in to the finished product or service, and this study determines what these sectors are, and how much economic value they bring to the YNYER region in terms of jobs and gross value added (GVA).

The complete value chain associated with insulation and fabric measures provided the greatest GVA and employment to the YNYER region in 2017, followed by activities related to electric and plug-in hybrid vehicles. In 2030, projections indicate that GVA generated by the heat pump value chain will be of most value to the YNYER region, and GVA associated with the electric vehicles and plug-in hybrids value chain is also expected to experience rapid growth. Similarly, employment in the heat pump and electric vehicles value chains is expected to be higher than in any of the other technology value chains in 2030. Focusing policy efforts, whether monetary or non-monetary interventions, in these technologies with the highest future potential will aid the YNYER region in gaining value for money and maximising the economic impact of low-carbon technologies in the region.

The potential opportunities and challenges specific to the prioritised low carbon technologies in the YNYER region have been identified, and based on these characteristics, recommendations for possible interventions needed to create or improve value within each technology value chain have been investigated. Various cross cutting policy recommendations were made, which were relevant to all the prioritised low carbon technologies. The key cross-cutting policy recommendations are:

- Campaigning for greater local policy powers, to be able to target investment and other interventions according to the characteristics of the local low-carbon sectors, recognising local differences in energy and environmental issues faced.
- Collaborating with the national government to shape policy at a national, as well as local, level in such a way that the climate and economic goals of the YNYER region are better facilitated.
- Designing policy to both facilitate R&D and to create incentives for private investors to support innovation and bring new low-carbon technologies to the marketplace, or increase uptake of these technologies, addressing financial barriers to uptake.
- Ensuring local workers are equipped with the right mix of skills and qualifications to carry out new and changing jobs.
- Creating and coordinating forums that connect workers, employers and investors, as well as promoting collaboration between local industries and research institutions, increasing the likelihood that the low carbon technologies become more commercially-viable and technology awareness and uptake rates are increased.
- Supporting and investing in community energy projects.

Technology-specific policy recommendations have also been researched. In many cases these build on the cross-cutting recommendations outlined above, incorporating more specific characteristics of the opportunities and challenges faced by the low carbon technology in question. Other policy recommendations focus on specific stages of the value chain that are deemed to have the greatest economic potential for the YNYER region in future. Key recommendations, specific to each technology, include:

**Electric and plug-in hybrid vehicles**

- Focus policy efforts on increasing the electric charging infrastructure in the region, to increase the likelihood of increased EV take-up
- Both the installation of charging points, and the manufacture of charging point and vehicle components, will require relatively specialised skills. It is essential to ensure that there are suitably-skilled workers to fill these posts as they arise.

**Energy efficiency measures**

- Community energy efficiency projects may also contribute to raising local awareness of the benefits of energy efficiency and to connecting households and businesses with local suppliers.
- YNYER LEP should press the Government to ensure energy efficiency funding schemes remain in place, and that the design of any new or replacement version of energy efficiency funds are open to as many households as possible.

**Anaerobic digestion**

- Support the development of a stronger supply of feedstocks. To promote the development of a more sustainable industry, additional feedstock pathways are required.
- YNYER LEP could replicate localised or specific funds, used in other regions of the UK, to provide financial assistance to AD projects in the region.

**Heat pumps**

- Putting in place emissions standards on heating systems in new builds or when heating systems are replaced could be a straightforward policy the YNYER LEP could utilise to support the uptake of heat pump technology in the region.
- There are various barriers to uptake of heat pumps, many of which can be addressed by local interventions. Increasing awareness of what heat pumps are and what they can achieve in terms of emissions reductions and energy cost savings, and connecting individuals with local suppliers and financiers can be aided through a 'one stop shop' scheme supported by the LEP.

**Biomass for heat**

- Financial barriers to increased uptake of biomass for heat and heat pumps could be overcome by encouraging community heat networks. YNYER LEP could assist with these kinds of community projects through providing financial assistance, or by connecting businesses and households with suppliers and investors.Better quality standards to raise efficiency and the attractiveness of biomass for heat is required, this is likely to come from central Government.
- YNYER LEP should help support the development of a local biomass fuel supply industry and connecting suppliers with customers.

The conclusions of this study aim to provide YNYER LEP with a better understanding of existing low carbon value chains in the region. The policy recommendations made allow the LEP to carry out better-informed interventions in relevant sectors, reducing GHG emissions in the region in line with national targets, whilst at the same time maximising economic growth and employment opportunities.

# 1 Introduction

## 1.1 The objectives and scope of the study

The UK energy sector faces a substantial challenge, as the UK government seeks to completely decouple economic growth from emissions of greenhouse gases (GHG), while at the same time ensuring that the supply of energy remains stable and affordable for UK households and businesses. The 2008 Climate Change Act commits the UK government by law to reducing GHG emissions by at least 80% of 1990 levels by 2050, with legally-binding carbon budgets providing interim targets to reach the 2050 target. At the same time the UK is committed to decarbonising its economy in line with its nationally determined contributions (NDCs) to the Paris Agreement, which seeks to limit global temperature increases to 2°C above pre-industrial levels in 2050.

*Local Energy Strategy*

The Government's Clean Growth Strategy proposes pathways for decarbonising all sectors of the UK economy through the 2020s and for meeting climate change obligations, while at the same time stimulating economic growth and job creation. However, it is recognised that there are various barriers at a local level to meeting UK-wide emissions targets, such as limited project development capacity and capability amongst local authority and LEP teams and a lack of capital for the initial stages of project development (UK100, 2017).

In light of these challenges, in 2017, the department for Business, Energy and Industrial Strategy (BEIS) invited Local Enterprise Partnerships (LEPs) to produce individual Local Energy Strategies. The York, North Yorkshire & East Riding (YNYER) LEP successfully secured funding to develop its energy strategy, to describe how the region will move towards a low carbon future while increasing economic growth and employment opportunities, in line with YNYER LEP's Strategic Economic Plans. Due to be finalised in early 2019, it will be used by the LEP and associated stakeholders to aid decision making on investment approaches and work packages.

*The YNYER region*

Many existing and planned low carbon energy assets are located within the YNYER region, including Drax Power Station, the Allerton Park Waste Recovery Facility and the Humber Estuary, which is the location of a large proportion of the UK's offshore wind industry. Furthermore, there is a substantial focus on developing bio-economy in the region, with ambitions to become a global leader in bio-renewables and bio-science. The region aims to become a more circular economy[1], in which household, agricultural and industrial waste is reduced through recycling and remanufacturing, and bio-economy activities will be an important part of this process.

Developing the low carbon economy in the YNYER region is expected to have additional benefits beyond environmental impacts through waste and emission reductions. Prioritising investment and intervention in the low carbon economy can also bring various economic benefits to the area, particularly as low carbon sectors are expected to grow nationally at a faster pace than traditional

[1] A circular economy can be defined as an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (WRAP, undated).

economic sectors, and there is the potential for strong export opportunities. A thriving low carbon economy could bring substantial growth in jobs and economic output to the YNYER region, and as such could help close productivity gaps between the region and other parts of the UK.

While the YNYER region has many growing low carbon technology sectors, it is also one of the highest GHG emitting regions in the UK. To meet UK targets set for 2032, emissions in the YNYER region would need to fall by 33% from 2018 levels. An effective Local Energy Strategy is needed to ensure the region harnesses the potential of its low carbon assets, in order to meet emissions targets and generate economic opportunities.

*Previously commissioned research*

The YNYER LEP has previously commissioned three studies to help inform its Local Energy Strategy.

Carbon Trust (2017) provided an overview of the different technologies that could play a role in a future energy system in the Leeds City region and YNYER region. The report shortlisted eighteen technologies to be taken forward to further assessment, based on the findings of a literature review and stakeholder interviews. The study then used a number of scoring criteria and weightings to rank the eighteen low carbon technologies to determine which could play the most significant role in future energy systems in the region.

Energy Baseline Report (2017) describes the current and future demand for energy in the Leeds City Region, Sheffield City Region and the YNYER LEP areas, while also considering the economic contribution the energy sector will make in these areas.

University of Leeds (undated) provides an assessment of the overall significance of energy and carbon within the YNYER LEP region, assessing how the characteristics of the region fit with national trends and policy commitments. The report evaluates the current and future spatial and sectoral composition of energy use and carbon emissions within the area. Based on an options appraisal, the report includes a list of prioritised cost and carbon effective options within the domestic, commercial, industrial, transport and waste sectors.

Through this stream of work the YNYER LEP has identified that the local area is not fully realising the low carbon opportunities that exist within YNYER and adjacent LEP areas. The present study seeks to provide recommendations regarding the technologies that could offer the greatest potential to the YNYER region in terms of economic value, and make suggestions of interventions that will be most effective at harnessing this potential. It is recognised that from the three previously commissioned studies it is difficult to obtain a coherent picture of the region's low carbon activities and future potential. The present study begins by building on this previous research and aims to provide a more comprehensive analysis of the low carbon opportunities and challenges present in the region, and provide policy recommendations to reflect these issues.

*Aims and objectives of the present study*

The overall aim of the present study is to increase the understanding of the low carbon value chains that exist in the YNYER region. Low carbon value chains consist of economic activities that add value at each stage of the production of a low carbon technology. The value chain may begin at the research and development phase of a technology and end at the manufacture of a finished product or the maintenance and operation of a technology. Many individual sectors may feed in to the finished product or service, and this study determines what these sectors are, and how much economic value they bring to the area in terms of jobs and gross value added (GVA). Value chains were identified for five technologies deemed to be priorities in the YNYER region, based on current and future prospects for deployment, cost effectiveness, policy incentives, local influence and potential economic value that could be accrued.

A better understanding of the value chains that exist for the prioritised low carbon technologies allows the YNYER LEP to carry out better-informed interventions in relevant sectors and to reduce GHG emissions in the region in line with national targets, whilst at the same time maximising economic growth and employment opportunities.

## 1.2 Overview of the approach to the study

In this chapter we provide an overview of the approach used to conduct this study, and the specific aims and objectives of each part of the study. More detailed descriptions of the methodology used are described in following chapters.

The study was broken down in to two main tasks:

Part 1: Short listing of significant low carbon technologies and energy options in the YNYER LEP area.

Part 2: Low carbon energy value chain assessment.

The two parts of the study were carried out sequentially, with the outcomes from Part 1 feeding in to Part 2.

*Part 1: Shortlisting of low carbon technologies*

Part 1 of the study analysed a range of low carbon technologies to determine which are most suitable for future development in the YNYER region. Starting from a list compiled for a previous study (Carbon Trust, December 2017), twelve technologies were assessed on a range of metrics covering the potential for roll-out and carbon abatement, local influence on deployment, cost-effectiveness and local value accrual. Five technologies which scored well across these measures were selected for the value chain analysis in Part 2.

*Part 2: Value chain assessment*

Part 2 of the study aimed to assess the value chains associated with the five prioritised technologies identified in Part 1. Specifically, Part 2 of this study was broken down in to various subtasks, carried out sequentially:

1. First, the key components and activities of the value chains for each of the five prioritised low carbon technologies were established.
2. Second, the current and potential future economic value of each stage of each value chain, in terms of jobs and GVA, was determined.
3. Finally, Part 2 of the study identified potential opportunities and challenges specific to the prioritised low carbon technologies in the YNYER region, and provided recommendations for possible interventions needed to create or improve value within each technology value chain.

The rest of this report describes the methodology and findings of the study in more detail.

# 2 Shortlisting of low carbon technologies in the LEP area

This Chapter describes the approach and results of Part 1 of the study; the shortlisting of low carbon technologies. The objective of Part 1 was to produce a list of five low carbon technologies relevant to York, Norther Yorkshire & East Riding (YNYER) for further analysis in subsequent tasks.

## 2.1 Method

The technology appraisal completed for the Leeds City Region and the York, North Yorkshire, and East Riding Local Enterprise Partnerships by the Carbon Trust was taken as the starting point for the present study (Carbon Trust, December 2017). The Carbon Trust performed a high-level analysis of technologies that could be deployed within the YNYER region and produced the longlist presented in Table 2.1. The various solutions were ranked based upon ten qualitative assessment criteria.

**Table 2.1 Technologies considered in the Carbon Trust's Energy Technology Appraisal[2]**

| Technology | Category | Carbon Trust Rank |
|---|---|---|
| Energy efficiency | Electricity, Heat | 1 |
| Offshore wind | Electricity | 2 |
| Electric and plug in hybrid vehicles | Transport | 3 |
| DSR | Smart grid | 4 |
| Renewable heat | Heat | 5 |
| Solar PV | Electricity | 6= |
| Hydrogen | Heat | 6= |
| Heat networks | Heat | 6= |
| CCS | Electricity, Heat | 9= |
| Energy storage | Smart grid | 9= |
| Anaerobic digestion | Electricity, Heat | 11 |
| Biomass | Electricity, Heat | 12 |
| Efficiency of the transport network | Transport | 13 |
| Hydropower | Electricity | 14 |
| Onshore wind | Electricity | 15 |
| Gas CCGT | Electricity | 16 |
| Hydrogen for transport | Transport | 17 |
| Energy from waste | Electricity | 18 |

[2] Carbon Trust, December 2017

An initial down-selection was performed on the basis of the Carbon Trust categorisation and rankings shown in Table 2.1. The technologies were first grouped into categories. The six technologies which received the lowest ranking were eliminated and the top twelve technologies were retained for further analysis.

Table 2.2 presents the technologies that were retained for further research on their potential within the YNYER region.

**Table 2.2 Technologies selected for region-specific research and analysis**

| Technology | Category | Carbon Trust Rank |
|---|---|---|
| Energy efficiency | Electricity, Heat | 1 |
| CCS | Electricity, Heat | 9= |
| Anaerobic digestion | Electricity, Heat | 11 |
| Biomass | Electricity, Heat | 12 |
| Offshore wind | Electricity | 2 |
| Solar PV | Electricity | 6= |
| Heat pumps | Heat | 5 |
| Hydrogen | Heat | 6= |
| Heat networks | Heat | 6= |
| DSR | Smart grid | 4 |
| Energy storage | Smart grid | 9= |
| Electric and plug in hybrid vehicles | Transport | 3 |

In the second down-selection stage, each technology was assessed against the following criteria as they relate to the YNYER region:

**Current level of deployment**

The best available data on the level of deployment of each technology within YNYER was compared to national deployment data to identify which systems are already deployed at a level above the national average in the region.

**Deployment potential**

The regional deployment potential of each technology was estimated based on industry and government projections, suitable characteristics of the region and/or the local economy, and the suitable stock within the region (of dwellings, commercial premises, and vehicles). The timeframe of future system deployment was also considered, with technologies likely to be deployed before 2030 rated more highly than those with longer-term deployment timeframes. This assessment included the potential to reduce carbon emissions in the YNYER region.

**Cost-effectiveness and policy incentives**

The cost-effectiveness of the various technologies to end-users within the YNYER region was assessed by comparing the feasible alternatives to each low carbon technology. This assessment included existing policy incentives such as programmes supporting deployment, subsidy payments, and tax breaks for end-users.

**Local influence**

The ability of the YNYER LEP and local government to influence the level of deployment of each technology was considered. Those that require significant national-scale infrastructure are less likely to be influenced by local and regional promotion.

**Local value accrual**

A first assessment of the location of value accrual from each system was included in the down-selection process. Technologies which generate further local economic activity, typically via local vendors and installers, are rated more highly than those which can be manufactured and delivered from outside the region without local involvement.

**Related technologies and associated benefits**

Synergies with other low carbon technologies and related benefits, including improvement in air quality and fuel poverty reduction are also noted, although these are not used for the final down-selection.

Each technology was awarded a relevance rating of High (3), Medium (2) or Low (1) against the above criteria. The five technologies with the highest rating (with equal weighting of the above criteria) were identified to take forward in the rest of the study. These are shown in Table 2.3.

The following sections detail the five selected technologies and their applicability to the YNYER region based on the criteria explained above. Further information on the technologies not selected for Part 2 of the study is provided in Appendix A.

**Table 2.3 Technologies selected for analysis in Part 2.**

| Technology | Category |
|---|---|
| Electric and plug in hybrid vehicles | Transport |
| Energy efficiency | Electricity, Heat |
| Anaerobic digestion | Electricity, Heat |
| Heat pumps | Heat |
| Biomass for heat | Heat |

## 2.2 Electric and plug-in hybrid vehicles

**Current and potential deployment – High**

In the present study, the focus is on electric and plug-in hybrid passenger vehicles for personal use. As shown in Table 2.4, there are currently around 515,000 personal vehicles registered in the region, of which around 2,000 are plug-in hybrids or full-electric vehicles (DfT, 2018). However, all vehicles could eventually be either plug-in hybrids or full-electric vehicles. The carbon abatement potential has been estimated using the existing mix of fuel types, assuming an average mileage of 15,000 km per year. In our estimate, 90% of the total regional mileage is covered by pure electric vehicles and by hybrids operating in electric mode, with the remaining 10% covered by hybrids running on petrol/diesel.

**Table 2.4 Deployment and carbon abatement potential of electric and plug-in hybrid vehicles**

| | Current | Technical potential |
|---|---|---|
| Deployment – vehicles | 2,000 | > 500,000 |
| Carbon abatement | 5 kt $CO_2$/year | 1.1 Mt $CO_2$/year |

**Local influence – High**

A dedicated vehicle charger will typically be installed for each electric and plug-in vehicle with an off-street parking space with convenient access to electricity. Around 80% of vehicles in YNYER fall into this category (DfT, 2018). Vehicle owners without access to off-street parking will be reluctant to purchase plug-in vehicles unless an on-street charging solution is available. The availability of fast and rapid chargers along routes and at destinations will also encourage the uptake of electric and hybrid vehicles. Local government involvement will likely be required to coordinate the installation of sufficient chargers in appropriate locations, especially in less populous areas which private companies may not prioritise.

**Local value accrual – High**

Although few to no vehicles are manufactured within the region, the installation of charge points and their maintenance will likely lead to a substantial requirement for local skilled labour. In addition to carbon abatement, the uptake of plug-in vehicles will improve regional air quality, and is likely to facilitate the deployment of “smart grid” technologies that will increase the resilience of the electricity grid; these include demand side response in vehicle charging and distributed energy storage through vehicle-to-grid applications.

**Cost-effectiveness and policy – High**

Pure electric vehicles are expected to reach lifetime cost parity with petrol vehicles by 2020, with upfront cost parity likely around 2025 (Element Energy for BEUC, 2016). New electric and hybrid vehicles with an electric range of at least 112 km are currently eligible for a Plug-in Car Grant worth up to £3,500, while vehicles with an electric range of 16 km are eligible for a grant of £500 towards the cost of installing a home vehicle charger (HM Government, 2018).

## 2.3 Energy efficiency (insulation and fabric measures)

**Current and potential deployment – High**

Improvements to the fabric of domestic dwellings have been selected as the focus for this opportunity. These measures include cavity wall insulation, insulation for solid wall dwellings, and loft insulation, which reduce energy consumed for space heating regardless of the heating technology used. Table 2.5 presents the current and potential deployment of and the resulting carbon abatement from dwelling fabric efficiency improvements (MHCLG, 2015-16; BEIS, 2017). Of the 510,000 dwellings within the region, 380,000 have EPC ratings worse than Band C. Upgrading these to at least B and C, with the current home heating fuel mix, would eliminate 1.7 TWh of energy used for heating each year, and lead to a reduction of 0.33 Mt $CO_2$ per annum.

**Table 2.5 Deployment and carbon abatement potential of domestic energy efficiency measures**

| | Current | Technical potential |
|---|---|---|
| Deployment – insulated cavity walls | 255,000 | 340,000 |
| Deployment – insulated solid walls | 15,000 | 160,000 |
| Deployment – loft insulation | 380,000 | 465,000 |
| Carbon abatement | -- | 0.33 Mt $CO_2$/year |

**Cost effectiveness and policy – High**

The payback time for the measures considered can be as low as five years (Energy Saving Trust, 2018), but consumers are slow to adopt these without external support and/or advice. There are several national schemes available supporting the installation of efficiency measures including the ECO, Green Deal, Central Heating Fund, and National Grid's Warm Homes Fund.

**Local influence – High**

Local programmes have an important role in raising awareness of, and facilitating engagement with, these national schemes. Local government is also well-placed to target eligible households, particularly fuel poor households and other vulnerable groups. For example, Better Homes Yorkshire is a joint programme from the West Yorkshire Combined Authority and the Leeds City Region LEP (Better Homes Yorkshire, 2018) that connects homeowners, tenants and landlords with installers of energy efficiency measures.

**Local value accrual – High**

The installation of dwelling fabric efficiency measures is employment intensive, with the majority of the final cost going towards labour rather than materials. Local skilled labour is required to specify and install the systems in individual dwellings. Dwelling efficiency improvements have ancillary benefits which affect public health, such as reductions in fuel poverty and chronic under-heating. High efficiency buildings are more suitable for the installation of heat pumps and other low carbon heating systems.

## 2.4 Anaerobic digestion

**Current deployment – High**

Anaerobic digestion (AD) produces methane-rich biogas from the breakdown of organic materials including farm and food wastes. The biogas can then be combusted to produce electricity and heat or upgraded to biomethane and injected into the natural gas grid. A by-product of AD is digestate, a nutrient-rich substance that can be used as fertiliser. YNYER is already a hotspot for AD, with over 6% of the national capacity currently operating within the region (compared with a regional population less than 2% of the UK's total).

**Potential deployment – High**

The current and potential levels of deployment are shown in Table 2.6. Values are shown for both the AD system capacity (MW) and the production of suitable feedstocks (GWh/year). The data on current deployment of AD is taken from published sources (NNFCC for DEFRA and DECC, 2018). The potential AD capacity has been determined from the availability of feedstocks, including municipal food waste, industrial wastes from bakeries and other food production, agricultural residues such as slurries, and crops grown specifically for AD. The availability of these has been estimated from several previous studies (AECOM for Local Government Yorkshire and Humber, 2011; Anthesis for BioVale & York University, 2018) and the 2016 DEFRA pollution inventory (DEFRA, 2018). The estimated availability is consistent with the NFU's goal to approximately double the number of AD plants by around 2020 (NFU, 2016). The carbon abatement has been calculated from the avoided use of natural gas for electricity and heating.

**Table 2.6 Deployment and carbon abatement potential of anaerobic digestion**

| | Current | Technical potential |
|---|---|---|
| MW biogas capacity | 105 | 250 |
| GWh/year feedstock | 800 | 2,000 |
| Carbon abatement | 0.1 Mt $CO_2$/year | 0.25 Mt $CO_2$/year |

**Cost effectiveness and policy – High**

There are several national incentives for AD currently available. The Renewable Heat Incentive (RHI) supports biomethane injection to the gas grid while the Renewable Transport Fuel Obligation (RTFO) supports the use of biomethane for transport. Electricity produced from biogas can receive support under the Feed-in Tariff scheme. These programmes, in addition to sales (or self-use) of digestate and gate fees for the disposal of unwanted wastes, contribute to a typical payback time of eight to twelve years for AD plants, making them viable for commercial investment (National Energy Foundation, 2013).

**Local influence – High**

Local government assistance may be needed to assist with access finance and the development of cooperative programmes for farms and businesses which are too small to supply and operate their own AD facilities. Efforts to increase awareness of AD and existing AD support programmes will also facilitate increased uptake within the region.

**Local value accrual – High**

AD plants are often installed by locally-owned farms and community energy schemes (Anthesis for BioVale & York University, 2018; NFU, 2016), and provide further benefits to the area by disposing of unwanted wastes and creating a source of fertiliser. The region hosts the University of York's Biorenewables Development Centre, which may contribute to the development of new technologies for export out of the region. The uptake of AD contributes to the circular economy and could support distributed energy production through heat networks.

## 2.5 Heat pumps

The present study considers renewable heat from both air- and ground-source heat pumps. Table 2.7 presents the current and potential future deployment of both types of heat pumps. For domestic heat pumps, the number of dwellings with heat pumps installed is presented, as these will be relatively consistent in size. The capacity, rather than the number, of installations of non-domestic heat pumps is reported because a wide size range will be required for different types of non-domestic premises.

**Current and potential deployment – High**

The current level of deployment of heat pumps in YNYER is around three times the national average (BEIS, 2018). This is likely related to the high fraction of off-gas buildings within the region (BEIS and ONS, 2018); around 21% of dwellings do not have gas connections compared with 14% in England as a whole. Future deployment is therefore likely to continue at rates above the national average. The technical potential level of deployment shown in Table 2.7 includes 90% of off-gas and 70% of on-gas dwellings and non-domestic premises.

**Table 2.7 Deployment and carbon abatement potential of heat pumps**

| | Current | Technical potential |
|---|---|---|
| Domestic heat pumps (#) | 2,200 | 370,000 |
| Non-domestic heat pump capacity (MW) | 7 | 2,000 |
| Carbon abatement | 10 kt $CO_2$/year | 2.1 Mt $CO_2$/year |

**Cost effectiveness and policy – High**

Financial support for both air- and ground-source heat pumps is available under the domestic and non-domestic RHI programmes. The current scheme aims to provide end-users with equal or lower lifetime heating costs than with the counterfactual fossil fuel, and will continue until 2021.

**Local influence – High**

Although historically local governments have not been significantly involved with heat pump deployment, local programmes increasing awareness and streamlining the purchasing process are likely to increase uptake, as with energy efficiency measures. Home- and building owners are generally slow to adopt new types of systems which are unfamiliar and require significant upfront investment. A scheme led by a trusted and neutral third-party organisation that brings together suppliers, installers, finance, and external funding for vulnerable groups may reduce the perceived risk in heat pump installations.

**Local value accrual – High**

Although heat pumps are not manufactured within the region, local skilled labour will be required to specify and install the heat pumps into individual dwellings. Heat pumps installation includes both electrical and plumbing trades, and ground-source heat pumps additionally require external construction work (trenching or borehole drilling). The Microgeneration Certification Scheme (MCS) database currently lists 446 certified heat pump installers in the wider Yorkshire and Humber region (MCS, 2018). Heat pumps require a high level of building fabric efficiency in the buildings in which they are installed, and have synergies with solar PV and energy storage installations. They can also improve air quality, especially when replacing solid fuel boilers.

## 2.6 Biomass for heat

**Current and potential deployment – High**

Biomass was included in the original shortlist as a single entry, but for the present study has been divided into biomass for electricity and biomass for heat. Only biomass for heat has been selected for further analysis. This category includes the installation of domestic and non-domestic biomass boilers as well as the production of biomass feedstock for use within YNYER and for export. As with heat pumps, the uptake of biomass boilers in the region is around three times higher than the national average. The current (BEIS, 2018) and potential deployment levels of biomass boilers are shown in Table 2.8. The technical potential for future system deployment includes 90% of off-gas buildings (both domestic and non-domestic) as well as 50% of on-gas non-domestic buildings located in rural areas (DEFRA, 2009), which is equivalent to 30% of all on-gas non-domestic buildings.

Table 2.8 also presents the current production of biomass feedstock (DEFRA, 2015) and the future deployment potential. These values include only production from energy crops; managed woodlands and use of waste woods contribute to biomass feedstock as well but are likely to make up less than 20% of the future UK biomass market (Anthesis and E4Tech for Cadent Gas, 2017). It has been assumed that 5% of the region's arable land may be dedicated to miscanthus in future, with a further 2% dedicated to short rotation coppiced willow. This results in a technical potential for the production of 1,100 GWh/year. An earlier study including wood sources and more ambitious assumptions around the availability of arable land estimated the regional biomass potential at 5,200 TWh/year (AECOM for Local Government Yorkshire and Humber, 2011). The current study used the more conservative estimate.

**Table 2.8 Deployment and carbon abatement potential of biomass boilers**

| | Current | Technical potential |
|---|---|---|
| Domestic biomass boilers (#) | 750 | 100,000 |
| Non-domestic biomass boiler capacity (MW) | 230 | 1,100 |
| Carbon abatement | 10 kt $CO_2$/year | 0.8 Mt $CO_2$/year |
| GWh/year biomass feedstock | 40 | 1,100 |
| Carbon abatement | 10 kt $CO_2$/year | 0.3 Mt $CO_2$/year |

**Cost effectiveness and policy – High**

Financial support for biomass boilers is available under the domestic and non-domestic Renewable Heat Incentive (RHI) programmes. The current scheme aims to provide end-users with equal or lower lifetime heating costs than with the counterfactual fossil fuel, and will continue until 2021.

**Local influence – High**

Local programmes increasing awareness and streamlining the purchasing process are likely to increase uptake, particularly for domestic systems. A scheme led by a trusted and neutral third-party organisation that brings together suppliers, installers, finance, and external funding for vulnerable groups may facilitate further installations. Support for farmers to transition to energy crops will be necessary to further develop feedstock production in the region. Short rotation coppiced willow, for example, requires several seasons' growth before it can be harvested, putting farmers at risk if a future market is not assured. Close consultation with farmers and project developers will be important to ensure the development of a stable market; this could be facilitated by the YNYER LEP. Schemes connecting farmers with local end-users and facilitating pellet production may help to de-risk investment in biomass production.

**Local value accrual – High**

Although few to no biomass boilers are manufactured within the region, local skilled labour will be required to specify and install the systems into individual dwellings. The Microgeneration Certification Scheme (MCS) database currently lists 174 certified heat pump installers in the wider Yorkshire and Humber region (MCS, 2018). Biomass installations benefit from fabric efficiency improvements; to receive RHI funding, loft and cavity wall insulation must be installed in domestic dwellings where these are suitable (unless the building is listed). Air quality implications and competition with food production should be considered as biomass for heat is promoted.

## 2.7 Further low carbon energy projects for the YNYER region

The sections above describe the evidence-based approach that was used to derive a shortlist of low carbon energy technologies deemed to have a strong potential to generate substantial value to the YNYER region. The selection of these five technologies does not mean, however, that other technologies and projects do not have the potential to generate substantial value in the region and bring many of the other environmental and economic benefits of the shortlisted technologies. Further information on the potential for deployment of the other technologies not shortlisted, and the benefits this could bring, is provided in Appendix A.

Two of the low carbon technologies that were not shortlisted, but were deemed of high relevance to the YNYER region given specific local factors, are worth describing further here. These are:

- Carbon capture, utilisation, and storage (CCUS)
- Energy storage to support deployment of offshore wind

**Carbon capture and storage**

The 2017 Clean Growth Strategy (BEIS, 2017) recognises that CCUS has an important role to play in reducing the UK's carbon emissions. CCUS offers a decarbonisation route for sectors with few other options (e.g. cement, chemicals, and steel production). The CCC has noted CCUS and other greenhouse gas removal (GGR) technologies will be needed to off-set emissions from industries where decarbonisation is most challenging and allow the UK to become carbon neutral (CCC, 2016). The UK will need to sequester between 60 and 180 $MtCO_2$ annually by 2050 (CCC, 2018). The Clean Growth Strategy dedicates £100 million from the BEIS Energy Innovation Programme to support CCUS innovation and deployment in the UK, including £20 million for a CCUS demonstration project.

The Clean Growth Strategy also called for the establishment of the CCUS Cost Challenge Taskforce, who produced their first report in July 2018 laying out a series of concrete steps for the staged development of the UK CCUS industry (CCUS Cost Challenge Taskforce , 2018). The Taskforce recommends that CCUS is first developed in areas where relevant businesses are tightly concentrated, and that projects within two such "clusters" should be operational by the mid-2020s. Humberside is one of five potential clusters mentioned, and Drax Power Station is a key asset within the cluster.

Drax Power Station is currently running a £400,000 bioenergy carbon capture and storage (BECCS) trial in collaboration with Leeds-based CCUS start up C-Capture (Drax, 2018). The CCUS system was commissioned in November 2018 and will operate for six months with the target of capturing 1 tonne $CO_2$

each day. If this system was deployed across all of Drax's biomass power production, 6 Mt $CO_2$ would be abated each year. This rises to 19 Mt $CO_2$ if 100% of Drax's power output was produced using BECCS. The CCC has recommended that 10 Mt$CO_2$ should be sequestered each year by 2030, rising to 20 Mt$CO_2$ by 2035 (CCC, 2018). A BECCS project at Drax would make a significant contribution to these targets.

Additionally, there are a number of saline aquifers and depleted hydrocarbon fields off the coast of East Yorkshire that may be suitable for long term carbon storage and are an important component of the Humberside CCUS cluster. A front-end engineering design study was previously completed for The White Rose project, which aimed to deliver captured $CO_2$ from a proposed new power plant adjacent to Drax to the Endeavour saline aquifer near Bridlington. This project was a frontrunner in the £1 billion CCS Competition organised by the government in 2013-15, but did not go ahead when the competition was cancelled (UK CCS Research Centre, 2015).

The YNYER region is well-placed to host CCUS projects within the coming decades. These projects depend on the decisions of national policy-makers, but it is vital for local government organisations to actively promote BECCS for Drax and the use of the geological resources near East Yorkshire. The CCUS Taskforce has recommended that the government publish a policy framework and criteria for the prioritisation of potential clusters in 2019. The LEP may facilitate engagement with local industry and other local government bodies to develop a cohesive plan for the Humberside cluster.

## Energy storage

The potential value of energy storage to the UK energy system is widely recognised. The first National Infrastructure Assessment, published in July 2018, reported that "*extra flexibility, which includes technologies such as storage, interconnection and demand side response, is a low regrets investment which reduces estimated total energy system costs by between £1-7 billion per year on average between 2030 and 2050*" (National Infrastructure Commission, 2018). The Government's Clean Growth Strategy commits to spending £70 million before 2022 to promote demand side response and energy storage (BEIS, 2017).

There is a wide range of potential use cases for energy storage. One important use case is to support the deployment of intermittent renewable generation, using battery storage to maximise the value of power sales and reduce curtailment, while generating further revenue by providing additional services to the grid. Analysis by the Renewable Energy Association, presented in a position paper by the All Party Parliamentary Group (APPG) on Energy Storage, suggests that up to 8 GW of energy storage capacity collocated specifically with renewables (wind and solar) could be deployed by 2021 (Renewable Energy Association, 2017).

The YNYER region is nationally significant in terms of the deployment of renewables, particularly relating to offshore wind; 6 GW of offshore wind is installed, under construction or planned off the coast of the East Riding, and at least 400 MW of power comes ashore and is connected to the electricity grid in the East Riding (see Appendix A). In the near-term, energy storage deployed to support offshore wind deployment is most likely to take the form of a battery. We note that a 50 MW battery project has already been approved, as of December 2017, near Cottingham, East Yorkshire. However, there is also the potential in future for power-to-gas technologies to be used, for example, to produce hydrogen from the renewable power using electrolysis. The hydrogen could then be stored, acting as another form of energy storage. Salt caverns in the East Riding are already used for natural gas storage and could be deployed to store hydrogen, as proposed in the Leeds H21 project (NGN, Kiwa Gastec and AMEX, 2016). This option would be most relevant in the case that hydrogen is used for heating on a wide scale in the future, perhaps replacing natural gas in the gas grid.

We therefore suggest that there could be significant potential for energy storage projects in some form in the YNYER region, and that further studies should be undertaken to consider this opportunity.

# 3 Establishing the key stages of the value chain

In this Chapter the method for identifying the sectors forming the value chain for each prioritised technology is described. Detailed lists of sectors included in each value chain are subsequently presented for each technology.

## 3.1 Method

To identify the sectors relevant to each of the value chains, three core sources of information were used. Value chain identification in all cases was based on a combination of expert understanding on the existing links amongst economic sectors and their relevant interactions, supplemented by a review of the relevant literature and, finally, input from relevant stakeholders. Value chains are built up from the sectoral level: specifically, sectors were identified at the 2-digit, 3-digit and 5-digit SIC code level and grouped together to form broader subsectors to be included in the value chain. In the rest of this section, the technology and value chain composition is briefly described for each technology.

**Electric and plug-in hybrids**

In accordance with the literature reviewed (for example Department for Business Innovation & Skills (2015), North Yorkshire County Council (2018)), the value chain of electric vehicles (EVs) and plug-in hybrids consists of five broad sectors;

- the manufacture of batteries;
- the manufacture of all other parts of the vehicle;
- the design and implementation of charging infrastructure;
- the fuelling of the vehicles; and
- R&D related to low-emission vehicles.

**Energy efficiency (insulation and fabric measures)**

Insulation and fabric materials' value chain consists of of two core sectors:

- manufacture and supply of insulation materials; and
- installation and commissioning.

The value chain stages were developed in accordance with Pavel & Blagoeva (2018), and the UK Department for Business Innovation & Skills (2015).

**Anaerobic digestion**

In the identification of sectors relevant to anaerobic digestion the key sources were NNFCC (2018) and AgroCycle (2017). The value chain of anaerobic digestion consists of four broad sectors;

- production and collection of feedstock (crops, farms, waste and sewerage included);
- construction of anaerobic digester and the manufacturing of equipment;
- the production of electricity, heat and digestate; and
- the distribution of biomethane, electricity and heat.

**Heat pumps**

The value chain for heat pumps incorporates four major sectors;

- manufacture and supply of heat pumps;
- technical consultancy and planning of systems;
- installation and commissioning; and
- operation and maintenance of heat pumps.

Value chain identification was based on Magagna et al. (2017).

### Biomass for heat

For biomass for heat, four broad sectors were identified within the value chain;

- production, collection and distribution of feedstock (plant and wood);
- construction of biomass boilers and manufacture of equipment;
- technical planning and installation of systems; and
- production and transfer of heat (for both industrial and domestic use).

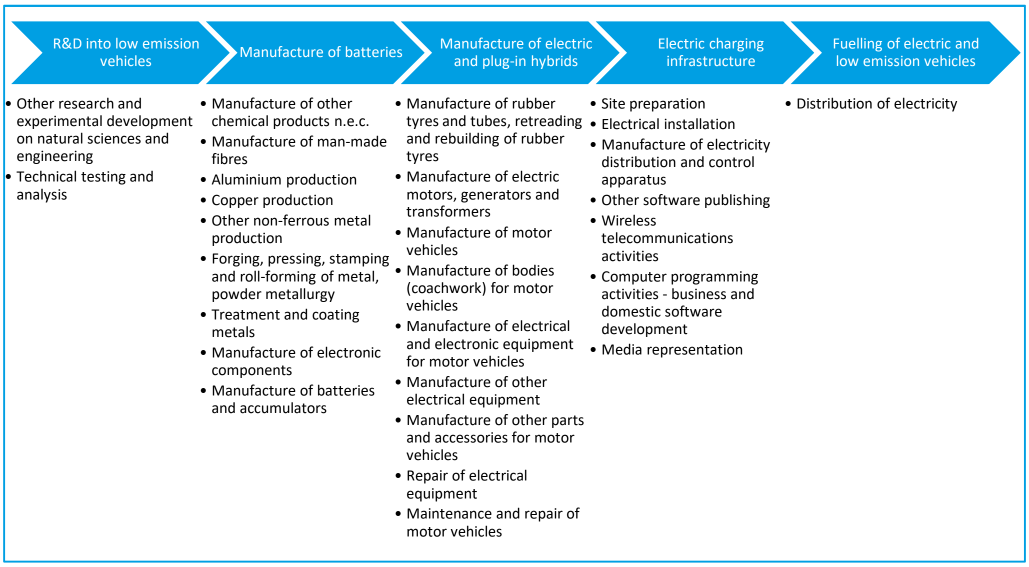
The value chain identification process was largely based on AgroCycle (2017) and a European Commission (2012) FOREST project paper on biomass heating systems.

## 3.2 Presentation of value chains

This section provides an overview of how each of the five low carbon technologies' value chains build up. Furthermore, each section highlights the relevant interdependencies between the sectors included in the value chain, and highlights potential links to other value chains.

### Electric and plug-in hybrid vehicles

**Figure 3.1 Electric and plug-in hybrid vehicles value chain**

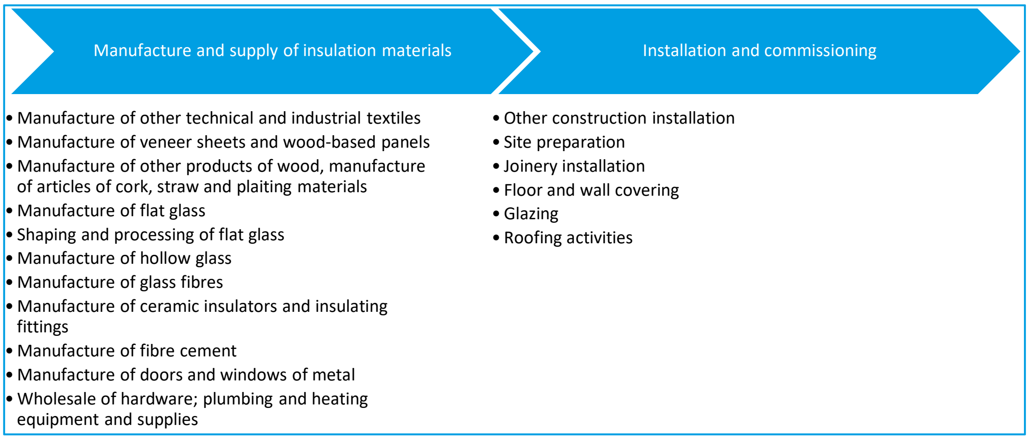



*Interdependency between sectors*

Within the value chain of electric vehicles (EVs) and plug-in hybrids, there are strong links with other sectors, mainly due to the large number of inputs to vehicles. Labour and raw material costs in sectors such as copper production, aluminium production and other part production have a substantial impact on the final cost of vehicles. Along the value chain it is the manufacture of batteries and accumulators that has the potential to most dramatically alter the costs of these vehicles, as it is the major component that is different compared to a standard internal combustion engine (ICE) vehicle.

## Energy efficiency (insulation and fabric measures)

**Figure 3.2 Insulation and fabric measures value chain**




*Interdependency between sectors*

The value chain of energy efficiency (EE) products that are used for insulation is largely embedded in the construction industry – in the sense that EE insulation is often offered as part of a wider range of measures. The construction sector is heavily influenced by the economic cycle. Any upswing in the national or regional economy therefore has major implications on the production and sales of EE products.

## Anaerobic digestion

### Figure 3.3 Anaerobic digestion value chain

**Production and collection of feedstock**

- Growing of cereals (except rice), leguminous crops and oil seeds
- Growing of vegetable and melons, roots and tubers
- Growing of sugar cane
- Growing of fibre crops
- Growing of other non-perennial crops
- Growing of oleaginous fruits
- Growing of beverage crops
- Growing of other perennial crops
- Raising of dairy cattle
- Raising of other cattle and buffaloes
- Raising of swinepigs
- Raising of poultry
- Sewerage
- Treatment and disposal of non-hazardous waste
- Remediation activities and other waste management services
- Wholesale of waste and scrap
- Processing and preserving of potatoes
- Manufacture of fruit and vegetable juice
- Other processing and preserving of fruit and vegetables
- Manufacture of oils and fats
- Manufacture of margarine and similar edible fats
- Liquid milk and cream production
- Butter and cheese production
- Manufacture of other milk products
- Manufacture of ice cream
- Grain milling
- Manufacture of breakfast cereals and cereals-based food
- Manufacture of starches and starch products
- Manufacture of bread; manufacture of fresh pastry goods and cakes
- Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes
- Manufacture of macaroni, noodles, couscous and similar farinaceous products
- Manufacture of sugar
- Manufacture of cocoa and chocolate confectionery
- Manufacture of sugar confectionery
- Tea processing
- Production of coffee and coffee substitutes
- Manufacture of condiments and seasonings
- Manufacture of prepared meals and dishes
- Manufacture of homogenized food preparations and dietetic food
- Manufacture of other food products n.e.c.
- Manufacture of prepared feeds for farm animals
- Manufacture of prepared pet foods
- Distilling, rectifying and blending of spirits
- Manufacture of wine from grape
- Manufacture of cider and other fruit wines
- Manufacture of other non-distilled fermented beverages
- Manufacture of beer
- Manufacture of malt

**Construction of anaerobic digester and manufacture of equipment**

- Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
- Construction of utility projects for electricity and telecommunications
- Site preparation
- Engineering design activities for industrial process and production
- Engineering related scientific and technical consulting activities
- Other research and experimental development on natural sciences and engineering

**Production of electricity, heat and digestate**

- Manufacture of other organic basic chemicals
- Manufacture of fertilers and nitrogen compounds
- Production of electricity
- Manufacture of gas

**Distribution of biomethane, electricity and heat**

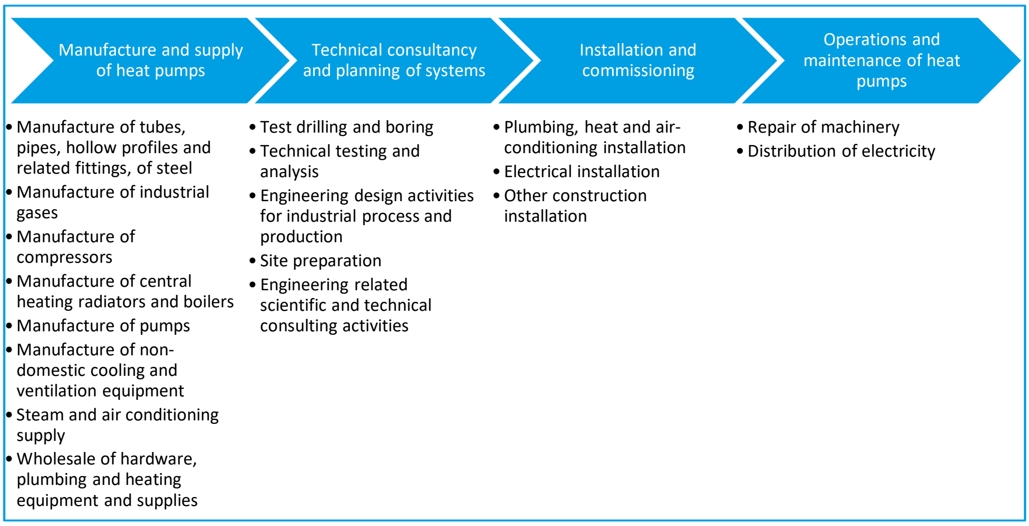
- Transmission of electricity
- Trade of electricity
- Distribution of gaseous fuels through mains
- Trade of gas through mains
- Wholesale of fuels and related products (other than petroleum and petroleum products)

*Interdependency between sectors*

The value chain of anaerobic digestion features many sectors in common with that of biomass, reflecting a significant overlap between the activities involved along the key processes. While anaerobic digestion involves the use of food and amenity waste, as well as crops and residues, waste and sewerage, biomass used for heat generation predominantly uses wood chips and wood pellets as inputs.

## Heat pumps

**Figure 3.4 Heat pumps value chain**




*Interdependency between sectors*

The value chain for heat pumps is somewhat interdependent with that of energy efficient insulation technologies, given that both technologies largely aim to increase buildings' energy efficiency and as such are likely to involve similar activities related to technical planning and installation.

## Biomass for heat

In the process of selecting technologies, biomass used for electricity and biomass used for heat were separated, and only the latter taken forward for further analysis. However, it should be noted that the value chain of biomass used for heat has several sectors in common with that of biomass used for electricity. In fact, two out of the four broad sectors can be fully attributed to both technologies: activities related to the production, collection and distribution of feedstock (plant and wood), and the sectors related to the process of technical planning and installation of systems (such as site preparation or technical testing). Indeed, the key difference is that the value chain of biomass used for heat generation necessarily incorporates the production and transfer of heat, and the manufacturing and distribution of heating equipment.

**Figure 3.4 Biomass for heat value chain**

**Production, collection and distribution of feedstock**

- Growing of cereals (except rice), leguminous crops and oil seeds
- Growing of vegetable and melons, roots and tubers
- Growing of sugar cane
- Growing of fibre crops
- Growing of other non-perennial crops
- Growing of oleaginous fruits
- Growing of beverage crops
- Growing of other perennial crops
- Silviculture and other forestry activities
- Logging
- Support services to forestry
- Treatment and disposal of non-hazardous waste
- Remediation activities and other waste management services
- Wholesale of other fuels and related products
- Wholesale of waste and scrap
- Sawmilling and planing of wood
- Manufacture of other products of wood, manufacture of articles of cork, straw, and plaiting materials
- Wholesale of wood, construction materials, and heating equipment and supplies
- Freight rail transport
- Freight transport by road
- Operation of warehousing and storage facilities for land transport activities of division 49
- Operation of rail freight terminals
- Other service activities incidental to land transportation, nec

**Construction of biomass boilers and manufacture of equipment**

- Manufacture of tubes; pipes; hollow profiles and related fittings; of steel
- Manufacture of central heating radiators and boilers
- Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
- Plumbing; heat and air-conditioning installation
- Wholesale of hardware, plumbing and heating equipment and supplies
- Engineering design activities for industrial process and production
- Manufacture of pumps
- Manufacture of compressors
- Manufacture of other taps and valves
- Manufacture of ovens, furnaces and furnace burners
- Manufacture of agricultural and forestry machinery (other than agricultural tractors)
- Repair of machinery
- Wholesale of agricultural machinery, equipment, and supplies

**Technical planning and installation of systems**

- Site preparation
- Engineering related scientific and technical consulting activities
- Technical testing and analysis
- Other research and experimental development on natural sciences and engineering

**Production and transfer of heat**

- Manufacture of gas
- Distribution of gaseous fuels through mains
- Water collection; treatment and supply

*Interdependency between sectors*

There are a few sectors within the value chain of biomass used for heat generation that are closely related to each other. Many sectors within the production, collection and distribution of feedstock are connected to agro-economic activities, which on one hand are largely exposed to climate and environmental conditions, on the other hand they are also highly interdependent. To give an example, tightening regulations in silviculture or logging will have a substantial impact on the wholesale price of wood, while increasing subsidies for the growing of fibre crops or cereal may have strong implications for the output of waste management service providers. Recent investment flows suggest that stage ‘production and transfer of heat’ is gaining more and more attention: Drax Power Station, one of the largest industrial actors in the region, has invested nearly £700m in upgrading half of its power stations to run on biomass (Hill, 2018).

# 4 Determining the economic value of each value chain

In order to determine which sectors of the value chain may bring the highest economic benefits to the YNYER region, it was necessary to determine the economic value of each stage of the individual value chains. The results of this exercise allow for side-by-side comparison of each stage of the value chains, both within and between technologies.

In this chapter we describe the methodology used to calculate current and future projections of economic value, and in Chapter 5 the value chain assessment results are presented.

## 4.1 Method

**Definition of economic value**

In this study, economic value is determined by the number of jobs that exist in each stage of the value chain, and the GVA created at each stage. The broader stages of the value chain as identified in Chapter 3, are considered and presented, rather than each individual 5-digit SIC code sector, to provide the results in a format that is easier to understand and interpret.

Table 4.1 below presents definitions of the two variables we analyse in this study, the source of the raw data used and the level of spatial and sectoral detail available.

**Table 4.1 Economic value variables**

| Variable | Definition | Data source | Spatial and sectoral detail |
|---|---|---|---|
| Employment | An employee is defined as anyone aged 16 years or over that is paid directly from the payroll, in return for carrying out a full-time or part-time job or being on a training scheme. Employment includes employees plus the number of working owners who receive drawings or a share of profits. | Office for National Statistics, Business Register and Employment Survey | Available at NUTS2 regional level, and for 5-digit SIC sectors. |
| GVA | GVA is the value generated by any unit engaged in the production of goods and services. | Office for National Statistics, Regional Accounts | Available at NUTS regional level, and for 2-digit SIC sectors. |

## Employment related to the low carbon technology

While the Office for National Statistics (ONS) data provides detailed regional and sectoral data for employment, it is necessary to determine how much of the employment in each sector can be directly attributed to low carbon technologies. Employment in most of the identified 5-digit SIC code sectors will be attributable not only to low carbon technologies, but also to other, often unrelated, end-users. For example, 'Manufacture of electronic components' is included in our analysis of electric and hybrid vehicles because it features in the value chain for this technology, but the employment data include total employment in 'Manufacture of electronic components' for all end-users.

It is therefore necessary to make assumptions about the percentage of employment in each sector that can be attributed to low carbon technologies. A literature review was conducted to determine what these percentages should be for the relevant sectors that make up the value chain of each of the five prioritised technologies. Within the reviewed literature, only direct (i.e. for the production of the final good/service) and indirect (i.e. the supply chain) estimates of employment for the broad sector that the finished technology falls under were available, rather than for each individual stage of the value chain. The same percentage share was therefore assumed for all stages of the value chain.

Department for Business, Innovation & Skills (2015) sets out a definition of the UK low carbon economy, divides it into 24 different sector areas and provides employment at a regional level. This data forms the basis of our assumptions for electric vehicles and plug-in hybrids, insulation and fabric measures and heat pumps, since these technologies map precisely with the sectors presented in the report. Further research was required for anaerobic digestion and biomass for heat, since these technologies were not explicitly included in Department for Business, Innovation & Skills (2015). Instead, the estimates for 'bioenergy'[3] were taken from the report, and a share of employment was taken from this sector based on the shares of biomass and anaerobic digestion that contribute to overall generation of renewable heat and/ or renewable electricity, according to the statistics provided by Digest of UK Energy Statistics (DUKES), Table 6.6.

Table 4.2 below provides details of the employment assumptions used for each technology.

[3] Three sectors from Department for Business, Innovation & Skills (2015) were selected as being part of the bioenergy category: biomass equipment, generation of energy from waste and biomass, alternative fuels.

**Table 4.2 Employment assumptions**[4]

| Broad sector | Low carbon technology | Proportion of employment attributable to low carbon technologies | Source |
|---|---|---|---|
| Motor vehicles | Electric vehicles and plug in hybrids | 2.8%[5] | Department for Business, Innovation & Skills (2015) |
| Energy efficiency products | Insulation and fabric measures | 17.0%[5] | Department for Business, Innovation & Skills (2015) |
| Bioenergy | Anaerobic digestion | 0.3% | Department for Business, Innovation & Skills (2015) and Digest of UK Energy Statistics (DUKES), Table 6.6 |
| Low carbon heat | Heat pumps | 2.1%[5] | Department for Business, Innovation & Skills (2015) |
| Bioenergy | Biomass for heat | 1.3% | Department for Business, Innovation & Skills (2015) and Digest of UK Energy Statistics (DUKES), Table 6.6 |

## Calculating GVA

While employment data was available at detailed sectoral and regional level, this was not the case for GVA data, which was available at the required NUTS2 level, but only for broader 2-digit sectors. The following calculations were therefore performed to provide estimates of GVA for each of the more

[4] Figures in Table 4.2 refer to the YNYER region.

[5] 2013 figures were taken since this was the only year for which data was provided across the different regions required.

detailed 5-digit sectors of the technology value chains, using the 2-digit GVA and employment data:

- The broader 2-digit sector GVA data was divided by the equivalent 2-digit employment data, to calculate productivity for the broader 2-digit sector, for the YNYER region as well as Great Britain, England, Wales and Scotland[6].
- It is assumed that productivity in the more detailed 5-digit sector is the same as in the broader 2-digit sector to which it belongs.
- The 2-digit productivity ratios were multiplied by the 5-digit employment data for the YNYER region.
- The end result was estimated GVA data at the 5-digit level, for the YNYER region.

**Forming projections**

As well as developing employment and GVA estimates over the 2009-2017 period for which data was available, the analysis of the identified low carbon value chains was extended to understand how future demand for these technologies might evolve up to 2030. This part of the analysis made use of a deployment index defined for each technology following research on future deployments expectations in the YNYER region for each technology.

This index was then applied to the current level of GVA in each stage of each technologies' value chains to calculate an estimate future value added. The implicit assumption here is that, while the cost of these low-carbon technologies might be expected to be lower in the future, this will be achieved through process and material innovation, rather than through reducing the per unit level of wages (i.e. labour contribution) or profit (since value added is the sum of these two components).

Following the calculation of GVA, future employment levels were obtained through applying a long-term productivity trend to the current level of productivity for each sector of the value chain to calculate the extent to which workers in each value chain can be expected to become more productive over time. By estimating future productivity in this way, it is possible to calculate the potential level of future employment while taking account of continued productivity improvements.

To determine future changes in sectoral productivity rates, the average productivity growth rate across the 2009-2017 time series of data was calculated for each sector, and then an average across all sectors of the value chain was estimated, resulting in a single figure useful to project future productivity ratios for each sector of the value chain. The productivity growth assumptions used for each low carbon technology are presented in Table 4.3.

[6] Labour productivity is equal to the ratio between a measure of output volume (in this case GVA) and a measure of input (in this case labour), and provides an indicator of the efficiency with which a sector converts an input in to finished goods or services.

**Table 4.3 Productivity assumptions**

| Low carbon technology | Productivity growth rate assumed |
|---|---|
| Electric vehicles and plug in hybrids | 1.0% |
| Insulation and fabric measures | 3.9% |
| Anaerobic digestion | 0.5% |
| Heat pumps | 0.9% |
| Biomass for heat | -0.4%[7] |

Once projections of productivity were calculated, future employment levels in each sector of the value chain were estimated by dividing GVA by the corresponding productivity value in each year.

## 4.2 Input from stakeholders

Determining the economic value of each value chain also relied on obtaining views from relevant stakeholders in the YNYER region, to further refine the estimates produced by the methodology described in Section 4.1. By conducting interviews and semi-structured conversations with contacts in local authorities, members of special interest groups (such as BioVale) and policy leads from the local Chambers of Commerce, the study was able to better understand the potential of the YNYER area to capture economic value now and in the future.

While stakeholders often did not have concrete suggestions for revisions to the assumptions outlined above, or more industry-specific employment and GVA data, they were able to provide a wealth of information about the prioritised low carbon technologies in the region, including viewpoints on key activities of the low carbon value chains taking place in the YNYER region, different business models operating in the region, opinions on future deployment levels, current and future opportunities and challenges that may impact upon the feasibility of future deployment, and the kind of interventions deemed most worthwhile.

The information obtained from stakeholder engagement was mainly used to help develop our understanding of the opportunities and challenges present in the YNYER region (outlined in Chapter 0), and add depth to our conclusions and policy recommendations set out in Chapter 7. However, some views and information were used to critique the employment and GVA estimates and projections presented in Chapter 5.

[7] The productivity growth rate for the biomass for heat technology was negative over the 2009-2017 period due to a reduction in GVA and, at the same time, an increase in employment in the technical planning and installation of systems sector.

# 5 Value chain assessment results

This Chapter presents the results of the quantification of the value chains. It presents, for each technology, the key economic indicators (employment and GVA) covering both the historical period (2009-17) and a projection out to 2030. The figures are calculated from ONS employment and GVA statistics and various assumptions, based on the method outlined in Section 4.1. The key assumption to note when interpreting these results is how much of the employment recorded in a particular sector in the YNYER region can reasonably be attributed to the low-carbon technology in question. For example, 'Manufacture of electronic components' is included in the analysis of electric and hybrid vehicles because it features in the identified value chain for this technology, but the employment data includes total employment in 'Manufacture of electronic components' for all end-users. In reality, it may be the case that there are currently few manufacturers of electrical components specifically being used by EV and plug-in hybrid vehicle manufacturers in the region; and if the estimate of the share of this industry is an over- or under-estimate it will skew the recorded figures accordingly.

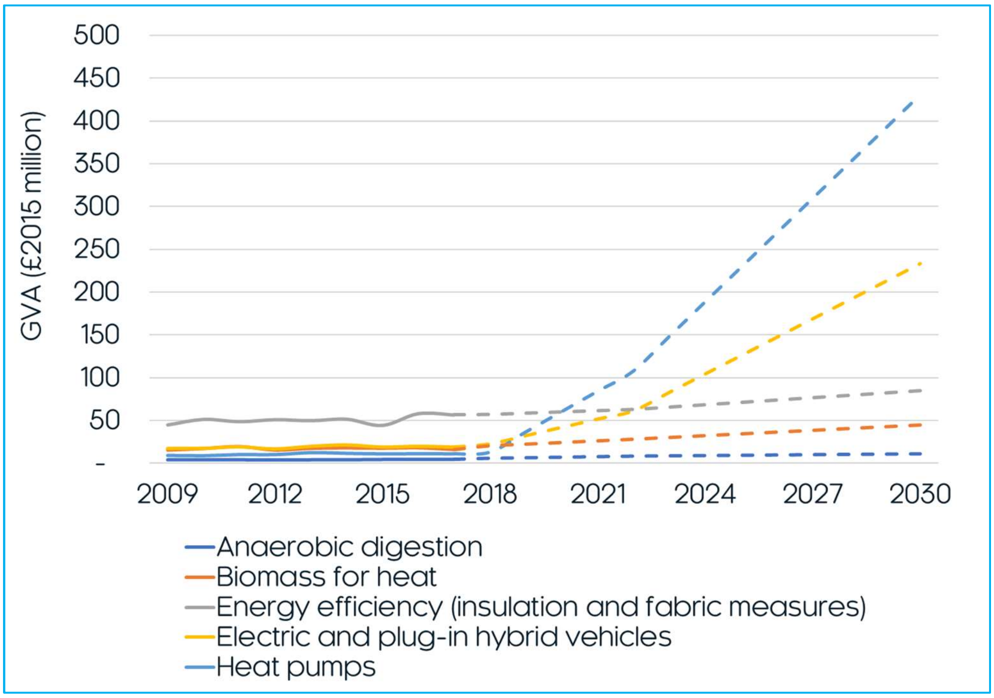
All figures presented in this chapter are for the YNYER region; the data tool, an appendix to this report, allows more detailed data for local authorities to be extracted. The data tool also allows stakeholders to adjust the assumptions used to construct the final GVA and employment estimates, to incorporate more up-to-date or detailed information about activity in low-carbon sectors in the region.

## 5.1 Overview

**GVA**

The technology which contributes the most value added to the YNYER economy, as of 2017, is energy efficiency insulation, totalling around £60 million. The second largest technology in terms of value added is electric and plug-in vehicles, followed by biomass for heat. The projections suggest, however, that heat pumps become by a distance the biggest technology in terms of GVA from 2020 onwards. GVA associated with EVs is also expected to grow rapidly, becoming around twelve times its current size by 2030. In contrast, both the anaerobic digestion and biomass for heat value chains are expected to grow more modestly; although biomass will still see value added almost triple by 2030 compared to current levels (see Figure 5.1).

**Figure 5.1 Gross value added (£2015 million) associated with the different low carbon technologies**

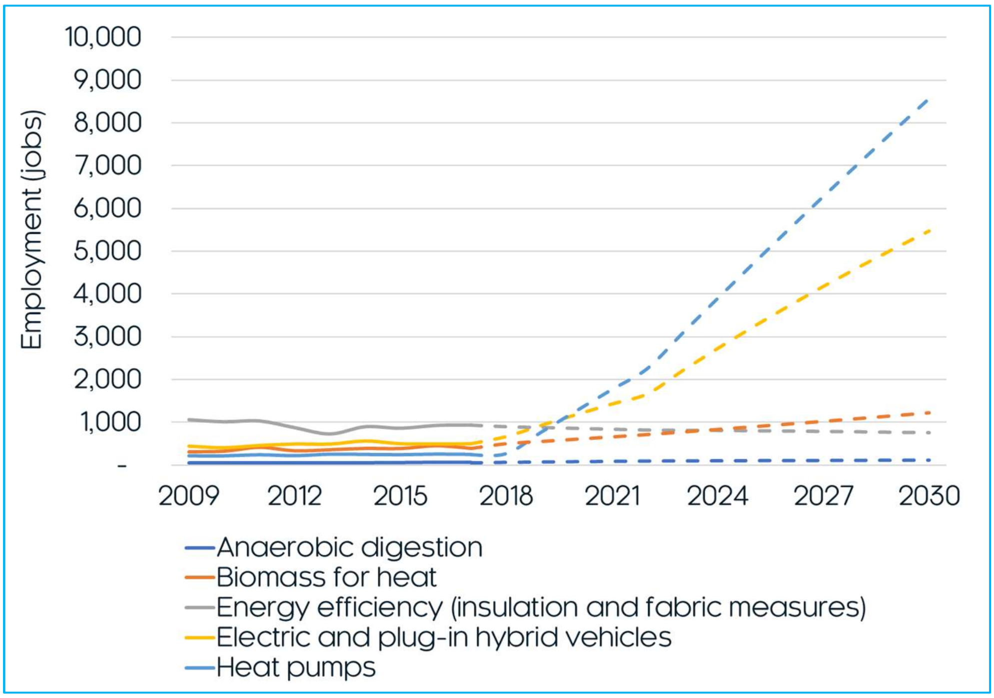



## Employment

In employment terms, energy efficiency insulation is associated with the highest number of jobs in the YNYER region (940 in 2017), followed by electric and plug-in hybrids (around 500).

From 2020, however, heat pumps are expected to become the leading technology in terms of employment, with around 8,600 jobs in 2030 (largely driven by activities associated with the installation and commissioning of heat pumps). Employment levels associated with EVs and biomass for heat are also expected to grow substantially, reaching about 5,500 and 1,200 respectively by 2030. Employment in energy efficient insulation is forecasted to slowly decrease over the period, despite increased deployment, due to strong productivity gains, while anaerobic digestion is projected to stagnate over time (see Figure 5.2).

**Figure 5.2 Employment (number of jobs) associated with the different low carbon technologies**

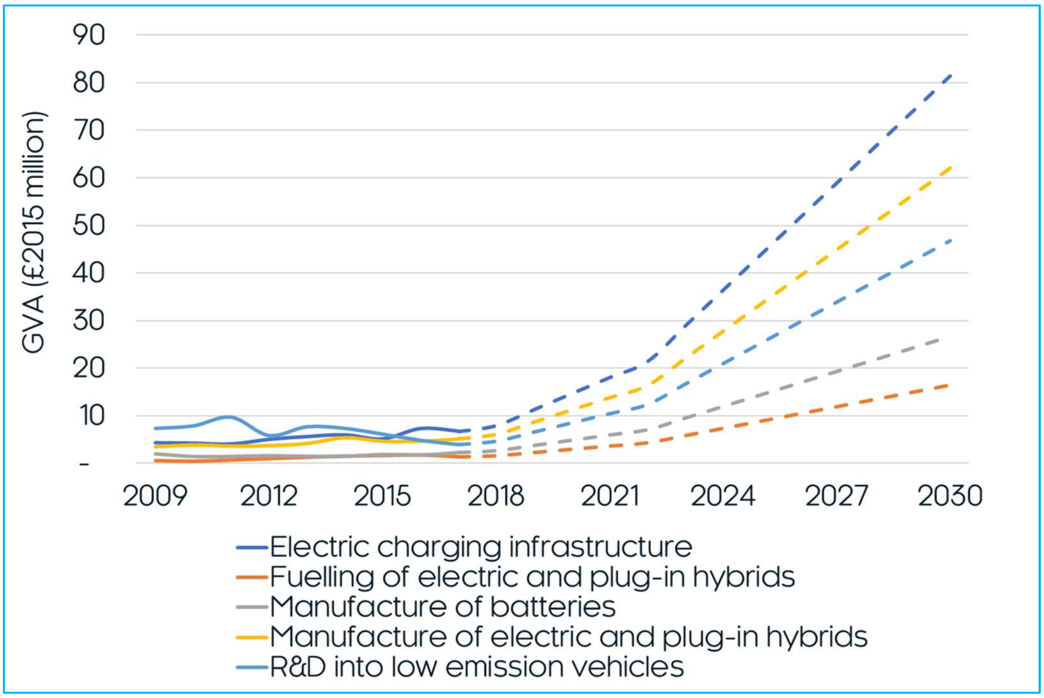



## 5.2 Results for each technology

**Electric and plug-in hybrid vehicles**

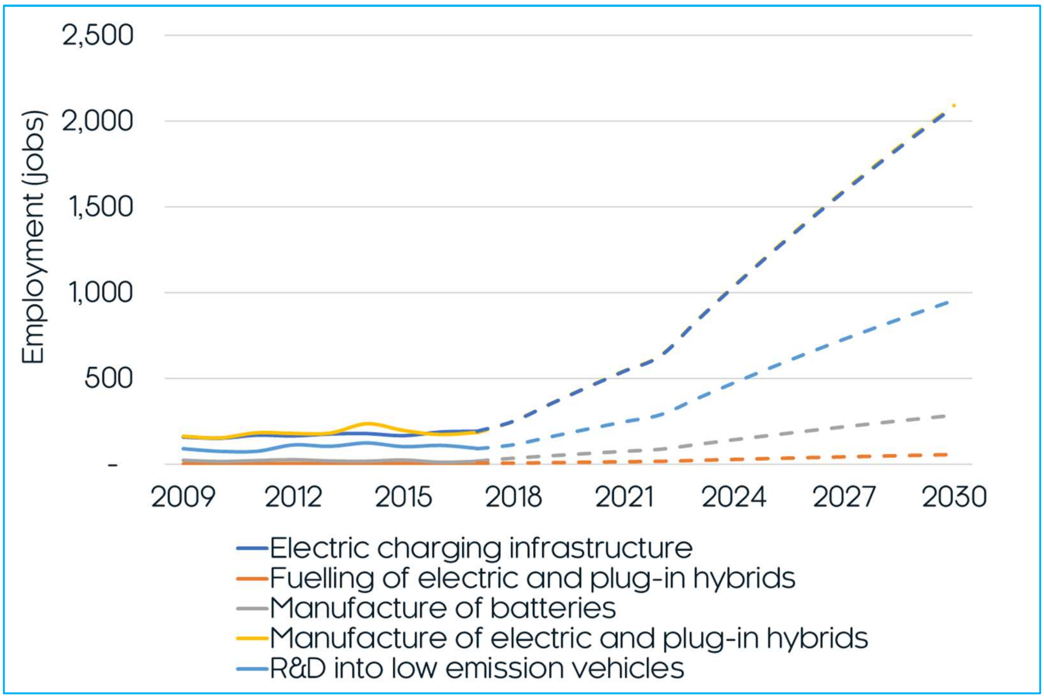
With the number of electric and hybrid vehicles projected to progressively increase over time, the GVA for all sectors of the corresponding value chain is expected to increase substantially. Electric charging infrastructure represents the sector with the highest economic value currently, followed by the manufacture of vehicles, the R&D into low emission vehicles, the manufacture of batteries and the refuelling infrastructure. All these sectors will increase their gross value-added component in future years, particularly in the 2020s, with the recharging infrastructure sector contributing value added of around £80 million in 2030 (see Figure 5.3).

**Figure 5.3 Gross value added (£2015 million) by sector in the electric and plug-in hybrid vehicles value chain**




The rapid increase in deployment of electric and hybrid vehicles technology will also lead to an increase in employment across the different stages of the value chain. Most of the new jobs will be created within the sectors with higher employment intensity: the electric charging infrastructure sector will add more than 1,800 jobs by 2030 compared to 2017, and the manufacturing of low carbon vehicles will add a further 1,900 jobs compared to 2017. Gains in other sectors in the value chain will push the total number of jobs associated with this technology to more than 5,400 in 2030 (see Figure 5.4).

**Figure 5.4 Employment (number of jobs) by sector in the electric and plug-in hybrid vehicles value chain**



**Energy efficiency (insulation and fabric measures)**

There have been fluctuations in value added associated with energy efficiency insulation in the YNYER region over 2009-17, although there has been a broad upward trend. With higher rates of deployment expected in the future, GVA is expected to increase by approximately 50% by 2030 (compared to 2017), in terms of both the manufacture and supply of insulation materials, and their installation and commissioning (see Figure 5.5).

**Figure 5.5 Gross value added (£2015 million) by sector in the domestic insulation and fabric measures value chain**

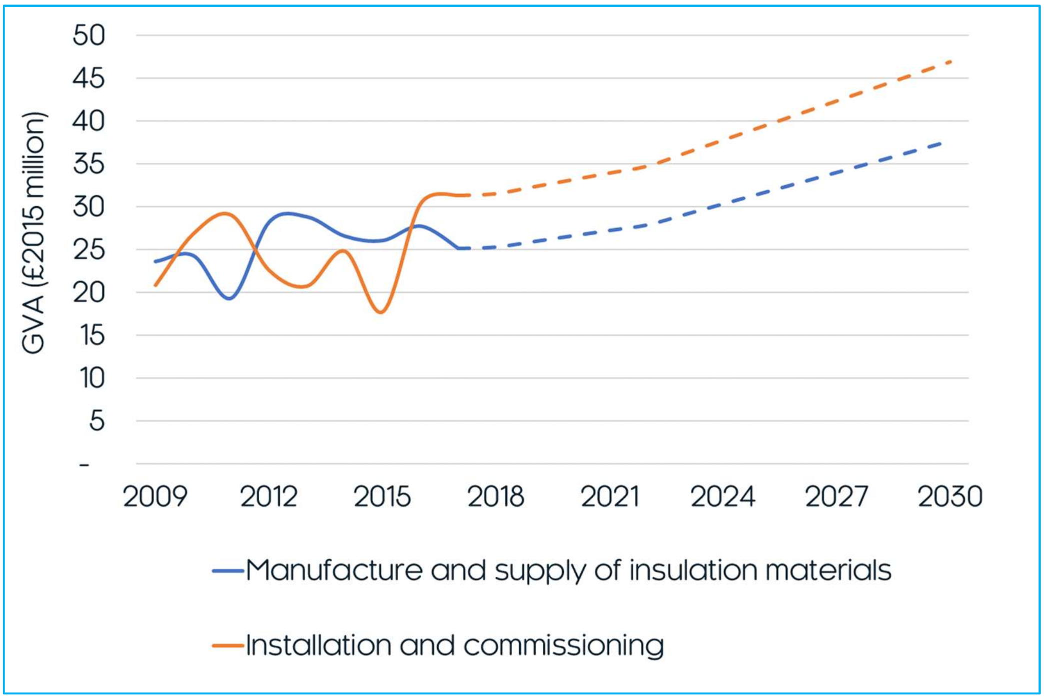
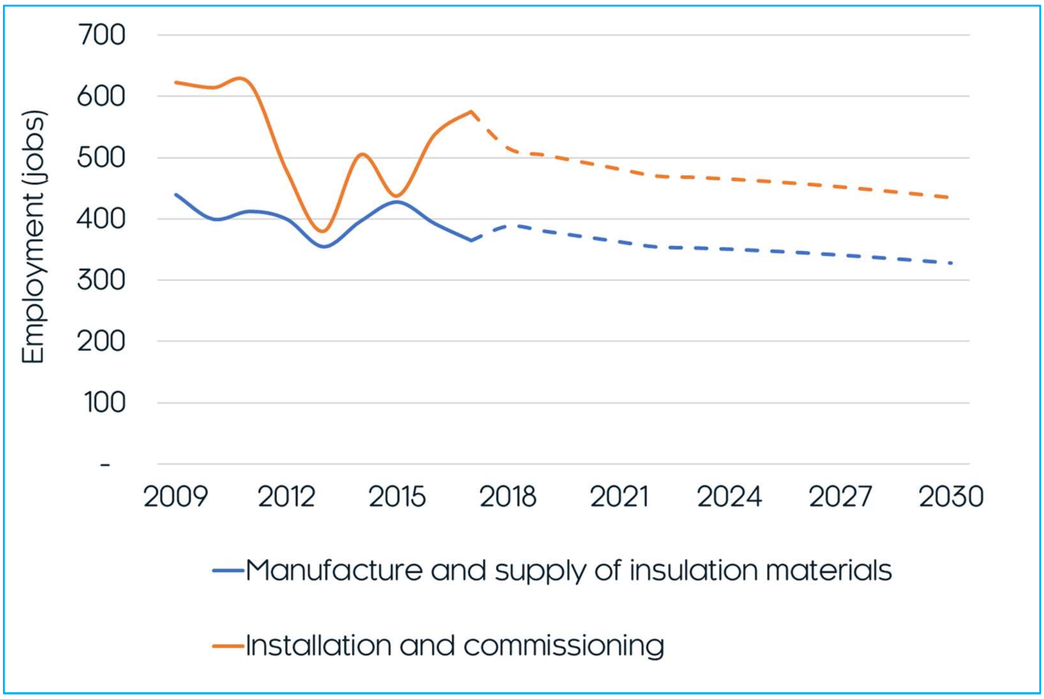



**Figure 5.6 Employment (number of jobs) by sector in the domestic insulation and fabric measures value chain**

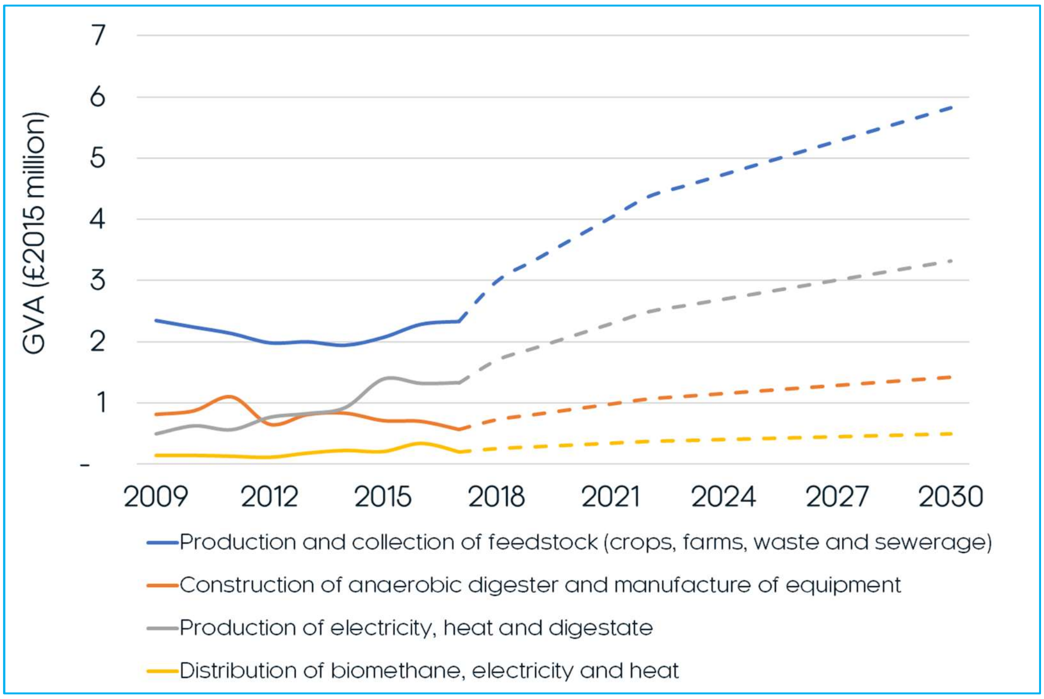



Despite the economic expansion of these sectors, the projections depicted in Figure 5.6 point towards a contraction in the number of jobs in the future. This is mostly due to a substantial increase in labour productivity which stems from the productivity improvements experienced by the value chain sectors from 2009 to 2017 (as shown in Table 4.3). Jobs within the value chain of the domestic insulation technology will reduce from the current level of 940 to approximately 760 in 2030.

**Anaerobic digestion**

The economic footprint of the AD sector is currently small compared to the other low carbon technologies considered in this study. However, rapid growth is anticipated over the next decade. This technology can make use of a diverse feedstock ranging from crop and farm wastes to sewerage sludge to generate power, heat and digestates. As activity in the sector increases, it is expected that GVA will more than double by 2030 in the production and collection of feedstock and in the production of electricity, heat and digestates compared to the current levels. While the other stages of the value chain will also expand over time, this will be at a slower rate (see Figure 5.7)).

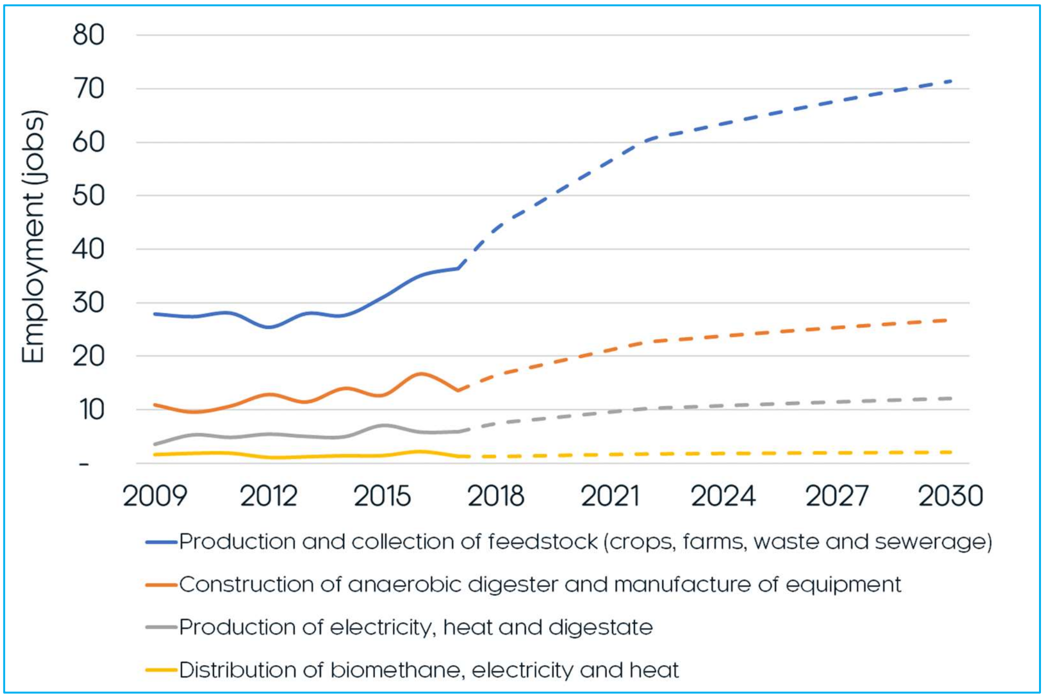
**Figure 5.7 Gross value added (£2015 million) by sector in the anaerobic digestion value chain**




Discussion with a regional AD special interest group, part of the BioVale group, revealed that current employment numbers in YNYER's AD value chain may be higher than the estimates presented in Figure 5.8, although no more precise estimates were provided. Nevertheless, stakeholders agreed with the future trajectory of employment, with feedstock continuing to dominate. However, this stakeholder input suggests that the absolute estimates of employment levels may be on the conservative side.

Employment trends are expected to be broadly similar; employment in the production and collection of feedstock will double. However, in contrast to the GVA measure, the next largest segment of the value chain in terms of employment is construction of anaerobic digestors and manufacture of equipment, and employment in this segment is also expected to increase. By contrast, employment in the production of electricity, heat and digestate and the distribution of biomethane, electricity and heat will grow only modestly (see Figure 5.8).

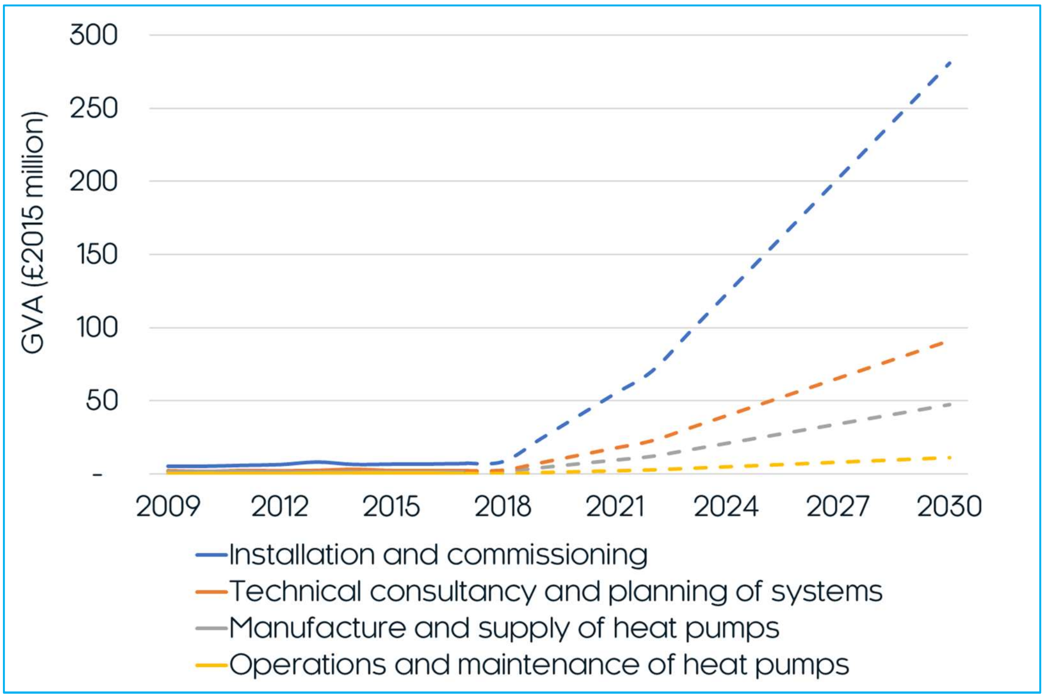
**Figure 5.8 Employment (number of jobs) by sector in the anaerobic digestion value chain**




## Heat pumps

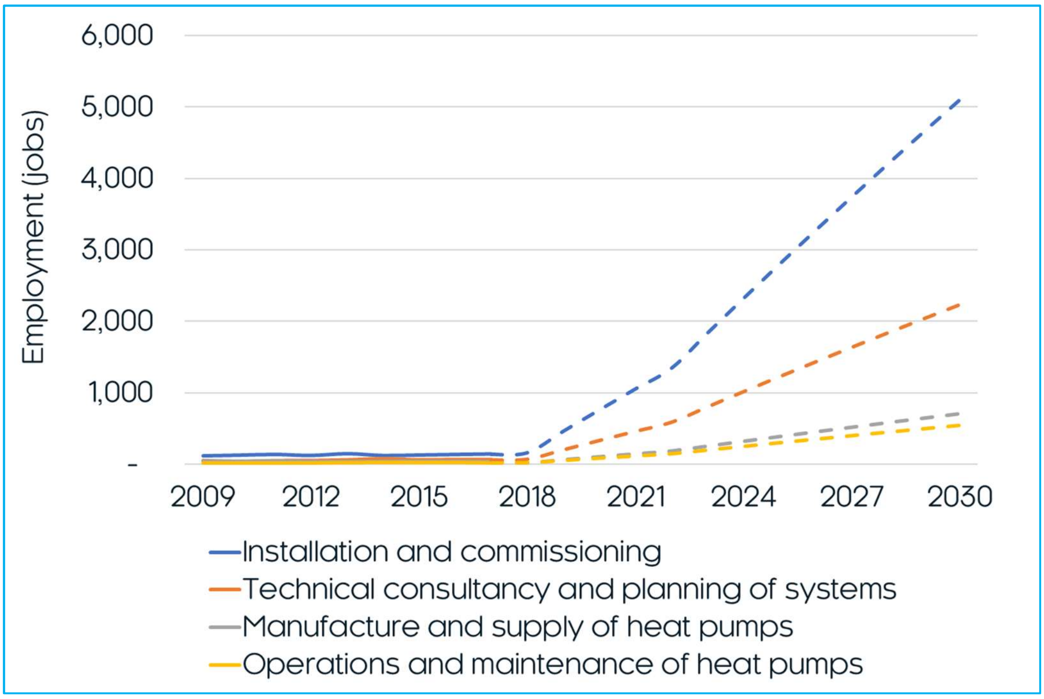
In total, the heat pump value chain is expected to see an immense growth in terms of gross value added and employment. Growth in both dimensions is predominantly driven by the installation and commissioning-related activities as well as technical consultancy and planning along the value chain.

**Figure 5.9 Gross value added (£2015 million) by sector in the heat pumps value chain**



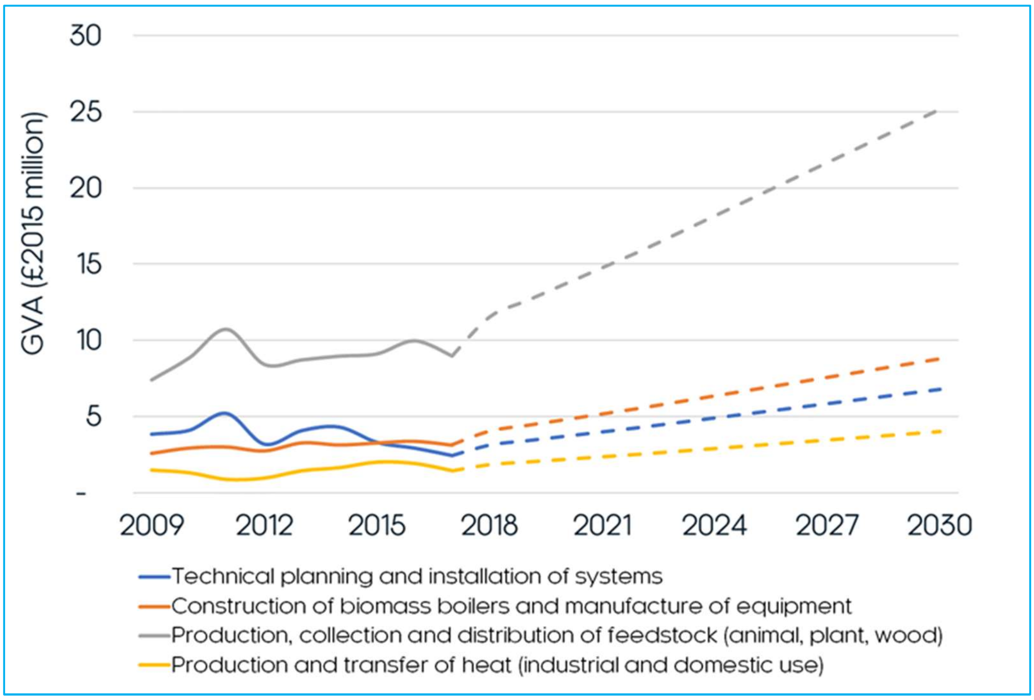

Nevertheless, employment and GVA associated with the manufacture and supply of heat pumps and operations and maintenance of heat pumps are also expected to grow over the next decade.

**Figure 5.10 Employment (number of jobs) by sector in the heat pumps value chain**



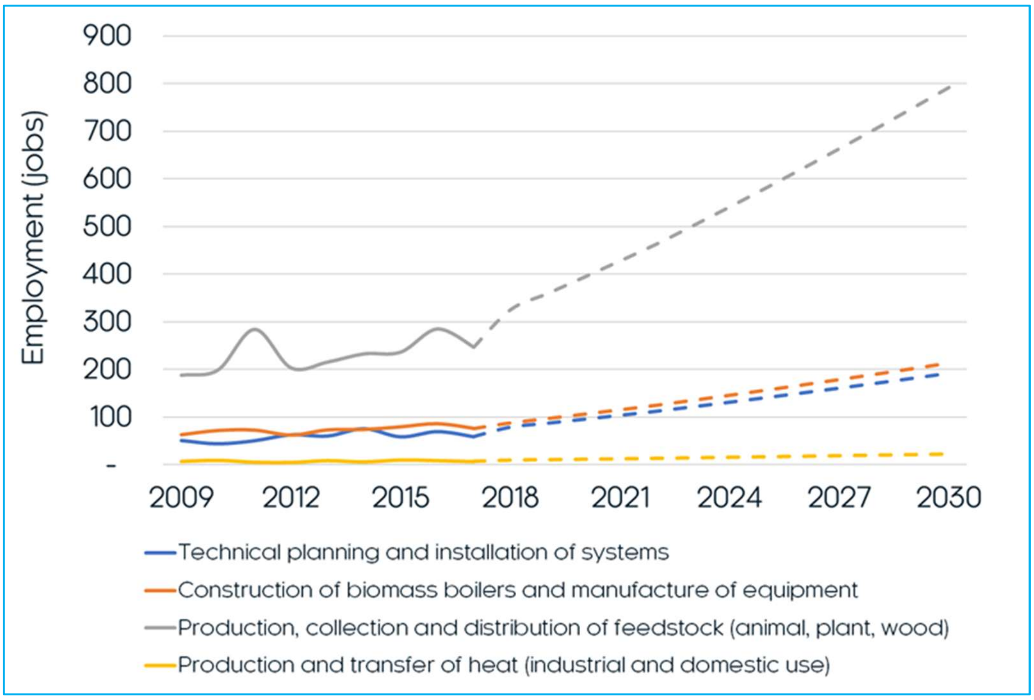

## Biomass for heat

**Figure 5.11 Gross value added (£2015 million) by sector in the biomass for heat value chain**




Rapid growth is expected in the production, collection and distribution of feedstock (animal, plant and wood), both in terms of value added (see Figure 5.11) and employment, and as such the dominant role that this sector plays in the overall value chain will be maintained. Overall, growth is expected in both GVA and employment within the construction of biomass boilers over the period to 2030 (see Figure 5.12). In the case of biomass boilers, production and transfer of heat for industrial and domestic use is also foreseen to grow but will still lag behind with regards to GVA and employment.

**Figure 5.12 Employment (number of jobs) by sector in the biomass for heat value chain**



# 6 Potential opportunities and challenges in the YNYER LEP region

## 6.1 Introduction

The quantitative analysis set out in the previous chapters has been supported by the identification of opportunities and challenges associated with each of the low carbon technologies (and value chains) identified.

This has been based upon a range of sources, including stakeholder engagement (through local district council contacts, local business groups such as the three Chambers of Commerce, as well as technology-specific engagement with organisations such as BioVale), desk research and drawing on our existing knowledge of the specifics of each technology, in both a local (the region covered by YNYER) and national context.

In the sections below, the identified opportunities and challenges associated with each technology are discussed in turn. These opportunities and challenges then inform the development of conclusions and policy recommendations in Chapter 7.

## 6.2 Electric and plug-in hybrid vehicles

**Summary**

The main opportunities and challenges for electric and plug-in hybrid vehicles in the YNYER region can be summarised as follows:

*Opportunities:*

- Increased demand for EVs and plug-in hybrids following national-level policy, incentives and support for the EV industry, creating opportunities for increased jobs and output across the EV value chain.
- While no EV manufacturing currently takes place in YNYER, there is the potential for increased manufacturing of components used within the EV supply chain in the future.
- The installation and maintenance of charging infrastructure is expected to provide the most substantial opportunity to job creation and increased economic output in the EV value chain going forwards.
- There is planned local authority support for electric charging infrastructure in off-street car parks.
- Central government support is available to support the deployment of charging infrastructure via OLEV grants.

*Challenges*

- The high proportion of remote rural areas limits the attractiveness of EVs and discourages uptake in the YNYER region.
- There is currently insufficient grid infrastructure to support the required charging infrastructure in some areas.
- There is insufficient mobile network coverage to support charge-point payment systems in some areas.
- The high costs of installing rapid charge points creates a substantial barrier to investment.

- Other regions of the UK already specialise in vehicle production or the production of batteries and therefore have a competitive advantage, meaning the YNYER region may lose out (in relative terms) to regions with a more developed incumbent industry.

Demand for EVs is expected to substantially increase in the near term, helped by the Government's pledge to end the sale of all petrol and diesel cars by 2040, and by measures to incentivise the purchase of EVs such as increasing tax on non-electric cars, providing funding for electric charging infrastructure and through working alongside the car industry to promote EVs. In North Yorkshire, the uptake of ultra-low emissions vehicles (ULEVs) (which includes electric and plug-in hybrid vehicles) has been increasing in recent years (North Yorkshire County Council, 2018), although ULEVs still account for less than 1% of registered cars in the region. A particular challenge to uptake in the region is the high proportion of remote rural areas, where residents may be concerned about the range of an EV. A well-established charging infrastructure in the region is therefore extremely important, as is the need for better mobile network coverage, so that EV users can more easily make online payments.

A key contact in North Yorkshire County Council (NYCC), working on the development of the local Air Quality Strategy, provided some useful insights on the low carbon value chain for EVs in the YNYER region. They confirmed that the future key activities of the EV value chain in the region are likely to relate to the installation of electric charging infrastructure, particularly in off-street car parks. Local district councils are currently constructing a business case for commissioning these installations and NYCC are in the early stages of looking at the potential for supporting district councils with these projects, or the potential for NYCC to provide on-street EV charging infrastructure, either as independently or in conjunction with a third-party operator. Given the high costs of installation, it is likely that on-street rapid charge points would be primarily installed along major routes such as motorways, and at service stations, but consideration could also be given to installation of charging points in residential areas (where residents have no access to off-street parking) and at park and ride sites.

Compared to the rest of England, the current distribution of charge points in Yorkshire and the Humber is sparse, with approximately 1.5 charge points per 10,000 people in the region, the lowest figure of any region in England, and compares to an average number of 2.4 charge points for England as a whole. There is clearly scope for increasing investment in the charge point infrastructure within the region. Furthermore, the majority of existing charging points in North Yorkshire are currently privately owned and operated. Outside of home chargers, while some are open to the general public, many are located at hotels and other accommodation sites, and are designed primarily for customer use. Points installed by local government are limited; North Yorkshire County Council have yet to install any, although some boroughs and districts are looking to install them (for example, Harrogate Borough Council have two at their civic centre). Currently, there are no regional recharging service providers in the YNYER region, but there are various national charging networks such as Ecotricity and Charge Your Car.

In the future, a broader deployment of charging points is expected. Across the UK, such infrastructure is typically provided in public off-street car parks, private sites with public access such as supermarkets and motorway service stations, in addition to dedicated charging sites. The OLEV grants that are available could be used to support the development of a network of chargers in residential areas (where off-street parking, and therefore private charging, is not available) and for workplace chargers. The involvement of local government stakeholders in this process can help to solve the 'chicken and egg' problem that can emerge when the provision of such infrastructure is left to the private sector; specifically, actors such as the County Council can fund the installation of charging infrastructure in anticipation of higher future demand, as compared to a private operator which requires (often) an immediately solvent business case in order to provide the infrastructure. The provision of this infrastructure provides the potential for clear economic benefits for the region; since the charging points will be installed locally, this will likely create local jobs and economic activity in the installation phase, even if many of the components used are sourced from outside of the region.

The future deployment figures estimated within this study, and used to estimate future potential economic value of the EV value chain, suggests that by 2030, up to 12,500 private slow chargers a year could be installed in the region, as well as 1,000 slow public chargers and eleven rapid chargers per year, while the EV and hybrid vehicle fleet will increase by around 20,000 vehicles per year.

NYCC believe the estimates for rapid charge points to be very optimistic. This is because of various barriers to investment in electric charging infrastructure, and they believe that unless there is substantial government funding for rapid chargers or technological advancements to bring down costs, it is unlikely that eleven rapid chargers per year will be installed in North Yorkshire. The current costs of the infrastructure alone can be up to £30,000 (UK EVSE, 2018), and at a meeting in November 2018 between EV charge point leads from various local district councils, it was highlighted that energy supply at proposed locations was not always sufficient, and new sub-stations would be required in some locations. Energy supply issues are further exacerbated in the region, since there is a high proportion of rural areas where the electricity supply is variable. Similar situations may arise at other preferred installation locations, leading to questions about how to meet the demand for additional energy supply in the area whilst also meeting emissions reductions targets. With the likely additional costs to meet electricity supply requirements, it is unlikely that enough funding will be available for rapid charging infrastructure in the area.

However, the slow charger deployment estimations were deemed to be more realistic, although there is some anecdotal evidence to suggest that existing slow chargers are insufficient for some newer EVs, taking longer than the standard 8-10 hours to provide full charge. Growth in fast chargers (providing full charge within 3-4 hours), which are often found at retail outlets and leisure facilities, should also be considered. Growth in private sector installations is likely to be focussed on this type of charge point, as retail and leisure businesses look to attract EV owners to their facilities. Future technological developments may also mean that 'traditional' charge point units are replaced with wireless charging points.

In other areas of the value chain, the YNYER region faces a challenge to catch up to established industry. For example, while the UK government is supporting the development of current- and next-generation batteries in the

UK, through funding of research projects and bodies such as the Faraday Institution, much of this activity is already focussed in other parts of the UK (for example the Faraday Institution is located in Didcot, Oxfordshire). In addition, the region has no major vehicle manufacturing facilities, and is therefore not well placed to develop these even as vehicle technologies change; a more realistic area of development is in the manufacture of electrical components to the manufacturers, i.e. the supply chain for vehicles.

## 6.3 Energy efficiency (insulation and fabric measures)

**Summary**

The main opportunities and challenges for insulation and fabric measures in the YNYER region can be summarised as follows:

*Opportunities*

- Various local organisations exist to promote the uptake of energy efficiency measures; additional support to these organisations could further encourage uptake.
- The retro-fitting of many off-gas grid properties in the YNYER region presents major opportunities for insulation manufacturers in the region and local installers.
- Additional central government support for retro-fitting is expected in the future.

*Challenges*

- Reduced demand for energy efficiency measures has led to several local installers going out of business recently.
- While GVA is expected to increase in all stages of the energy efficiency value chain, the number of jobs is projected to decline in the future due to productivity improvements.

As has been noted previously, insulation is typically installed as one of several energy efficiency measures, as part of a combined package. As such, installation and commissioning, the larger part of employment in the value chain, can be split into those surveying and commissioning work, and the installers themselves.

In recent years, according to viewpoints from contacts at the North Yorkshire County Council, several installers based in the region have gone out of business, reflecting reduced demand for energy efficiency measures from households, industry and the public sector. There are already organisations aimed at improving engagement and take-up of these measures, such as Better Homes Yorkshire (supported by the West Yorkshire Combined Authority and Leeds City Region LEP, amongst others), but further support for these organisations, and broader information campaigns (whether organised at a local or national level) will be required to realise the higher rates of energy efficiency installation foreseen in the coming years.

The retrofitting of heating systems in the large number of off gas grid homes in the region present a major opportunity for insulation manufacturers and installers, as well as clear links with some of the other value chains discussed in this report. It is anticipated that BEIS will follow up its Future Framework for Heat in Buildings consultation (which took place earlier in 2018) with various policies to support the retro-fitting of such properties in the near future. Shifting these properties to alternative energy sources (such as biomass boilers and heat pumps) is likely to be a prime opportunity to also improve the energy efficiency of the homes (in order to allow cost-effective retro-fitting), driving up demand for insulation and other energy efficiency measures. However, as noted in Chapter 5, while GVA of all stages of the energy efficiency value chain is expected to increase in future, the number of jobs is expected to decline due to productivity improvements.

## 6.4 Anaerobic digestion

**Summary**

The main opportunities and challenges for anaerobic digestion in the YNYER region can be summarised as follows:

*Opportunities*

- The YNYER region currently has a competitive edge in AD technology, with a high volume of AD capacity compared to the rest of the UK, plus a state-of-the-art household waste AD facility and various bioeconomy research groups.
- Growing crops that support AD is considered less risky by local farmers than cultivating bio-energy crops.

*Challenges*

- Large AD plants have experienced falling subsidies, leading to a consolidation of firms into a relatively small pool of larger operators. This has led to higher gate fees as larger operators can exert market power over local feedstock suppliers.
- Local feedstock volumes are not keeping pace with the development of new AD facilities, additional feedstock pathways are needed.
- Local farmers participating in the market for AD feedstock are concerned about the future impact of AD on their farming practices and the longevity of feedstock contracts.

The YNYER region is currently has a competitive advantage in AD technology, with over 6% of national capacity currently operating within the region (compared with a population less than 2% of the UK total), and in 2018 opened a state-of-the-art large-scale AD facility, the Allerton Waste Recovery Park, to generate power from household waste. The region also hosts various research groups, such as the University of York's Biorenewables Development Centre and the BioVale group, promoting the area as a centre for innovation in bioeconomy technologies, including AD. These research centres contribute to the development of new technologies for use within YNYER and for exporting out of the region.

Insights obtained from members of a local AD special interest group reveal that the AD industry has changed substantially in recent years; the incentives made available to small-scale AD plants set up on farms led to major cropping changes. Government policy (whether deliberately or otherwise) has supported a shift away from food production and towards maize and other AD plants. Such polices have led to the proliferation of these small operators. At the same time, large AD plants have experienced falling subsidies, leading to consolidation of firms to a relatively small pool of larger operators. This consolidation of AD plants has the potential to reduce competition, and therefore lead to higher gate fees as larger operators can exert market power over local feedstock suppliers.

Conversations with the Environment and Land Use Adviser for the North East division of the National Farmers Union (NFU) revealed that farmers and commercial businesses are using a variety of feedstocks in the region, but primarily composted plant material. At smaller-scale farm level, slurry is the main feedstock. Both AD feedstocks depend on maize biomass production, which is relatively easy to switch in and out of production of, therefore there are few concerns about reverting back to other crop production as required. While farmers are somewhat nervous about changing arable land into land for growing energy crops (such as miscanthus) due to the adverse effects this can have on drainage and the future ability to revert back to arable land, this is not the case for crops grown for use in AD. However, local farmers participating in the market for AD feedstock will still be concerned about the impact on their farming practices, whether they have the correct equipment and whether they are committed to contracts with buyers which come to an abrupt end[8]. Looking forward, gate fees are expected to continue to fall; new AD plants are continuing to be built, but feedstock volumes are not keeping pace, leading to increased competition (and therefore lower fees). To avoid this, and promote the development of a more sustainable industry, additional feedstock pathways are required; most notably, there is no current legislation to capture food waste from households and businesses. The introduction of this legislation (aimed at guaranteeing that such waste is used for AD) would support feedstock gate fees (by increasing volumes). This could take the form of separate food waste collections, such as are currently carried out in Scotland.

In addition, policy to support digestate processing (and create a fully-functioning market for this product) would help to support the industry, and maximise value created from feedstock.

The AD industry relies very much on local feedstocks –suppliers are keen to minimise costs beyond gate fees – and as such while local jobs and economic activity will be created in the region, it is primarily aimed at serving local need (i.e. local feedstock pathways), rather than focussing on exporting to the rest of the UK or beyond. This limits the potential development of the industry.

## 6.5 Heat pumps

**Summary**

The main opportunities and challenges for heat pumps in the YNYER region can be summarised as follows:

*Opportunities*

- There are a relatively high proportion of off-gas-grid properties in YNYER compared to the UK average, therefore future deployment rates of new heating technologies, including heat pumps, are likely to be higher than the UK average.
- Although there are currently no known heat pump manufacturers operating in the region, it may be the case that other manufacturing firms in the region operate further down the heat pump supply chain.
- The expected increased uptake of heat pumps in the YNYER region will create substantial opportunities for increased economic activity and jobs in

[8] Such as the discontinuation of Drax Power Station's direct contracts with miscanthus growers:https://www.nfuonline.com/cross-sector/farm-business/energy-and-renewables/energy-and-renewables-news/nfu-moves-to-reassure-drax-miscanthus-growers/

all stages of the heat pump value chain, particularly in commissioning and installation.

- Central government policy and initiatives are supporting the uptake of heat pumps, and this is expected to increase in the future.

*Challenges*

- The high up-front cost, and the lack of awareness about the potential benefits of heat pump technology, currently present substantial barriers to take-up.

Heat pumps, along with biomass, energy efficiency (both also evaluated in this study) and potentially hydrogen, will form part of the solution for future heating needs (residential and industrial). In the YNYER region, where there are a relatively high proportion of properties that are not on the gas grid, these are likely to be deployed in volume in the near future,  at rates above the national average, as part of the retro-fitting of such properties (which are typically currently heated via oil, and therefore have substantial environmental footprints which need to be reduced if the UK is to meet it's carbon reduction targets).

Government policy has a major role to play in accelerating the take-up of such technologies; for example, mandating the switching of oil-heated homes to low-carbon alternatives such as heat pumps would boost the local planning and installation industries, which dominate current economic activity within the value chain, as well as providing a boost to other low-carbon technologies such as biomass for heat and insulation. Current financial support for both air- and ground-source heat pumps, such as the domestic and non-domestic RHI programmes, also presents opportunities for uptake.

The expected increased uptake of heat pumps in the YNYER region will create substantial opportunities for increased economic activity and jobs in all stages of the heat pump value chain. Although there are currently no known heat pump manufacturers operating in the region, it may be the case that production of components used by heat pump manufacturers is taking place in YNYER (see Section 3.2 for a list of relevant sectors and Section 5.2 for estimates of local GVA and employment in these sectors). However, the highest increases in jobs and GVA in the region are expected to occur in the installation and commissioning and planning stages of the value chain.

A key challenge on heat pumps is around the up-front cost of the technology, which currently presents a substantial barrier to take-up, and a lack of information around the potential benefits of heat pumps (including on cost, when evaluated across the lifetime of the pump). Cost subsidies would have to be decided by central government, but there is a clear role for local action with regards to information campaigns aimed at improving take-up and therefore creating domestic jobs and activity.

## 6.6 Biomass for heat

**Summary**

The main opportunities and challenges for biomass for heat in the YNYER region can be summarised as follows:

*Opportunities*

- A high proportion of off-gas-grid properties exist in the region, presenting a substantial opportunity for biomass for heat uptake locally.

- The vast majority of the increasee employment and economic activity within the value chain is likely to occur in the production, collection and distribution of feedstock stage.
- The region currently has high employment in manufacturing sectors that contribute to the manufacture of biomass boilers and is well-placed to increase activity in this stage of the value chain.

*Challenges*

- At a European level, there has been some controversy around the sustainability and carbon footprint of wood-based fuels.

As with heat pumps, the uptake of biomass boilers in YNYER is around three times higher than the national average, predominately due to the number of off-gas-grid properties in the region. As previously noted, biomass for heat can benefit from the transition away from oil used for heating in off-grid properties, and measures to accelerate that would also be expected to benefit biomass for heat (assuming that the regulations do not favour one technology over another, i.e. allow for some houses to adopt heat pumps and others biomass boilers).

The increased rollout of biomass boilers is expected to lead to increased employment and economic activity in the provision of feedstock. While most feedstock is sourced locally, woodchip is easier to transport that AD feedstocks, and therefore there is the potential for (intra-UK) trade in feedstocks as demand ramps up across the UK. The region is also well-placed to increase activity in the manufacture of biomass boilers and related equipment, which currently employs almost 5,000 people across the YNYER region.

Key challenges here are most notably around government policy on renewable fuels; at a European level, there has been some controversy around the sustainability and carbon footprint of wood-based fuels, and it is currently unclear what view the UK will take in the longer term.

# 7 Conclusions and policy recommendations

Through a shortlisting procedure, this study has identified five low carbon technologies deemed to have the most potential in the YNYER region. These five technologies have been assessed in further detail to determine the key stages and corresponding sectors of the value chain for each technology. The current and projected economic value of each stage of the value chain, in terms of jobs and GVA, has then been calculated.

**Value chains with the greatest potential value**

From the value chain assessment, it can be concluded that in 2017, the complete value chain associated with insulation and fabric measures provided the greatest GVA and employment to the YNYER region, followed by activities related to electric and plug-in hybrid vehicles. The projections indicate that GVA generated by the heat pump value chain will be of most value to the YNYER region, and GVA associated with the electric vehicles and plug-in hybrids value chain is also expected to experience fast growth. Similarly, employment in the heat pump and electric vehicles value chains is expected to be greater than in any of the other technology value chains. Focusing policy efforts, whether that involves monetary or non-monetary intervention, in these technologies with the highest potential will aid the YNYER region in gaining value for money and maximising the economic impact of low-carbon technologies in the region.

*Particularly important stages of the value chain*

Within the electric and plug-in hybrid vehicles value chain, electric charging infrastructure represents the stage of the value chain with the highest economic value in terms of GVA. This reflects the need for increased investment in public and private charge points in the YNYER region, to both meet the demand for such infrastructure given future increases in EV and plug-in hybrid deployment (in line with the mooted UK-wide ban on the sale of ICE vehicles by 2040), as well as to increase the likelihood of EV and plug-in hybrid vehicle uptake in the region. Without the required charge-point infrastructure, consumers and businesses will be reluctant to invest in EVs (the so-called ‘chicken and egg’ problem). The expected rapid up-take of EV and plug-in hybrid vehicles will also lead to an increased number of jobs across the different stages of the associated value chain in the region. Most of the new jobs will be created within the value chain stages with higher employment intensity, including electric charging infrastructure, in which more than 8,000 jobs are expected to exist in the YNYER region by 2030.

Within the value chain for heat pumps, the projections indicate that the greatest growth in both GVA and employment is expected to occur in the installation and commissioning stage of the value chain. Employment in technical consultancy and planning of systems is also expected to outstrip employment in other stages, due to relatively high labour intensities in sectors such as technical testing and engineering design activities. Currently, a lack of a local drilling industry contributes to the high costs of heat pump installation. With greater future deployment of heat pumps assumed, it will be essential that the YNYER region develops a cohort of trained suppliers to carry out drilling and installation activities, and this is reflected in the projected employment figures. While employment in the manufacture and supply of heat pumps is not expected to be as high as in the labour-intensive stage of technical testing, GVA will be greater.

The current and projected estimates of employment and GVA in each of the stages of the value chains, outlined in Chapter 5 and above, provide some guidance as to where the greatest economic potential lies within the low carbon value chains. Targeting interventions at these sectors could lead to the highest economic rewards for the region. In this context, it is recommended that key stages or sectors of low carbon value chains are integrated within local economic strategies, to ensure policy interventions are aligned with the Local Energy Strategy.

## Cross-cutting policy recommendations

In the sections that follow some policy recommendations specific to each technology are outlined, in light of the characteristics of the technology value chain identified in Chapter 5, and the opportunities and challenges identified in Chapter 6. In the following text, some cross-cutting policy recommendations are set out, which are relevant to all the prioritised low carbon technologies.

*Greater local policy powers*

While local authorities and LEPs have some policy levers available to them, greater local powers would be beneficial, to be able to target investment and other interventions according to the characteristics of the local low-carbon sectors, recognising local differences in energy and environmental issues, rather than assuming that a given industry has similar characteristics across the whole of the UK. Localisation of emissions and renewable energy targets and decentralised support for renewable technologies and energy efficiency policies could allow the local authorities and LEP in the YNYER region greater opportunity to develop and pursue local policy goals. Greater local powers could also lead to the added benefit of increased local investor confidence, due to clearer planning of the evolution of the low-carbon economy. However, issues related to GHG emissions and energy demand are not only a national consideration, but are also international issues. For this reason, it is difficult to devolve some areas of energy and environmental policy.

A key task in developing the YNYER Local Energy Strategy will be to consider the recommendations set out in this study and in the previously commissioned research. Based on these recommendations, YNYER LEP needs to determine exactly which policy levers the LEP is able to use within its Energy Strategy to initiate investment in the prioritised low carbon technologies (University of Leeds, undated).

Alongside this, the LEP can use its role as a voice for local businesses, households and communities, using the recommendations set out in this study and in the previously commissioned research, to work with the national government to shape policy at a national, as well as local level, in such a way that the climate and economic goals of the YNYER region are better facilitated.

*Facilitating investment*

Across all of the prioritised low carbon technologies, often a substantial barrier to uptake is high upfront costs and difficulty in securing finance from investors. Developing and commercialising a new low-carbon technology is expensive, time-consuming and often risky – presenting innovators with many challenges in securing sufficient investment to bring products to market, and unaffordable prices present a barrier for consumer and businesses to switch to low carbon alternatives. Some of the barriers to innovation faced by low-carbon technologies relate to challenges in encouraging businesses to develop the technology, such as uncertainties about the future risks and rewards of investment in new technologies, limited knowledge of potential markets, and high upfront capital costs and long payback periods. Other barriers relate to challenges surrounding the marketplace for the low carbon technology, such as a lack of opportunity to benefit from economies of scale due to slow uptake of the technology, and incompatible public policies (Grubb, 2014). However, these barriers can be addressed through appropriate national and local policy.

Policy must be designed to both facilitate R&D and to create incentives for private investors to support innovation and bring new low-carbon technologies to the marketplace or increase up-take of these technologies. Technology-push policies support the development of initial ideas (i.e. from the invention stage of the innovation chain) through to commercially-viable products. Policies the YNYER LEP could pursue to encourage the further development of prioritised technologies include funding of local R&D, subsidies and grants and demonstrations of the technology and its application. Creating forums that connect local businesses operating in the low carbon value chains to appropriate investors would enable easier access to finance to kick-start low carbon technology developments, and supporting businesses in applications for funding from central government (such as the Regional Growth Fund). The LEP could also explore the potential for new investment mechanisms to finance green infrastructure and technology development, such as green bonds (as pioneered by Swindon Borough Council in 2016[9]). These bonds, issued by local authorities or LEPs, not only benefit low carbon technology development through financing community-owned low carbon facilities or infrastructure, but mean that the profits raised from developing a low carbon sector (through business rates, rent etc.) can be put back in to local community services and initiatives.

To address the market-pull barriers, national and local policy needs to be aimed at creating a viable local marketplace for the low-carbon technologies. In this context, national policy options include carbon pricing (making existing technologies expensive to run) and standards and regulation, all creating a demand for low-carbon alternatives. At the local level, the YNYER LEP could promote the up-take of each low carbon technology through raising awareness (within communities, local authorities and other stakeholders) of the application, practicalities and benefits (both environment and monetary) of each low carbon technology.

*Equipping local workers with the right skills*

As the YNYER region transitions to a low carbon economy and focuses efforts on developing local low carbon value chains, the local authority and LEP should ensure that workers can easily migrate between sectors so that workers have sufficient opportunities for employment in growing low carbon sectors, particularly those workers who may be displaced by declining high-GHG-emitting sectors. To enable migration between sectors it is vital that workers are equipped with the right mix of skills and qualifications to carry out new and changing jobs. Literature that focuses on the skills implications of green transitions (see for example Cedefop, 2010) tend to agree that the required topping up of skills is likely to be minor and is likely to focus on core STEM skills. Through close collaboration between the LEP and local

[9] For more information see for example https://www.swindonadvertiser.co.uk/news/14529160.uks-first-solar-bonds-sell-out-a-month-early-in-swindon/

employers, job centres and learning providers, the LEP should focus on anticipating the skills implications of growing low-carbon sectors (and declining high-emitting sectors) and quickly identify potential skills gaps in the workforce. Ensuring that appropriate training and education programmes are in place will mean that local workers are equipped with the necessary skills to fully realise new job opportunities, and the pathway towards a low carbon economy will be successfully realised, in terms of the impact on the environment, on the economy and on society.

The YNYER LEP should also ensure that the labour market and skills issues related to the focus on developing low carbon opportunities are recognised in any other policy aimed at the local labour market, leading to a coordinated approach to increasing employment in the region. Furthermore, those workers who are displaced by declining sectors should be suitably safeguarded, not only through social protection systems (which are determined at national level) but also through additional investment in skills development programmes.

*Knowledge-sharing*

Creating platforms for local knowledge and skills sharing has benefits beyond helping to address some of the skills gaps issues that could arise, as identified in the paragraphs above. Creating and coordinating forums that connect workers, employers and investors, as well as promoting collaboration between local industries and research institutions, also increases the likelihood that the low carbon technologies become more commercially-viable, increasing uptake rates. Furthermore, facilitating engagement between all stakeholders in this way embeds the local element of the low carbon value chains, creating more economic value for the YNYER region.

Initiatives such as the establishment of a climate commission for the local area provides an opportunity to bring together public, private and other groups to address the issues of climate change, and help develop low carbon value chains in the region. A local climate commission, akin to the Leeds Climate Commission[10], can help monitor progress within YNYER towards emissions targets, and recommend actions to local stakeholders and decision makers in line with the policy actions and priorities set out in the Local Energy Strategy.

It is also beneficial to facilitate opportunities for knowledge-sharing with other local authorities and LEPs, such as through the Energy Hub. Although all regions are different in terms of local assets and characteristics, lessons or methods of best practice can still be transferred to the YNYER region.

*Community energy projects*

A final cross-cutting policy recommendation is to consider supporting and investing in community energy projects. Community energy projects almost always utilise low-carbon technologies such as local renewable electricity generation or community heat projects, and can help address key energy challenges faced not just by the YNYER region, but nationally. The ‘Energy Trilemma’ refers to three specific energy challenges faced by the UK energy system; the affordability of energy, the sustainability of energy and power generation and the security of the UK’s energy supply. By encouraging the deployment of community energy projects in the YNYER region, the LEP can go some way to addressing these issues.

Community energy projects have the potential to create local jobs, allow easier access to cheaper forms of finance, tackle local fuel poverty more

[10] http://leeds.candocities.org/about-leeds-climate-commission

directly and create benefits for local communities from local tariffs. All these benefits help address the affordability of energy aspect of the energy trilemma.

Furthermore, community energy projects can help address security of supply issues by supporting the decentralisation of the UK energy system and encouraging the local community to match their demand to local renewable supply. Community energy projects can help increase the self-sufficiency of the UK energy sector, reducing reliance on energy imports.

Finally, the low-carbon nature of community energy projects reduce dependency on high-carbon fossil fuels, help meet local decarbonisation targets and encourages the transfer of low-carbon skills and knowledge between communities and regions, all benefits that contribute to solving the sustainability aspect of the energy trilemma (Good Energy, 2016).

In many cases, community energy projects refer to the installation of small-scale renewables not considered as priority technologies in this study, such as wind or solar farms. However, community projects can include the installation of small-scale AD plants, community energy efficiency measures and community heat networks, and in the following technology-specific sections examples of these projects are discussed in the corresponding section.

## 7.1 Electric and plug-in hybrid vehicles

**National-level policy support**

The Government currently provides various grants for consumers who wish to purchase an electric of plug-in hybrid vehicle. However recent (2018) changes to the grants offered on electric vehicles are likely to have a material impact on future purchases; the grant for plug-in hybrid vehicles (PHEVs) was removed entirely, and the grant for EVs has been reduced by £1,000 to £3,500. However, the cost of these vehicles continues to come down, and are widely expected to reach parity in the 2020s (BNEF, 2018), so the impact of changes in these grants on take-up should diminish over time.

There are also a number of schemes and grants offered by the Office for Low Emission Vehicles (OLEV) to support the installation of EV charging infrastructure:

- Electric Vehicle Homecharge Scheme –funding up to 75% towards the cost of installing electric vehicle chargepoints at domestic properties across the UK
- Workplace Charging Scheme – a scheme that provides support towards the up-front costs of the purchase and installation of electric vehicle charge points for eligible businesses
- On-street Residential Chargepoint Scheme - provides funding for local authorities towards the cost of installing on-street residential chargepoints

The YNYER LEP could consider applying for funding under the On-street Residential Chargepoint Scheme for some EV charge point infrastructure, and can also consider promoting the Electric Vehicle Homecharge Scheme to households in the region, and the Workplace Charging Scheme to businesses.

**Charging infrastructure**

The co-dependency between EV take-up and the deployment of charging infrastructure is often described as a ‘chicken and egg’ problem, in so much as individuals are reluctant to purchase an EV until they feel that there is adequate charging infrastructure to support them (particularly when they do not have off-street parking available at their residence for slow overnight charging), while private companies are reluctant to provide infrastructure until there is a critical mass of potential users to make the business case more compelling. There is a clear role for Government, local authorities and the YNYER LEP to step in and bridge this gap, primarily in two ways:

- First, through the potential funding of key infrastructure; this might be particularly important in rural areas, where business cases are currently more difficult to make for private investors, but where there are high levels of car dependency (and therefore a shift to EVs would have a greater environmental benefit). The cost for installation of charging infrastructure is expected to be high in the region, particularly when coupled with electricity supply and mobile network coverage issues (as identified in section 6.2). It is likely that central Government funding support will be required.
- Second, through information campaigns aimed at highlighting the benefits of EVs, and explaining how the current infrastructure can support users in the YNYER region. Through doing this, it is possible to address consumer concerns around range anxiety and a lack of infrastructure and encourage take-up.

In addition, some specific forms of charging infrastructure will require other kinds of public sector support. For example, the deployment of slower overnight charging for road-side parking is currently the subject of a number of trials (including a trial of lamppost charging in Greenwich). At the very least, the deployment of such infrastructure (either using existing infrastructure or built on public footpaths) will require local government support/permission.

**Workforce skills**

Both the installation of charging points, and (to a lesser extent, given the greater role for automation) the manufacture of charging point and vehicle components, will require relatively specialised skills, and if the YNYER region is to create the anticipated number of jobs in these segments of the value chain it is essential to ensure that there are suitably-skilled workers to fill these posts as they arise. This requires specific interventions, through the provision of relevant training schemes and formal qualifications, to deliver the skills required into the workforce.

**Maintaining competitiveness in component manufacturing**

There has been substantial press coverage of the potential adverse effects of the UK leaving the European Union upon the motor vehicle industry – and this is just as relevant to the nascent EV sector as to established technologies. The ‘just in time’ manufacturing and delivery of components with Europe is likely to be more challenging in the future, and supply chains will have to adapt to adjust to the new reality. From the perspective of component manufacturers in the region, that means consolidating and strengthening domestic supply chains (local and national), with a potential role for local government in helping to facilitate the development of local networks, and identifying relevant export opportunities as they arise.

## 7.2 Energy efficiency (insulation and fabric measures)

**Strengthening of the local value chain**

Demand for goods and services related to insulation and fabric measures is expected to increase rapidly up to 2030, as a result of central government targets and policies aimed at new builds and retro-fitting of older properties (particularly off-gas grid properties). As demand increases, ensuring access to materials and installers is key to ensuring that the YNYER region is positioned to realise the economic benefits. Supporting and developing the local value chain can be achieved through the establishment of 'growth hubs'[11] or by prioritising the value chain within economic strategies.

**Investment in training and best practice**

Related to support for the local insulation value chain is the development of the necessary skills base within the local labour market. If higher levels of deployment are expected in future, this will create an increased number of available jobs in the value chain. In anticipation of this, YNYER LEP should provide essential investment in training and best practice workshop programmes, in collaboration with local education providers, and should also work with local Jobcentres to promote these new opportunities.National-level policy support

**National-level policy support**

Although many insulation and fabric measures have a high impact in terms of the emissions reductions and energy savings that can be made, installing these measures is costly (although cheaper in comparison to other low-carbon options) and the payback time can be long (up to 5 years). Without additional support, consumers are slow to adopt these technologies.

The Green Deal was a scheme set up by central Government to help homeowners pay for home improvements such as double-glazing and solid wall insulation to improve the energy efficiency of their home. Since 2015 Green Deal funding was removed and was not replaced with any similar funding scheme. However, other central Government support is indirectly available under the Energy Company Obligation (ECO) (under which each large energy supplier has to contribute to a certain amount of energy-efficient home improvements, based on its market share) and the Warm Homes Fund (supporting people who are living in fuel poverty or a fuel poverty risk group). Continuation of these schemes is not guaranteed, but is crucial for high future deployment rates of insulation measures and for the development of the associated value chain in the YNYER region. The previous version of the ECO came to an end in September 2018 and the future of ECO is currently being debated in Parliament. YNYER LEP should press the Government to ensure these schemes remain in place, and that the design of any new or replacement version of energy efficiency funds are open to as many households as possible.

**Raising awareness of funding and local suppliers**

It may be the case that local households in the YNYER region are not aware of the various funding and grant options available to improve the energy efficiency of their home. Promoting local awareness of the various options would be beneficial, through leaflet drops, posters, advertisements through local radio or local news portals, canvassing or information points in public areas such as shopping centres. For vulnerable groups, information could be provided through local health care providers or facilities, or local Jobcentres.

Awareness campaigns can also be used to simultaneously promote local suppliers and installers operating in the region, helping to support the local value chain. Connecting individuals with local suppliers can be further aided through a 'one stop shop' scheme supported by the LEP. This scheme would bring together customers, suppliers, installers, finance, and external funding for vulnerable groups, all in one place. There are various examples of successful information and 'one stop shop' schemes elsewhere in the UK,

[11] http://www.growthhubs.co.uk/

which could be replicated in the YNYER region with the help of the LEP, such as Better Homes Yorkshire or the Kirklees Warm Homes Scheme.

**Community energy projects**

Community energy efficiency projects may also contribute to raising local awareness of the benefits of energy efficiency and to connecting households and businesses with local suppliers. These projects can involve members of the community organising meetings to discuss the benefits of energy efficiency measures, and mobilising consumers to take action, plan projects and make improvements. Projects may specifically focus on housing areas with high rates of fuel poverty. The YNYER LEP can assist with these initiatives, through funding or by helping to promote awareness of community groups or projects. The LEP could collaborate with organisations such as Community Energy England to support local energy projects in the YNYER region and assist with advocating for supportive policies at national and local levels.

## 7.3 Anaerobic digestion

**Strengthening local feedstock supply chains**

As identified in Chapter 6, a key challenge for the AD value chain in the YNYER region is the expected fall in gate fees[12] due to increased AD facilities, but a lack of growth in feedstock. Therefore, a key policy consideration for the YNYER LEP is how to support the development of a stronger supply of feedstocks. To promote the development of a more sustainable industry, additional feedstock pathways are required; most notably, there is no current legislation to capture food waste from households and businesses. Other regions of the UK, particularly Scotland, separate food waste collections, thus providing a ready supply of AD feedstock. The introduction of similar legislation in the YNYER region (aimed at guaranteeing that such waste is used for AD), and the introduction of incentives for households to separate out their food waste (such as monthly prize draws for all bins put out for collection[13]), would support feedstock gate fees (by increasing volumes).

In addition, policy to support digestate processing (and create a fully-functioning market for this product) would help to support the industry, and maximise value created from feedstock.

Stimulating the development of regional biomass supply markets would require close collaboration between the LEP and local farmers, foresters, local authorities and renewable energy sectors.

**National-level policy support**

At national level there are various initiatives that currently help increase the uptake of AD technology, supporting the AD industry and its associated value chain. Initiatives such as RHI for biomethane for gas grid, Renewable Transport Fuel Obligation (RTFO) for biomethane for transport and Feed in Tariffs (FiT) for electricity produced from AD, all help to address high costs of installation, which is one of the main barriers to the uptake of AD technology. Providing funding to help with the initial start-up costs of AD facilities can make it a more feasible low-carbon option. Furthermore, since the technology is relatively new (and is therefore considered risky), and the payback period can be long, gaining access to private finance can be difficult.

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[12] The amount a plant is paid per tonne to receive the waste.

[13] A successful prize draw scheme was carried out in East Cambridgeshire https://www.eastcambs.gov.uk/sites/default/files/it%20pays%20to%20recycle%20leaflet%201.pdf

The YNYER LEP can join forces with other groups lobbying for the Government to extend such funding and further incentivise the deployment of AD, such as the National Farmers Union (NFU), who have a UK-wide target of doubling the current number of farm-based AD facilities by 2020 to 1000 facilities.

**Localised support**

More localised or specific funds have existed in the past, such as the Rural Carbon Challenge Fund (managed by Defra, and part financed by the European Agricultural Fund for Rural Development,) which supported community renewable energy projects in the rural North West of England, including the installation of a 50kW on-farm anaerobic digestion plant at the Low Luckens Organic Resource Centre near Carlisle. WRAP developed the On-Farm Anaerobic Digestion Fund to help farmers in England get financial support to build small-scale AD plants on their farms, but the fund is now closed to new applicants[14]. YNYER LEP could replicate such funds to provide financial assistance to AD projects in the region.

YNYER LEP can also support businesses wishing to utilise available funding through identifying appropriate sources of funding, providing a reviewing role to help improve the quality of bids prior to submission and providing feedback and ongoing support.

**Community energy projects**

For individual farms or businesses producing suitable waste (such as food and drinks manufacturers) but which are too small to finance, install and run their own AD facility, the YNYER LEP can provide financial and management assistance for developing shared facilities through farming community energy projects. Successful examples of community AD facilities exist within the UK (such as the Cockerham Green Energy shared AD plant in Lancashire[15]), and the YNYER LEP can help promote dialogue with other communities who have successfully implemented these facilities, to share knowledge and suggestions of best practice.

**Raising awareness of AD and its benefits**

As well as encouraging the continuation and potential expansion of nation-level policy support, the YNYER LEP could also promote the awareness of AD technologies and the benefits of the technology by organising workshops for local businesses and relevant stakeholders in collaboration with organisations such as the Waste and Resources Action Programme (WRAP)[16] or the NFU. These workshops could help to inform stakeholders about what AD technology is, how it works, how much it costs to install and what the environmental and economic benefits of such systems are.

As well as referring to local reference sites or case studies within the region, practical demonstrations of the application of AD could be organised at facilities to showcase its use.

**Changes to planning requirements**

A final policy recommendation would be for the YNYER LEP to extend local planning requirements to include a condition that AD is considered during the expansion of premises, or in the development of new build sites.

[14] http://www.wrap.org.uk/content/farm-ad-fund

[15] http://www.energysavingtrust.org.uk/sites/default/files/RCCF+factsheet+Cockerham+GE.pdf

[16] http://www.wrap.org.uk/

## 7.4 Heat pumps

**Addressing barriers to uptake**

While heat pump technology offers the opportunity to substantially reduce the financial cost and carbon footprint of heating residential and commercial properties, the uptake of this technology is slow, not just in the YNYER region, but nationally. There are various barriers to uptake, many of which can be addressed by local interventions.

First, awareness of what heat pumps are and what they can achieve in terms of emissions reductions and energy cost savings can be improved, both amongst households and businesses in the YNYER region. Many individuals have never come across the concept of heat pumps, and would know little about what system is appropriate or feasible for their home or business premises, or who to contact for more information. YNYER LEP can actively promote an awareness campaign that not only provides households and businesses with information about the technology (including costs of installation, and energy savings), but that also recommends local suppliers who can provide further information, provide quotes and carry out installations. A campaign may involve leaflet drops, posters, advertisements through local radio or local news portals, canvassing or information points in public areas such as shopping centres and providing information at local business group events. YNYER LEP can also suggest for central government to support local awareness campaigns through large-scale national information campaigns.

Connecting individuals with local suppliers can be aided through ‘one stop shop’ scheme supported by the LEP. This scheme would bring together customers, suppliers, installers, finance, and external funding for vulnerable groups, all in one place. There are various examples of successful information and ‘one stop shop’ schemes elsewhere in the UK, which could be replicated in the YNYER region with the help of the LEP, such as Better Homes Yorkshire[17] or the Kirklees Warm Homes Scheme[18].

Increasing awareness of the features and benefits of heat pump systems does not overcome all barriers to increased uptake of this technology. The higher capital set-up cost of a heat pump system compared to conventional gas boiler presents a major barrier to entry. The Energy Savings Trust estimates that installing an air source heat pump costs between £6,000 and £8,000, and between £10,000 and £18,000 for installing a ground source system[19]. Central government funding schemes such as the Renewable Heat Incentive (RHI) can help address this barrier. The RHI is open to new applicants until at least March 2021, but it is vital that schemes such as this remain in operation to support households and businesses with the initial high set up costs. It is therefore recommended that the RHI scheme is extended beyond 2021, and the LEP could also consider more local funding initiatives. Local support from the LEP can also come in the form of connecting households and firms with financial institutions willing to provide the necessary funds to install new systems, at favourable rates.

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[17] https://www.betterhomesyorkshire.co.uk/

[18] http://www.kirklees.gov.uk/beta/delivering-services/pdf/warmzone-process-report.pdf

[19] The higher costs associated with the ground source system relate to drilling activities. The supply of drilling services is low within the UK in general, and promoting the development of a more local drilling industry would help bring costs of this stage of installation down.

Heat pump systems also rely on the building it is installed in to have a certain level of energy efficiency. Adequate levels of insulation and double glazing are required, to ensure that the heat pump system is efficiently heating the building. Further costs may be required to bring a buildings' energy efficiency up to standard, and while this presents further opportunities for the local insulation and double-glazing industry, it can mean heat pump systems are even more unaffordable for households and businesses. Policy that incentivises (or regulates) home or buildings insulation improvements is therefore required in partnership with funding support and other policy incentives aimed at increased heat pump uptake.

**Ensuring workers have adequate skills**

In line with one of the main policy recommendations encompassing all the low carbon technologies is the need to ensure there are enough workers with the right skills for the low carbon value chain to flourish – in this case there is an increased need for trained heat pump installers in the region. The LEP should work with local education providers to provide funding for the establishment of training schemes that equip workers with the correct skills, and should work alongside local Jobcentres to encourage workers to realise new job opportunities. The LEP could also work with existing local heat pump installers to promote apprenticeships within these firms.

**Strengthening of the value chain**

The local low carbon value chain for heat pumps could be strengthened through coordinated action between stakeholders associated with sectors of the value chain. Promoting the development of technology 'hub' in the region, which creates a community specialising in heat pump technology, could position the region well for anticipated future increases in local and national deployment – providing additional demand within the heat pump value chain through exporting opportunities. The YNYER region could declare itself a 'renewable heat zones'; a region where manufacturers, installers, and district network operators can work together, learning how to address individual barriers to uptake, to penetrate the market and increase uptake of heat pump technology (Frontier Economics, 2013). The establishment of a local heat pump association[20] can also provide additional support to local stakeholders associated with the value chain, and can be an important catalyst for technology introduction.

**Increased carbon emissions standards**

More stringent carbon emissions standards on new builds or heating system replacements, could regulate out existing heating technologies (starting with oil-fired systems, but ultimately including natural gas systems as well). This type of intervention is more likely to come from central government, but something akin to the Merton Rule could be applied in the YNYER region. The Merton Rule refers to a ground breaking policy adopted in the London Borough of Merton in 2003, which stipulated that all major new housing and commercial developments must have provision to generate at least 10% of their projected CO2 emissions from on-site renewable energy sources. The policy was subsequently adopted in other local authorities, and is now commonplace. Putting in place emissions standards on heating systems in new builds or when heating systems are replaced could be a straightforward policy the YNYER LEP could utilise to support the uptake of heat pump technology in the region.

[20] Similar to the European Heat Pump Association, but on a smaller scale focusing on local opportunities and challenges.

**National-level policy support**

There are various policy actions that can also be taken at a national level to help develop the heat pump value chain in the YNYER region, and while the LEP does not have any direct control over central government decisions, it can influence national policy, to help alignment with its own strategies and priorities. As already discussed, national information campaigns and funding schemes can help overcome some of the national barriers to increased uptake of heat pump technology. Other national level policy actions include introducing performance and labelling standards for heat pump technology, which can increase confidence about choosing and installing a system. Similarly, installer certification standards specific to heat pump systems would make choosing an installer more transparent[21].

**Community energy projects**

Community energy projects related to heat pumps are discussed in the next section, due to the substantial overlap in the kinds of projects relevant to the two technologies.

## 7.5 Biomass for heat

The government's Clean Growth Strategy aims to phase out high carbon fossil heating for off-gas grid properties by 2030 (BEIS, 2017), and biomass for heat presents a viable low carbon option for these properties. In Yorkshire and Humber there is a higher proportion of properties that are off-gas grid compared to the national average (21% compared to 13%). Renewable heat options such as biomass for heat will therefore be particularly important for the region in the period up to 2030.

Similar to the policy recommendations for heat pump systems, a starting point to increasing the deployment of biomass heating systems, and to phasing out the use of oil systems in off-gas grid areas, is to initiate more stringent standards on emissions limits of heating systems in new builds, or where heating system are being replaced, in the region, essentially regulating existing technologies out of the market. In its Clean Growth Strategy, The Government also vows to consider *'a range of policy options'* to support the phase out of high carbon fossil heating for off-gas grid properties and will invest £10 million in *'an innovation challenge fund to support low carbon heating systems'*.

**Barriers to uptake**

Many of the policy recommendations for biomass for heat are similar to the recommendations made for heat pumps. Both technologies offer great environmental and economic benefits for the YNYER region, but in both cases there are barriers to uptake. These similar barriers, and potential interventions the LEP can apply to address them, are reiterated below:

- Lack of awareness amongst households of biomass for heat technology and its benefits – addressed via local awareness campaigns and support from large-scale national information campaigns would be advantageous
- Connecting individuals with local suppliers – the LEP can support 'one-stop shop' portals that connect households, suppliers and financiers
- Higher capital set-up cost of a biomass heat system compared to conventional heat systems – The Energy Savings Trust estimates that

[21] Currently the main UK quality assurance scheme for low-carbon and renewable energy technologies (which includes heat pumps) is the Microgeneration Certification Scheme (MCS).

although a biomass heating system can save around £800 a year compared to electric heating systems, the installation costs are between £8,000 and £15,000[22]. Local funding and grants for households in the YNYER region wishing to install a biomass heating system would help overcome this financial barrier

**Community energy projects**

The financial barrier to increased uptake of biomass for heat and heat pumps could in some instances also be overcome by encouraging community heat networks. Community heat networks differ from district heating networks in that they are much smaller-scale, and typically supply centralised heat to one building block with multiple users, or a few buildings in close proximity on one site. Small business parks could be good candidates for this type of community heating, with businesses collectively funding a centralised biomass boiler or heat pump system. Community heat projects can also take the form of replacing individual heating systems with biomass or heat pump systems in key community buildings, such as libraries or schools, and bulk buying of biomass heating fuels (DECC 2016). YNYER LEP could assist with these kinds of community projects through providing financial assistance, as well as support in other ways such as by connecting businesses and households with suppliers and investors. The LEP could promote the establishment of local community cooperatives and stimulate engagement with other successful community heat projects in other regions, such as the Green Fox Community Energy Co-operative in Leicestershire[23], or Woolhope Woodheat[24].

To support community heating projects such as these, DECC has produced a 'Community Heat Toolkit' to help communities and smaller local authorities identify and develop opportunities in their region, and identify challenges associated with community-led heating projects[25]. YNYER LEP can utilise this resource, as well as resources and information offered by organisations such as Community Energy England, when providing assistance to local communities.

**Investment in training**

A cross-cutting policy issue across all the prioritised low carbon technologies is the potential skills gaps that may exist in the local value chains. As is the case for other low carbon value chains in the region, the YNYER LEP should work alongside education providers and employers in the region to identify current and future skills gaps, and provide support and funding for training schemes or best practice workshops.

**Improving quality standards**

Research indicates that biomass boilers may not be as efficient as expected, meaning biomass heating systems may not be providing the emissions reductions hoped for (DECC, 2014), and confidence in their viability may be reduced. The research notes that currently, the only form of standards or regulation affiliated with biomass boiler installation is Microgeneration Certification Scheme (MCS) but it only covers smaller boilers below 45KW in capacity. This means for larger boilers there is no quality standard. Introducing

[22] http://www.energysavingtrust.org.uk/renewable-energy/heat/biomass

[23] https://greenfoxcommunityenergy.coop/

[24] https://woolhopewoodheat.org.uk/

[25] https://s3.eu-west-2.amazonaws.com/prod-wl-cee/resources/files/Community_Heat_Introduction_Document_2.1.pdf

better quality standards to raise efficiency and the attractiveness of biomass for heat is required, and is likely to come from central Government.

### Developing the local fuel supply chain

Households looking to install a biomass heating system will consider the running costs of the system, including fuel, which may be in the form of logs, wood chips or pellets. In order to ensure the running costs of biomass systems are competitive with other conventional heating systems, the YNYER LEP should help support the development of a local fuel supply industry and connecting suppliers with customers – buying locally should be cheaper as transportation costs are lower. Furthermore, carbon emissions are produced from the cultivation, manufacture and transportation biomass fuel, meaning it is important that fuel is sourced locally, to keep these associated emissions as low as possible.

As well as reducing emissions associated with the production and transportation of biomass fuel, biomass heating systems can only be considered low-carbon options if new plants continue to grow in place of those used. It is therefore fundamental that the YNYER LEP encourages local foresters and farmers to produce *sustainable* fuel. Support could come in the form of subsidies or grants, or through sharing best practice techniques for sustainable production and environmental management. Simultaneously, YNYER LEP should encourage households to purchase their fuel from sustainable sources. The Government provides a list of registered sustainable suppliers[26] that must be used by RHI participants. YNYER LEP can help households in the region connect with those firms located nearest to them who feature on this list.

### National-level policy support

At national level, the RHI is open to new applicants until at least March 2021, but as already discussed in the policy recommendations for heat pumps, initiatives such as the RHI are hugely beneficial to households wishing to install renewable heat systems who would otherwise be dissuaded by the high installation costs. Extending the scheme beyond 20121 would be hugely beneficial for the future deployment levels of biomass for heat technology in the YNYER region.

[26] https://www.gov.uk/find-fuel-supplier

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# Appendix A Low carbon technology options assessment

## Offshore wind

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | ≈ 6 GW is installed, under construction, or planned off the coast of the East Riding of Yorkshire (Orsted, 2018) (E.ON, 2018)<br>At least 400 MW comes ashore and is connected to the electricity grid in East Riding (Orsted, 2018) (E.ON, 2018) | – |
| Deployment potential | As many as 30 GW off-shore wind could be installed in the UK by 2030, and around quarter of this may be near the Yorkshire coast (OWIC and ORE Catapult, 2018)<br>6 GW capacity will prevent 7.5 $MtCO_2$/year compared with CCGT electricity generation, while 12 GW would prevent 15 $MtCO_2$/year | ↑ |
| Cost effectiveness | Yorkshire Hornsea Project Two and Triton Knoll achieved strike prices of £57.50/MWh and £74.75/MWh in the second Contracts for Difference auction, making them cheaper than new CCGT plants (Ofgem, Contracts for Difference Round 2 Allocation Results, 2017) | ↑ |
| Policy incentives | Offshore wind is eligible for CfD auctions, unlike solar PV and onshore wind.<br>Offshore Renewable Energy Catapult supports sector development | ↑ |
| Local influence | Planning permission for offshore wind projects are considered by the Planning Inspectorate<br>Local government may be able to encourage local development of related industries | ↓ |
| Value accrual | The majority of the offshore wind production, installation, and maintenance occurs in Hull and Grimsby, which host world-class offshore wind facilities (Orsted, 2018) (E.ON, 2018)<br>Some specialist offshore marine companies are based in Scarborough (Orsted, 2018) (E.ON, 2018) | ↓ |
| Related benefits and technologies | DSR and energy storage may help to minimise curtailment of offshore wind | Not rated |

## Solar PV

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | 2016: 21,000 solar installations in YNYER, totalling 147 MW capacity<br>Annual production 130 MWh (BEIS, Renewable electricity by local authority 2016, 2017) | – |
| Deployment potential | Rooftop solar potential: 340 MW identified in York (AMEC for York CC, 2014), 81 MW in Harrogate (AECOM for Harrogate BC, 2011), and 2 MW in Richmondshire (AECOM for Richmondshire DC, 2012). Deployment at this level would prevent 0.15 $MtCO_2$/year relative to CCGTs. | ↑ |
| Cost effectiveness | UK's first 'subsidy-free' solar (and energy storage) farm opened in Milton Keynes 2017 (Anesco, 2018)<br>Small scale solar costs between £1300 and £1800 per kW installed (BEIS, Annual Cost of Small scale Solar Technology Summary, 2018)<br>In first CfD auction, solar projects achieved strike price of £79.23/MWh (Ofgem, Contracts for Difference Round 1 Allocation Results, 2015) | – |
| Policy incentives | Large scale solar is not eligible for the next CfD auction, May 2019 (Current News, 2018)<br>FiT (both generation and export tariffs) scheduled to end April 2019 although BEIS is currently consulting on this | ↓ |
| Local influence | Local government can promote solar installations by eliminating the need for planning permission for rooftop solar PV, and by encouraging the installation of solar panels on new buildings where appropriate<br>LAs may also provide support for community energy projects and approve permission requests for solar farms | ↑ |
| Value accrual | Solar panels are not produced in the region, but rooftop PV systems are installed by local tradesman; there are currently 661 MCS-accredited installers in Yorkshire and Humber (MCS, 2018)<br>Large scale solar installations are typically developed by specialised companies which operate nationally or internationally | – |
| Related benefits and technologies | DSR and energy storage may help to minimise curtailment of solar PV<br>Rooftop solar installations combine favourably with EVs and heat pumps (renewable heat)<br>Combining energy storage with large scale solar PV can improve the business case | Not rated |

## Energy efficiency (fabric efficiency measures)

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | Of the nearly 500,000 dwellings in the region, 230,000 have insulated cavity walls (DHCLG, 2015-16)<br>90% of the dwellings have at least 80% of their windows double-glazed (DHCLG, 2015-16)<br>55% of the dwellings have at least 150 mm of loft insulation (DHCLG, 2015-16) | – |
| Deployment potential | 85,000 dwellings have uninsulated cavity walls (DHCLG, 2015-16), 25% in Yorkshire and Humber vs 31% in England<br>145,000 dwellings have uninsulated solid walls (DHCLG, 2015-16), 90% in Yorkshire and Humber, similar to England<br>22,000 dwellings have no loft insulation and 160,000 dwellings have < 100 mm of loft insulation (DHCLG, 2015-16)<br>Bringing the ≈ 380,000 dwellings below EPC C up to that level would eliminate 0.3 $MCO_2$/year (DHCLG, 2015-16) (BEIS, 2017) (Energy Bill Revolution, 2014) | ↑ |
| Cost effectiveness | Lower cost measures (e.g. double glazing) have largely been taken up<br>Many remaining high impact measures (e.g. cavity insulation and solid wall insulation) have payback times of around 5 years (Energy Saving Trust, 2018), but consumers are slow to adopt these without external support | ↑ |
| Policy incentives | Government support: ECO, Green Deal, Central Heating Fund, and National Grid Warm Homes Fund | ↑ |
| Local influence | Schemes set up by local governments have proven to be effective promoters of home efficiency measures. Such schemes help to reduce perceived risk in investment and may also defray costs (either through grants to low income households or by bulk purchasing)<br>Successful local schemes often set up ‘one stop shops’ bringing together customers, suppliers, installers, finance, and external funding for vulnerable groups, e.g. Better Homes Yorkshire (Better Homes Yorkshire, 2018)<br>Installer training and best practice workshops have also been helpful | ↑ |
| Value accrual | Installation of energy efficiency measures into existing buildings is employment-intensive<br>Materials are fabricated elsewhere but most of the funding will be dedicated to skilled local tradesman and distributors<br>Aggressive promotion of energy efficiency measures is predicted to generate 1400 jobs in the region (Energy Bill Revolution, 2014) | ↑ |
| Related benefits and technologies | Energy efficiency measures also reduce fuel poverty and improve public health<br>Renewable heating systems are more appropriate for high efficiency buildings | Not rated |

## Anaerobic digestion

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | 31 MW electricity and 30 MW biomethane capacity from 28 AD facilities in the YNYER region, corresponding to 8% and 6% of the UK total and 75% and 60% of the Yorkshire and Humber total, respectively. (NNFC, 2018)<br>240 kt per annum farm feedstock (including wastes and energy crops) and 525 kt per annum waste feedstock are used (NNFC, 2018) | – |
| Deployment potential | AD can make use of a range of feedstock including food waste, animal manure and slurry and the biogenic component of municipal solid waste and commercial/industrial waste<br>300 kt of food manufacturing waste is discarded in Yorkshire and the Humber each year (Anthesis for BioVale & York University, 2018)<br>Assuming an energy content of 7 GJ/t (HM Government, 2018), using 300 kt of food waste could recover up to 600 GWh of biogas<br>2016 Defra Pollution Inventory indicates a further 300 kt of AD-appropriate waste in Yorkshire and the Humber (DEFRA, 2016)<br>NFU has UK-wide target of 1000 farm-based AD facilities by 2020, twice the current number (NFU, 2016)<br>A separate study estimates that the YNYER region has the potential to produce around 700 GWh of renewable heat and electricity from various waste resources in the region (AECOM for Local Government Yorkshire and Humber, 2011)<br>Currently, 0.1 $MtCO_2$/year are avoided due to reduced use of natural gas for heating and electricity generation, this could be increased to about 0.25 $MtCO_2$/year | ↑ |
| Cost effectiveness | Typical payback time between 8 and 12 years, making plants commercially viable (National Energy Foundation, 2013) | ↑ |
| Policy incentives | RHI for biomethane for gas grid, RTFO for biomethane for transport<br>FiT for electricity produced from AD | ↑ |
| Local influence | Assistance for individual farms and small food and drink companies which are often too small to run their own AD facility (National Energy Foundation, 2013), but could contribute to a shared facility<br>A planning requirement to consider AD during expansion of relevant facilities<br>Workshops/communication to raise awareness of opportunities from WRAP (WRAP, 2018) and other bodies<br>Providing access to finance, which is often a critical barrier (National Energy Foundation, 2013) | ↑ |

| | | |
|---|---|---|
| Value accrual | The majority of the relevant businesses are small and locally owned (Anthesis for BioVale & York University, 2018) (National Energy Foundation, 2013)<br>Market value of municipal and commercial/industrial waste has been estimated (HM Government, 2018) in the range -£46 to -£10 per tonne (the negative values indicate a "gate fee" i.e. a cost for disposal); use of 300 kt/yr of this waste for AD has the potential to mitigate waste disposal costs in the region of £3-14 million/yr<br>The digestate resulting from AD can be used or sold as fertiliser<br>Prior studies have estimated that AD plant can create 14 FTE jobs per MWe (NNFC for DECC, 2012) | ↑ |
| Related benefits | Circular economy, heat networks | Not rated |

### Biomass for heat

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | ≈ 750 domestic biomass boilers installed during the RHI<br>55% of the domestic RHI installations within Yorkshire and the Humber are in YNYER (BEIS, 2018)<br>≈ 1200 non-domestic biomass boilers installed during the RHI<br>70% of non-domestic RHI installations within Yorkshire and the Humber are in YNYER (BEIS, 2018), 230 MW capacity | – |
| Deployment potential | 21% of the YNYER housing stock (110,000 dwellings) is off-gas vs 13% all-England average (BEIS and ONS, 2018)<br>Clean Growth Strategy aims to phase out high carbon fossil heating for off-gas grid properties in the 2020s (BEIS, 2017)<br>Conversion of 90% off-gas grid homes to biomass would prevent 0.4 $MtCO_2$/year. Conversion of 90% of off-gas non-domestic buildings and 30% of on-gas non-domestic dwellings would prevent a further 0.4 $MtCO_2$/year<br>Agricultural waste and energy crops in the region could produce 1.1 TWh/year, which would prevent 0.3 $MtCO_2$/year if used for biomass heating | ↑ |
| Cost effectiveness | Positive ROI for end users with RHI support | ↑ |
| Policy incentives | RHI is open to new customers until March 2021 | ↑ |
| Local influence | A ‘one stop shop’ bringing together customers, suppliers, installers, finance, and external funding may be successful.<br>Installer training and best practice workshops have also been helpful | ↑ |
| Value accrual | Development of a local supply chain for biomass would increase the local value accrual<br>Domestic and commercial biomass installations are installed by local tradesmen, 293 MCS-certified biomass installers within Yorkshire and the Humber (MCS, 2018) | ↑ |
| Related benefits and technologies | Energy efficiency – domestic fabric improvements<br>Also need to consider air quality implications and competition with food production | Not rated |

## Biomass for electricity

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | 1960 MWe capacity at Drax, although the majority of the biomass fuel is supplied from outside the region (BEIS, 2017)<br>22 MWe capacity at a biomass plant in Tansterne, East Riding. Fuel is primarily waste wood from the local area (Solar 21, 2018) | – |
| Deployment potential | ≈ 6 Mtonnes biomass is needed for Drax annually (NFU, 2016), roughly 50 TWh/year<br>200,000 tonnes were provided by UK farmers until contracts ended in 2017 (see below)<br>Agricultural waste, energy crops, and waste wood in the region could produce 5.2 TWh/year (AECOM for Local Government Yorkshire and Humber, 2011)<br>This would prevent 0.6 $MtCO_2$/year if used to generate electricity | ↑ |
| Cost effectiveness | Drax has invested £135 million in developing the Immingham Renewable Fuels Terminal, which is the largest renewable fuels handling facility in the world (Drax, 2018)<br>Drax ended its contracts with UK miscanthus growers in 2017, citing the low cost of overseas wood pellets (NFU, 2016). Contracts were re-assigned to Terravesta which supports several end uses | ↓ |
| Policy incentives | Biomass may participate in the CfD auction only if operating as a CHP plant | ↓ |
| Local influence | Support for farmers to transition to energy crops may include training on best practices, support for the upfront costs, or measures to reduce risk<br>Limited influence over sourcing decisions made by Drax and other large biomass plants | – |
| Value accrual | Development of a local supply chain for biomass would increase the local value accrual from the region's biomass power generation<br>100 people were employed in the construction of the Tansterne plant, and 24 longer-term jobs were created (HRS, 2018) | ↑ |
| Related benefits and technologies | Heat networks<br>Also need to consider air quality implications and competition with food production | Not rated |

## Carbon Capture and Storage

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | 15 CCS projects are in operation globally (NGN, Kiwa Gastec and AMEX, 2016)<br>Front end engineering work has been completed on 6 UK projects, including two projects involving the Endeavour saline aquifer off the Yorkshire coast (neither being pursued currently) | – |
| Deployment potential | The Teesside Collective is a cluster of public and private organisations working to develop industrial carbon capture and storage (support recently received from Teesside City Deal) (Teesside Collective, 2018)<br>HyNet NW intends to produce hydrogen from natural gas and store the resulting CO2 (Teesside Collective, 2018), construction scheduled to begin in 2021<br>Drax has announced investment of £400,000 in a pilot scheme for CCS (BBC news, 2018)<br>If CCS was added to Drax's biomass portion, this would prevent 6 Mt/year $CO_2$ (negative emissions)<br>Converting Drax to 100% biomass with CCS would prevent 19 Mt/year $CO_2$ (12 Mt negative emissions) | ↓ |
| Cost effectiveness | Cost to end users will depend significantly on the financing mechanisms and level of government support provided<br>Recent studies indicate the total long-term infrastructure and consumer costs are likely comparable to other solutions (HyNet, 2018) | – |
| Policy incentives | Government is committed to further research (BEIS, 2017) and has established the CCUS Cost Challenge Task Force to develop the option for the UK to deploy CCUS at scale in the 2030s | ↑ |
| Local influence | Key decisions on the future of the gas grid will be made at the national level, but active promotion of local projects is critical.<br>The CCUS Cost Challenge Task Force has recommended the development of CCS in clusters and that two clusters should be operational from the mid-2020s (CCUS Cost Challenge Taskforce , 2018).<br>Both Yorkshire-based CCS projects mentioned above are not being pursued due to decisions made by Drax and the UK government (BBC news, 2015) | ↓ |

| | | |
|---|---|---|
| Value accrual | The benefits of offshore storage are likely to accrue in the areas hosting larger ports although businesses in Scarborough and Bridlington may also benefit<br>The installation and operation of carbon capture equipment and onshore pipelines through the region would bring value locally | – |
| Related benefits and technologies | Hydrogen, biomass for electricity | – |

## Heat pumps

| Criteria | Comments | Impact |
| --- | --- | --- |
| Current level of deployment | ≈ 1800 domestic ASHPs and ≈ 500 GSHPs installed during the Renewable Heat Incentive (RHI)<br>55% of the domestic RHI installations within Yorkshire and the Humber are in the YNYER (BEIS, 2018)<br>Non-domestic installations difficult to estimate due to low volumes, estimate 7 MW capacity installed (BEIS, 2018) | – |
| Deployment potential | 21% of the YNYER housing stock (110,000 dwellings) is off-gas vs 13% all-England average (BEIS and ONS, 2018)<br>Clean Growth Strategy aims to phase out high carbon fossil heating for off-gas grid properties in the 2020s (BEIS, 2017)<br>0.6 Mt$CO_2$/year would be prevented if 90% of off-gas households and commercial premises switched to heat pumps, and a further 1.5 Mt $CO_2$/year would be prevented if 70% of on-gas homes and commercial premises switched to heat pumps | ↑ |
| Cost effectiveness | RHI designed to lead to the same or lower lifetime cost of heating than the counterfactual fossil fuel | ↑ |
| Policy incentives | RHI is open to new customers until March 2021 | ↑ |
| Local influence | Local governments have not been significantly involved in heat pump deployment to date<br>Requirement for consideration of heat pumps for new builds where appropriate<br>A ‘one stop shop’ bringing together customers, suppliers, installers, finance, and external funding for vulnerable groups may be successful | ↑ |
| Value accrual | Heat pumps are installed by local skilled tradesman although they are not manufactured within the region<br>There are currently 447 MCS-certified installers within Yorkshire and the Humber (MCS, 2018)<br>GSHPs require external construction work (trench or borehole) in addition to in-home installation<br>Prior work by Element Energy (Element Energy and Eider Consulting for BEIS, 2017) suggests value of HP installation alone (i.e. excluding product cost) is in range £2-3,000 per dwelling for ASHP and £5-8,000 for GSHP; value of installing HPs in all 30,000 off-gas houses in YNYER expected to be in the range £60-240 million, of which the majority expected to accrue to local installers | ↑ |

| | | |
|---|---|---|
| Related benefits and technologies | Heat pumps require a high level of building fabric efficiency (typically assumed to be EPC C)<br>Energy storage and rooftop solar panels combine favourably with heat pumps | Not rated |

## Heat networks

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | In the University of York Heslington East scheme, an 850 kW biomass boiler and 2 x 1.5 MWe gas-fired CHP engines produce 7 GWh per year (ADE, 2018)<br>Derwenthorpe is a development of 580 homes built by the Joseph Rowntree Housing Trust. Heat is supplied from centrally located biomass boilers (JRHT, 2018)<br>Significant existing schemes in Sheffield (existing) and Leeds (under construction) | – |
| Deployment potential | North Yorkshire and Hambleton have been awarded HNDU funding to consider a district heating scheme for Northallerton (North Yorkshire CC, 2018), York City potential deployment estimated at 85 GWh/year (14 MW) (AMEC for York CC, 2014)<br>Hospitals and local industry may have excess heat that could be delivered to a heat network, if suitable heat loads are located nearby<br>Deployment of 125 GWh would prevent 0.02 Mt $CO_2$/year if recovered waste heat used | ↓ |
| Cost effectiveness | Heat network feasibility depends strongly on the density of heat demand, which is likely to be too low outside of urban areas, and potentially a limited number of densely populated rural agglomerations | ↓ |
| Policy incentives | Heat Networks Development Unit (HNDU) funds masterplanning and project development<br>Heat Networks Investment Programme (HNIP) funds or part-funds capital expenses, and aims to invest £320 million while leveraging about £2 billion in private/other investment | ↑ |
| Local influence | Heat networks are capital intensive, and often require commitment from local government to provide anchor heat sources, and potentially capital or access to finance<br>Local government can impose planning requirements to consider heat networks for new developments, but many may be too low density to be economical | ↑ |
| Value accrual | Heat network development is typically overseen by nationally or internationally operating ESCOs, but work may be contracted to local construction firms<br>Maintenance and oversight performed locally | – |
| Related benefits and technologies | Biomass, renewable heat (heat pumps), energy storage | Not rated |

### Hydrogen for heating

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | Tees Valley hosts majority of existing hydrogen facilities<br>Feasibility studies and tests are ongoing, including Leeds H21 project (2021 to 2029) (NGN, Kiwa Gastec and AMEX, 2016) and the Hy4Heat series of studies (ARUP, 2017) | – |
| Deployment potential | Extensive system of salt caverns near Scarborough, Bridlington, and Whitby are planned for use during H21, see conceptual map below (NGN, Kiwa Gastec and AMEX, 2016)<br>Teesside is the first choice for hydrogen production (SMR + CCS), but Hull and the surrounding area are considered to be the backup option (NGN, Kiwa Gastec and AMEX, 2016)<br>Ultimate regional potential: conversion of ≈ 400,000 on-gas households to hydrogen (DHCLG, 2011-12), which would prevent 0.9 $MtCO_2$/year if converted to hydrogen with CCS<br>HyNet NW aims to demonstrate CCUS and will start in 2021 (HyNet, 2018)<br>Significant uncertainty remains around wide-scale hydrogen deployment. Near-term projects are not located in the YNYER. | ↓ |
| Cost effectiveness | Cost to end users will depend significantly on the financing mechanisms and level of government support provided<br>Recent studies indicate the total long-term infrastructure and consumer costs are likely comparable to other solutions (Element Energy and E4Tech for NIC, 2018) | – |
| Policy incentives | Government is committed to further research (BEIS, 2017), has dedicated £25 million to the Hy4Heat studies, and an additional £20 million recently committed | ↑ |
| Local influence | Key decisions on the future of the gas grid will be made at the national level<br>Decisions on the H21 project will be made by Northern Gas Networks, with involvement of Leeds CC and other local authorities | ↓ |
| Value accrual | H21 project will occur primarily in Leeds and Teesside, although pipelines and storage facilities will be developed in the YNYER | – |
| Related benefits and technologies | CCS, Energy storage | Not rated |

## Demand-side response and energy storage

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | Nationally, 613 MW DSR is contracted for the Capacity Market in 2018/19, 1.2% of the total (National Grid, 2018)<br>2900 MW compressed air and battery storage is contracted for the Capacity Market in 2018/19, 6% of the total (National Grid, 2018)<br>DSR and energy storage also provide auxiliary services such as FFR, EFR, STOR | – |
| Deployment potential | BEIS Clean Growth Strategy indicates that DSR could provide 4.9 GW by 2032 (BEIS, 2017)<br>Time of Use tariffs will encourage DSR at household and business level<br>EVs may be leveraged to provide both DSR and electricity storage | ↑ |
| Cost effectiveness | 2018/19 T-1 auction clearing price was £6/kW/year, the lowest ever (National Grid, 2018)<br>Distributed DSR and energy storage can reduce the need for network reinforcement<br>Addition of ‘smart’ functionality to existing systems (EVs, heat pumps, appliances) adds relatively little over existing technology cost | ↑ |
| Policy incentives | Clean Growth Strategy commits the government to spending £70 million before 2022 to promote DSR and energy storage, including £20 million for vehicle-to-grid products and services (BEIS, 2017)<br>Further policy steps have been laid out by Ofgem (Ofgem, 2017) | ↑ |
| Local influence | Uptake of distributed DSR and storage systems can be promoted locally, but this does not appear to be a USP for the YNYER region<br>Limited influence over the citing of large scale projects | ↓ |
| Value accrual | Distributed DSR and energy storage shift spending away from infrastructure and towards manufactured goods, typically made outside the region. | ↓ |
| Related benefits and technologies | Offshore wind, solar PV | Not rated |

## Electric and plug-in hybrid vehicles

| Criteria | Comments | Impact |
|---|---|---|
| Current level of deployment | Approx. 500,000 personal vehicles in the YNYER region; ≈ 7000 hybrid and ≈ 500 electric vehicles (DfT, 2018)<br>Across Yorkshire and the Humber, 916 public chargers are already installed (ZapMap, 2018) | – |
| Deployment potential | ≈ 40,400 new vehicles are purchased each year in the YNYER region (DfT, 2018)<br>UK gov't has committed to banning non-hybrid IC engines by 2040<br>Over 1500 rapid chargers would be needed in the YNYER region if all vehicles became electric (assuming 1 charge point per 300 vehicles)<br>Conversion of all personal vehicles to electric would prevent 1.1 Mt $CO_2$/year | ↑ |
| Cost effectiveness | Some EV models may reach initial cost parity with IC engines around 2025 (Element Energy for BEUC, 2016)<br>Electric vehicle charging is already more affordable than fossil fuel purchase, and TCO parity with petrol ICE vehicles may be reached by 2020 (Element Energy for BEUC, 2016) | ↑ |
| Policy incentives | Plug-in car grants cover up to 35% of the vehicle's purchase price | ↑ |
| Local influence | Coordinated provision of standard and rapid public charge points facilitates the uptake of EVs<br>Many charge points are installed by private industry, but public promotion of charge points in less populous areas may be required<br>A solution for charging vehicles parked on-street will likely require local government involvement (e.g. Greenwich lamppost charging trial (Greenwich Lamppost Charging, 2018))<br>Several innovative schemes have been funded by the Office for Low Emissions Vehicles (Office for Low Emmisions Vehicles, 2018) | ↑ |
| Value accrual | Vehicles are not produced within the region<br>Installation of home and public charge points will involve local skilled labour including electricians and some construction<br>Charge point maintenance will also be done locally | ↑ |
| Related benefits and technologies | EVs can participate in DSR and energy storage | Not rated |

## Summary of assessment

| Technology | Category | Carbon Trust Rank | Mt/year $CO_2$ reduction | Deployment potential | Cost effectiveness | Policy incentives | Local influence | Value accrual |
|---|---|---|---|---|---|---|---|---|
| **Energy efficiency** | **Electricity, Heat** | 1 | 0.3 | ↑ | ↑ | ↑ | ↑ | ↑ |
| **Electric and plug in hybrid vehicles** | **Transport** | 3 | 1.1 | ↑ | ↑ | ↑ | ↑ | ↑ |
| **Renewable heat** | **Heat** | 5 | 2.1 | ↑ | ↑ | ↑ | ↑ | ↑ |
| **Anaerobic digestion** | **Electricity, Heat** | 11 | 0.25 | ↑ | ↑ | ↑ | ↑ | ↑ |
| **Biomass for heat** | **Electricity, Heat** | 12 | 0.8 / 0.3[1] | ↑ | ↑ | ↑ | ↑ | ↑ |
| Energy storage | Smart grid | 9 | 0.5 | ↑ | ↑ | ↑ | ↓ | ↓ |
| CCS | Electricity, Heat | 9 | 6 | ↓ | — | ↑ | ↓ | — |
| Solar PV | Electricity | 6 | 0.15 | ↑ | — | ↓ | ↑ | — |
| DSR | Smart grid | 4 | 0.5[2] | ↑ | ↑ | ↑ | ↓ | ↓ |
| Offshore wind | Electricity | 2 | 15 | ↑ | ↑ | ↑ | ↓ | ↓ |
| Heat networks | Heat | 6 | 0.02 | ↓ | ↓ | ↑ | ↑ | — |
| Hydrogen | Heat | 6 | 1.0 | ↓ | — | ↑ | ↓ | — |
| Biomass for electricity | Electricity, Heat | 12 | 0.6 | ↑ | ↓ | ↓ | — | ↑ |

1: The two values are carbon avoided from use of biomass boilers and carbon avoided from using the full regional potential for biomass appropriate for biomass boilers

2: Avoided carbon from a smart grid project increasing offshore wind energy production by 3% by reducing curtailment

# Appendix B Data tool user guidance

This section is dedicated to helping the user navigate through the key features of the Excel tool that Cambridge Econometrics developed to analyse the low carbon value chains in the YNYER region. The structure of the appendix is the following. After clarifying the purpose of the analysis, the broad methodology adopted to assess GVA and employment impacts for each technology is introduced. Data sources and manipulations to produce the final results are also outlined. The structure of the tool is finally described in detail together with an elucidation over the tool's informative and illustrative capabilities.

## Objective of the tool

The Excel tool has been designed to increase the understanding about the low carbon value chains that were deemed to be priorities in the YNYER region. In doing so, the primary aim of the tool is to determine the economic value at each stage of the production of each low carbon technology, both in terms of jobs and gross value added brought to the area. This analysis covers all historical years for which data was available (2009 to 2017) and projects results up to 2030. The results of this exercise allow for side-by-side comparisons of each stage of the value chains, within and between technologies. Besides, the analysis has been extended to allow further comparisons across counties and districts within the YNYER region and across countries in Great Britain.

## Methodology

Please refer to chapter 4 of this report for a thorough presentation of the methodology used to calculate current and future projections of economic value for each stage of the identified low carbon value chains.

## Structure of the tool

The tool is organised into a series of spreadsheets classified according to five main categories of different colours:

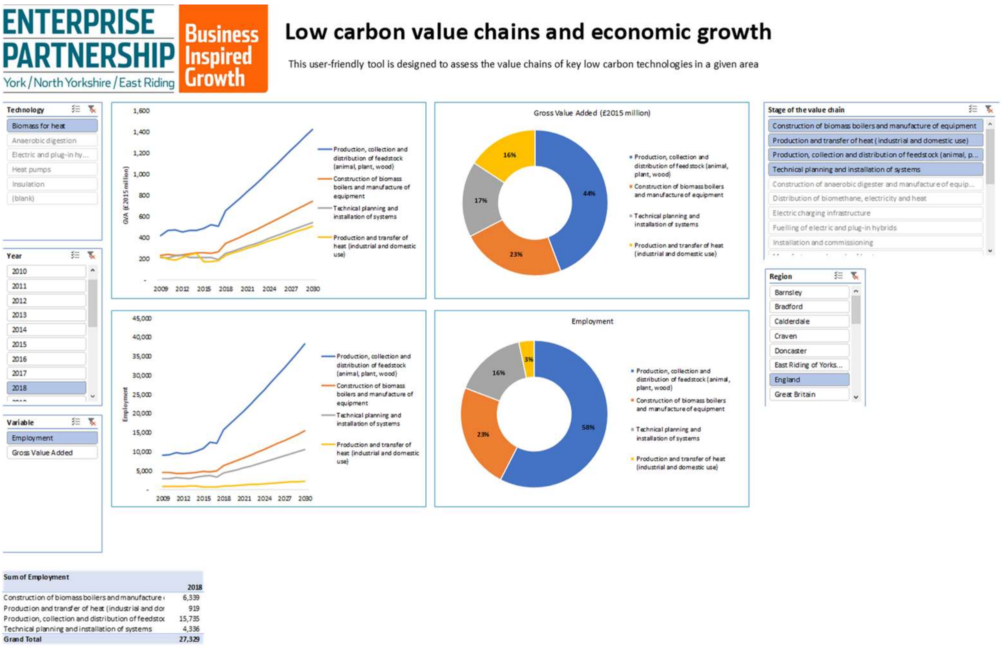
1. the Dashboard, highlighted in green;
2. the Source data, highlighted in violet;
3. the Employment and GVA calculations, highlighted in light blue;
4. the supportive Productivity assumptions, highlighted in blue;
5. the Metadata, highlighted in yellow.

The first spreadsheet is the "Dashboard", which represents the main interface for the user to interrogate the tool and visualise the key results of interest. Employment and GVA estimates are depicted in a line- and a pie-chart format to provide the user with an intertemporal comparison across stages of the value chain and with a static assessment of each sector's relative economic value. Numerical employment and GVA values are also listed in a table format below the charts.

Crucially, the dashboard has the characteristic of being interactive, allowing the user to visualise a specific set of data through the application of filters.

These filters can be activated using the available slicer tools to select the low-carbon technology, the year(s), the stage(s) of the value chain and the geographical area of interest.

**Figure 8.1 The dashboard interface**




The charts presented in the dashboard are built using the calculated employment and GVA estimates as listed in a unique table in the “Source data” spreadsheet. Besides being the main data source for the charts, this table can be easily filtered by the user to allow further checking of the results.

**Figure 8.2 The source data table**

| Category | Variable | Technology | Region | Year | Employment |
|---|---|---|---|---|---|
| Manufacture of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Great Britain | 2009 | 6,117 |
| Manufacture of batteries | Employment | Electric and plug-in hybrid vehicles | Great Britain | 2009 | 1,529 |
| Electric charging infrastructure | Employment | Electric and plug-in hybrid vehicles | Great Britain | 2009 | 6,746 |
| R&D into low emission vehicles | Employment | Electric and plug-in hybrid vehicles | Great Britain | 2009 | 2,470 |
| Fuelling of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Great Britain | 2009 | 481 |
| Manufacture of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | England | 2009 | 5,333 |
| Manufacture of batteries | Employment | Electric and plug-in hybrid vehicles | England | 2009 | 1,327 |
| Electric charging infrastructure | Employment | Electric and plug-in hybrid vehicles | England | 2009 | 5,957 |
| R&D into low emission vehicles | Employment | Electric and plug-in hybrid vehicles | England | 2009 | 2,246 |
| Fuelling of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | England | 2009 | 399 |
| Manufacture of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Scotland | 2009 | 585 |
| Manufacture of batteries | Employment | Electric and plug-in hybrid vehicles | Scotland | 2009 | 125 |
| Electric charging infrastructure | Employment | Electric and plug-in hybrid vehicles | Scotland | 2009 | 749 |
| R&D into low emission vehicles | Employment | Electric and plug-in hybrid vehicles | Scotland | 2009 | 215 |
| Fuelling of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Scotland | 2009 | 84 |
| Manufacture of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Wales | 2009 | 162 |
| Manufacture of batteries | Employment | Electric and plug-in hybrid vehicles | Wales | 2009 | 52 |
| Electric charging infrastructure | Employment | Electric and plug-in hybrid vehicles | Wales | 2009 | 121 |
| R&D into low emission vehicles | Employment | Electric and plug-in hybrid vehicles | Wales | 2009 | 29 |
| Fuelling of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Wales | 2009 | 10 |
| Manufacture of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Yorkshire and The Humber | 2009 | 719 |
| Manufacture of batteries | Employment | Electric and plug-in hybrid vehicles | Yorkshire and The Humber | 2009 | 203 |
| Electric charging infrastructure | Employment | Electric and plug-in hybrid vehicles | Yorkshire and The Humber | 2009 | 722 |
| R&D into low emission vehicles | Employment | Electric and plug-in hybrid vehicles | Yorkshire and The Humber | 2009 | 238 |
| Fuelling of electric and plug-in hybrids | Employment | Electric and plug-in hybrid vehicles | Yorkshire and The Humber | 2009 | 84 |

All the employment and GVA estimates reported in the source data table are directly linked to a series of spreadsheets highlighted in light-blue holding the raw data, assumptions, calculations and outputs for each of the five low-carbon technologies. At the top of each spreadsheet, results were aggregated into colourful tables showing employment and GVA aggregated by region and by stage of the value chain. Projections are arranged into green tables, while historical estimates are represented in blue.

### Figure 8.3 An example of summary employment outputs

| Indicator | Country | Unit | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Employment | Great Britain | Count | 17,343 | 16,622 | 17,567 | 17,235 | 17,700 | 17,970 | 19,696 | 19,633 | 19,716 | 23,154 | 32,684 | 42,049 | 51,250 | 60,290 | 80,691 | 100,736 | 120,431 | 139,779 | 158,786 | 177,455 | 195,791 | 213,798 |
| Employment | England | Count | 15,263 | 14,783 | 15,775 | 15,392 | 15,600 | 15,943 | 17,442 | 17,488 | 17,592 | 20,646 | 29,125 | 37,446 | 45,610 | 53,621 | 71,719 | 89,479 | 106,904 | 124,000 | 140,771 | 157,221 | 173,355 | 189,178 |
| Employment | Wales | Count | 374 | 342 | 319 | 355 | 400 | 361 | 394 | 376 | 426 | 499 | 701 | 897 | 1,089 | 1,275 | 1,699 | 2,112 | 2,514 | 2,905 | 3,285 | 3,655 | 4,015 | 4,365 |
| Employment | Scotland | Count | 1,758 | 1,571 | 1,582 | 1,507 | 1,700 | 1,710 | 1,777 | 1,826 | 1,679 | 1,984 | 2,818 | 3,648 | 4,474 | 5,296 | 7,133 | 8,960 | 10,779 | 12,589 | 14,389 | 16,181 | 17,965 | 19,739 |

| Indicator | Region | Unit | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Employment | Yorkshire and The Humber | Count | 1,966 | 1,828 | 2,106 | 2,075 | 2,200 | 2,508 | 2,234 | 2,212 | 2,331 | 2,713 | 3,795 | 4,837 | 5,842 | 6,810 | 9,031 | 11,172 | 13,235 | 15,222 | 17,134 | 18,975 | 20,745 | 22,446 |

| Indicator | County | Unit | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Employment | Barnsley | Count | 61 | 62 | 108 | 94 | 83 | 113 | 95 | 86 | 83 | 88 | 123 | 156 | 189 | 220 | 292 | 361 | 427 | 491 | 553 | 613 | 670 | 725 |
| Employment | Bradford | Count | 150 | 148 | 164 | 159 | 176 | 200 | 193 | 193 | 183 | 182 | 255 | 325 | 393 | 458 | 607 | 751 | 890 | 1,023 | 1,152 | 1,276 | 1,395 | 1,509 |
| Employment | Calderdale | Count | 81 | 67 | 86 | 77 | 90 | 98 | 86 | 80 | 89 | 83 | 116 | 148 | 179 | 208 | 276 | 342 | 405 | 466 | 524 | 580 | 635 | 687 |
| Employment | Doncaster | Count | 65 | 76 | 77 | 89 | 83 | 100 | 88 | 86 | 87 | 82 | 115 | 147 | 178 | 207 | 274 | 340 | 402 | 463 | 521 | 577 | 630 | 682 |
| Employment | East Riding of Yorkshire | Count | 100 | 88 | 101 | 101 | 100 | 118 | 108 | 104 | 99 | 112 | 157 | 200 | 242 | 282 | 374 | 463 | 548 | 631 | 710 | 786 | 860 | 930 |
| Employment | Kingston upon Hull, City of | Count | 82 | 77 | 76 | 72 | 87 | 90 | 79 | 81 | 89 | 86 | 120 | 153 | 185 | 215 | 285 | 353 | 418 | 481 | 542 | 600 | 656 | 710 |
| Employment | Kirklees | Count | 160 | 123 | 153 | 122 | 141 | 160 | 136 | 142 | 150 | 157 | 220 | 281 | 339 | 395 | 524 | 648 | 768 | 883 | 994 | 1,100 | 1,203 | 1,302 |
| Employment | Leeds | Count | 316 | 318 | 342 | 314 | 397 | 416 | 371 | 421 | 431 | 569 | 796 | 1,014 | 1,225 | 1,428 | 1,894 | 2,343 | 2,775 | 3,192 | 3,593 | 3,979 | 4,350 | 4,707 |
| Employment | North East Lincolnshire | Count | 60 | 63 | 71 | 61 | 69 | 65 | 58 | 55 | 64 | 52 | 73 | 93 | 112 | 131 | 173 | 214 | 254 | 292 | 328 | 364 | 398 | 430 |
| Employment | North Lincolnshire | Count | 53 | 48 | 50 | 46 | 55 | 75 | 63 | 65 | 61 | 44 | 61 | 78 | 94 | 109 | 145 | 179 | 212 | 244 | 275 | 304 | 333 | 360 |
| Employment | North Yorkshire | Count | 274 | 254 | 293 | 306 | 322 | 369 | 316 | 321 | 325 | 476 | 665 | 848 | 1,024 | 1,194 | 1,583 | 1,959 | 2,320 | 2,669 | 3,004 | 3,326 | 3,637 | 3,935 |
| Employment | Rotherham | Count | 151 | 149 | 139 | 143 | 113 | 137 | 132 | 119 | 136 | 174 | 244 | 310 | 375 | 437 | 580 | 717 | 850 | 977 | 1,100 | 1,218 | 1,332 | 1,441 |
| Employment | Sheffield | Count | 221 | 184 | 231 | 234 | 268 | 305 | 298 | 279 | 287 | 306 | 428 | 546 | 659 | 769 | 1,019 | 1,261 | 1,494 | 1,718 | 1,934 | 2,142 | 2,342 | 2,534 |
| Employment | Wakefield | Count | 115 | 119 | 137 | 152 | 132 | 158 | 141 | 137 | 137 | 146 | 204 | 260 | 314 | 366 | 485 | 600 | 711 | 817 | 920 | 1,019 | 1,114 | 1,205 |
| Employment | York | Count | 64 | 57 | 60 | 82 | 65 | 75 | 72 | 67 | 69 | 73 | 102 | 131 | 158 | 184 | 244 | 301 | 357 | 411 | 462 | 512 | 560 | 606 |

| Indicator | District | Unit | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Employment | Barnsley | Count | 61 | 62 | 108 | 94 | 83 | 113 | 95 | 86 | 83 | 88 | 123 | 156 | 189 | 220 | 292 | 361 | 427 | 491 | 553 | 613 | 670 | 725 |
| Employment | Bradford | Count | 150 | 148 | 164 | 159 | 176 | 200 | 193 | 193 | 183 | 182 | 255 | 325 | 393 | 458 | 607 | 751 | 890 | 1,023 | 1,152 | 1,276 | 1,395 | 1,509 |
| Employment | Calderdale | Count | 81 | 67 | 86 | 77 | 90 | 98 | 86 | 80 | 89 | 83 | 116 | 148 | 179 | 208 | 276 | 342 | 405 | 466 | 524 | 580 | 635 | 687 |
| Employment | Craven | Count | 14 | 12 | 14 | 15 | 13 | 18 | 12 | 12 | 14 | 10 | 14 | 18 | 22 | 26 | 34 | 42 | 50 | 58 | 65 | 72 | 79 | 85 |
| Employment | Doncaster | Count | 65 | 76 | 77 | 89 | 83 | 100 | 88 | 86 | 87 | 82 | 115 | 147 | 178 | 207 | 274 | 340 | 402 | 463 | 521 | 577 | 630 | 682 |
| Employment | East Riding of Yorkshire | Count | 100 | 88 | 101 | 101 | 100 | 118 | 108 | 104 | 99 | 112 | 157 | 200 | 242 | 282 | 374 | 463 | 548 | 631 | 710 | 786 | 860 | 930 |
| Employment | Hambleton | Count | 33 | 28 | 40 | 41 | 40 | 50 | 32 | 33 | 35 | 37 | 52 | 66 | 79 | 92 | 123 | 152 | 180 | 207 | 233 | 258 | 282 | 305 |
| Employment | Harrogate | Count | 100 | 82 | 87 | 87 | 89 | 99 | 107 | 114 | 111 | 157 | 220 | 280 | 338 | 394 | 523 | 646 | 766 | 881 | 991 | 1,098 | 1,200 | 1,299 |
| Employment | Kingston upon Hull, City of | Count | 82 | 77 | 76 | 72 | 87 | 90 | 79 | 81 | 89 | 86 | 120 | 153 | 185 | 215 | 285 | 353 | 418 | 481 | 542 | 600 | 656 | 710 |
| Employment | Kirklees | Count | 160 | 123 | 153 | 122 | 141 | 160 | 136 | 142 | 150 | 157 | 220 | 281 | 339 | 395 | 524 | 648 | 768 | 883 | 994 | 1,100 | 1,203 | 1,302 |
| Employment | Leeds | Count | 316 | 318 | 342 | 314 | 397 | 416 | 371 | 421 | 431 | 569 | 796 | 1,014 | 1,225 | 1,428 | 1,894 | 2,343 | 2,775 | 3,192 | 3,593 | 3,979 | 4,350 | 4,707 |
| Employment | North East Lincolnshire | Count | 60 | 63 | 71 | 61 | 69 | 65 | 58 | 55 | 64 | 52 | 73 | 93 | 112 | 131 | 173 | 214 | 254 | 292 | 328 | 364 | 398 | 430 |
| Employment | North Lincolnshire | Count | 53 | 48 | 50 | 46 | 55 | 75 | 63 | 65 | 61 | 44 | 61 | 78 | 94 | 109 | 145 | 179 | 212 | 244 | 275 | 304 | 333 | 360 |
| Employment | Richmondshire | Count | 10 | 9 | 12 | 12 | 16 | 18 | 18 | 20 | 22 | 25 | 34 | 44 | 53 | 62 | 82 | 101 | 120 | 137 | 155 | 171 | 187 | 203 |
| Employment | Rotherham | Count | 151 | 149 | 139 | 143 | 113 | 137 | 132 | 119 | 136 | 174 | 244 | 310 | 375 | 437 | 580 | 717 | 850 | 977 | 1,100 | 1,218 | 1,332 | 1,441 |
| Employment | Ryedale | Count | 32 | 37 | 40 | 27 | 45 | 56 | 37 | 38 | 32 | 39 | 54 | 69 | 83 | 97 | 128 | 159 | 188 | 216 | 243 | 269 | 295 | 319 |
| Employment | Scarborough | Count | 49 | 45 | 49 | 51 | 48 | 61 | 53 | 50 | 54 | 88 | 123 | 157 | 190 | 221 | 293 | 363 | 430 | 494 | 556 | 616 | 674 | 729 |
| Employment | Selby | Count | 37 | 31 | 38 | 53 | 46 | 47 | 48 | 47 | 47 | 103 | 145 | 184 | 223 | 259 | 344 | 426 | 504 | 580 | 653 | 723 | 790 | 855 |
| Employment | Sheffield | Count | 221 | 184 | 231 | 234 | 268 | 305 | 298 | 279 | 287 | 306 | 428 | 546 | 659 | 769 | 1,019 | 1,261 | 1,494 | 1,718 | 1,934 | 2,142 | 2,342 | 2,534 |
| Employment | Wakefield | Count | 115 | 119 | 137 | 152 | 132 | 158 | 141 | 137 | 137 | 146 | 204 | 260 | 314 | 366 | 485 | 600 | 711 | 817 | 920 | 1,019 | 1,114 | 1,205 |
| Employment | York | Count | 64 | 57 | 60 | 82 | 65 | 75 | 72 | 67 | 69 | 73 | 102 | 131 | 158 | 184 | 244 | 301 | 357 | 411 | 462 | 512 | 560 | 606 |

Below the outputs' section, the key assumptions behind each technology assessment are specified, together with the data sources and the sectoral conversion tables. The report of the Department for Business Innovation & Skills (2015) on the UK low carbon economy has been the main reference for the employment estimates across the considered low carbon technologies. In the case of GVA, tables showing the productivity assumptions for 2-digit sectors are also located in this section.

### Figure 8.4 An example of sectoral conversion table for the Electric and plug-in hybrid vehicles value chain

| Category | Sector | Code |
|---|---|---|
| **Manufacture of electric and plug-in hybrids** | Manufacture of rubber tyres and tubes, retreading and re | 22110 |
| | Manufacture of electric motors, generators and transform | 27110 |
| | Manufacture of motor vehicles | 29100 |
| | Manufacture of bodies (coachwork) for motor vehicles (e | 29201 |
| | Manufacture of electrical and electronic equipment for m | 29310 |
| | Manufacture of other electrical equipment | 27900 |
| | Manufacture of other parts and accessories for motor veh | 29320 |
| | Repair of electrical equipment | 33140 |
| | Maintenance and repair of motor vehicles | 45200 |
| **Manufacture of batteries** | Manufacture of other chemical products n.e.c. | 20590 |
| | Manufacture of man-made fibres | 20600 |
| | Aluminium production | 24420 |
| | Copper production | 24440 |
| | Other non-ferrous metal production | 24450 |
| | Forging, pressing, stamping and roll-forming of metal, po | 25500 |
| | Treatment and coating metals | 25610 |
| | Manufacture of electronic components | 26110 |
| | Manufacture of batteries and accumulators | 27200 |
| **Electric charging infrastructure** | Site preparation | 43120 |
| | Electrical installation | 43210 |
| | Manufacture of electricity distribution and control appara | 27120 |
| | Other software publishing | 58290 |
| | Wireless telecommunications activities | 61200 |
| | Computer programming activities - business and domesti | 62012 |
| | Media representation | 73120 |
| **R&D into low emission vehicles** | Other research and experimental development on natura | 72190 |
| | Technical testing and analysis | 71200 |
| **Fuelling of electric and plug-in hybrids** | Distribution of electricity | 35130 |

Finally, the intermediate calculations for all sectors included in the low carbon value chains and the raw data downloaded from BRES are displayed in the last two sections of each GVA and employment spreadsheet. Given the detailed geographical coverage and the high number of sectors considered, the data tables cover a large number of rows.

Complementary to the assumptions and calculations presented in each of the light-blue spreadsheets on employment and GVA for each technology, the assumed productivity levels for each stage of the value chain are explicated in the "Productivity" spreadsheet. Future productivity rates are calculated on the basis of historical rates, and differ across low carbon technologies.

The last two spreadsheets included in the tool provide the user with some useful metadata. The "Sectors involved" tab clarifies which 2-, 3- and 5-digit sectors according to the SIC 2007 classification were deemed as relevant and, therefore, included in the supply chains. Finally, the "Categories" spreadsheet lists all the elements considered in terms of regions, technologies, stages of the value chain and years.