North West Leicestershire
Renewable & Low Carbon Energy Study

AECOM
February 2021

Quality information

Prepared by	Checked by	Verified by	Approved by
Alice Purcell Consultant Harper Robertson Senior Consultant Luke Aldred Associate Director	Harper Robertson Senior Consultant Alex Duckworth Principal Consultant Philip Exton Principal Consultant	Emily Loquidis Associate Director Lauren Williams Associate Director	Miles Attenborough Technical Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
00	4.09.20	Policy and Benchmarking Draft Technical Sections	EL	Emily Loquidis	Associate Director
01	30.10.20	First draft	LW	Lauren Williams	Associate Director
02	13.11.20	First draft w/ updated maps and Appendix B	HR	Harper Robertson	Senior Consultant
03	16.12.20	Second draft incorporating client comments	LW	Lauren Williams	Associate Director
04	27.01.21	Final	LW	Lauren Williams	Associate Director
05	16.02.21	Update to reflect policy changes	MA	Miles Attenborough	Technical Director

Prepared for:

North West Leicestershire District Council

Prepared by:

AECOM Limited
Aldgate Tower
2 Leman Street
London E1 8FA
United Kingdom
aecom.com

Table of Contents

Figures

Tables

Glossary

Notation	Definition
AQMA	Air Quality Management Areas
ASHP	Air Source Heat Pump
BECCS	Bioenergy with Carbon Capture and Storage
BEIS	Department for Business, Energy & Industrial Strategy
BEV	Battery Electric Vehicles
BREEAM	Building Research Establishment Environmental Assessment Mechanism
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
CEF	Carbon Emission Factor
CHP	Combined Heat and Power
CIBSE	Chartered Institution of Building Services Engineers
CO_2	Carbon Dioxide
COP	Coefficient of Performance. *This is the ratio of how well a technology can covert one form of energy (usually electricity) into another (usually heat). For instance, a heat pump with a COP of 3 can produce 3 units of heat for every 1 unit of electricity.*
CSE	Centre for Sustainable Energy
DECC	(Formerly) Department of Energy & Climate Change
DEFRA	Department for Environment, Food & Rural Affairs
DEH	Direct Electric Heating
DfT	Department for Transport
DHN	District Heating Network
DHW	Domestic Hot Water
DNO	Distribution Network Operator
EA	Environment Agency
EfW	Energy from Waste
EIA	Environmental Impact Assessment
ELM	Environmental Land Management
EMS	Environmental Management Systems
EPC	Energy Performance Certificate
EV	Electric Vehicle
FSC	Forest Stewardship Council
GGBS	Ground Granulated Blast-furnace Slag
GHG	Greenhouse Gas

GIS	Geographic Information Systems
GLA	Greater London Authority
GSHP	Ground Source Heat Pump
HIF	Housing Infrastructure Fund
HQM	Home Quality Mark (assessment mechanism)
ISO	International Organisation for Standardization
IRENA	International Renewable Energy Agency
LDO	Local Development Order
LULUCF	Land Use, Land-Use Change & Forestry
LZC	Low and Zero Carbon
MEES	Minimum Energy Efficiency Standards
MOD	Ministry of Defence
MSW	Municipal Solid Waste
NEED	National Energy Efficiency Data-Framework
NOABL	Numerical Objective Analysis Boundary Layer
NPPF	National Planning Policy Framework
NWLDC	North West Leicestershire District Council
OLEV	Office for Low Emission Vehicles
PEFC	Programme for the Endorsement of Forest Certification
PHEV	Plug-in Hybrid Electric Vehicles
PM or PMx	Particulate Matter
PV	Photovoltaic (solar panel)
REPD	Renewable Energy Planning Database
RRS	Regional Renewables Statistics
SAC	Special Area of Conservation
SAP	Standard Assessment Procedure
SHW	Solar Hot Water
SPD	Supplementary guidance document
STC	Sludge Treatment Centre (for sewage sludge)
SuDS	Sustainable Urban Drainage System
UHI	Urban Heat Island
UK-GBC	UK Green Building Council
ULEV	Ultra-Low Emissions Vehicle
WPD	Western Power Distribution
WRAP	Waste and Resources Action Programme
WSHP	Water Source Heat Pump
WWTW	Waste Water Treatment Works

Executive Summary

Introduction

AECOM has been commissioned by North West Leicestershire District Council (NWLDC) to provide technical support to assess low and zero carbon (LZC) energy opportunities across the District. Building on previous analytical work such as the Renewable Wind Study undertaken in 2016, and local targets and commitments such as those laid out in the 2019 Zero Carbon Roadmap, this study will form part of a technical evidence base to support the substantive review of the Local Plan.

Policy Context

In 2019, the UK became the first country to declare a Climate Emergency, and subsequently, by amending the Climate Change Act (2008), legally committed to achieving Net Zero greenhouse gas emissions by 2050. North West Leicestershire District Council made an individual climate emergency declaration on 25th June 2019 setting out its intent to support the Government's net zero target to 2050 and its aim to achieve carbon neutrality for the Council's own emissions by 2030.

The North West Leicestershire Local Plan was adopted in November 2017 and is currently in the process of review. NWLDC set out key objectives for the Local Plan, including *Objective 8, "prepare for, limit and adapt to climate change."* The plan includes the following key policies relevant to climate change mitigation and adaptation:

- *Policy Cc1 Renewable Energy*
- *Policy Cc2 Flood Risk*
- *Policy Cc3 Sustainable Drainage Systems*

In addition, *Policy D1 Design of New Development* of the Local Plan broadly addresses the need for new development to acknowledge sustainable design and construction methods. This is supported by further guidance set out in the Good Design Supplementary Guidance Document (SPD), also adopted in 2017.

This report will support the evidence base for the new Local Plan for NWLDC, providing evidence on the technical potential for renewable and low carbon energy across the District.

The Zero Carbon Roadmap (2019)

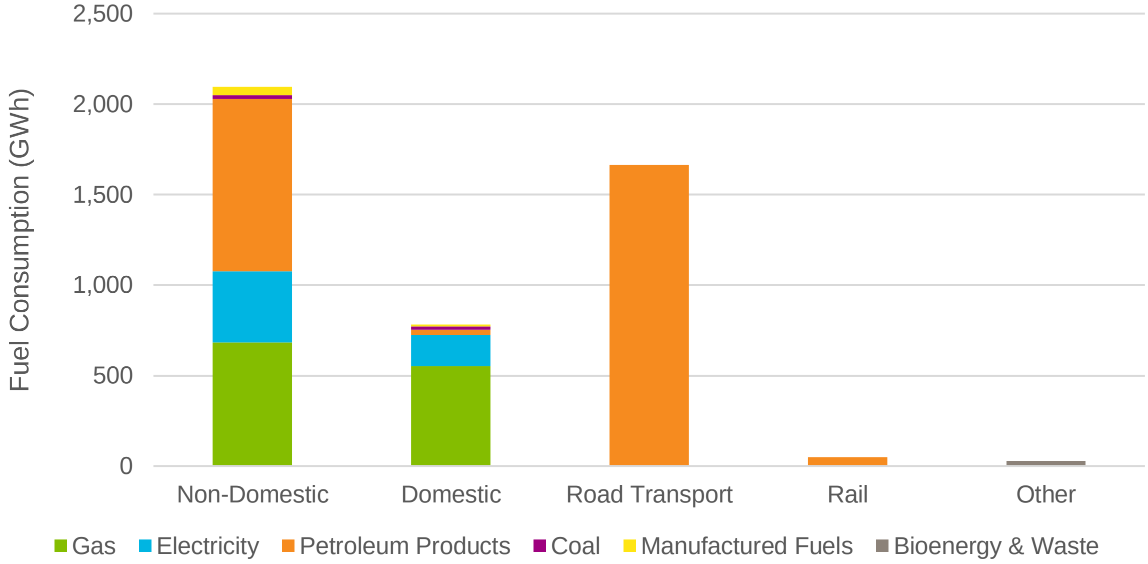
Following NWLDC's Climate Emergency declaration in June 2019, the Council commissioned a study to develop a response to the need to reduce both the council's own and district-wide carbon emissions. The Zero Carbon Roadmap and Action Plan were formally adopted in March 2020 and are expected to inform the focus and trajectory of policy in the new Local Plan.

A key component of the present study is to review some of the low and zero carbon (LZC) energy targets set out in the Zero Carbon Roadmap and assess whether they are likely to be achievable within the specified timescales. Key findings are presented in the table below.

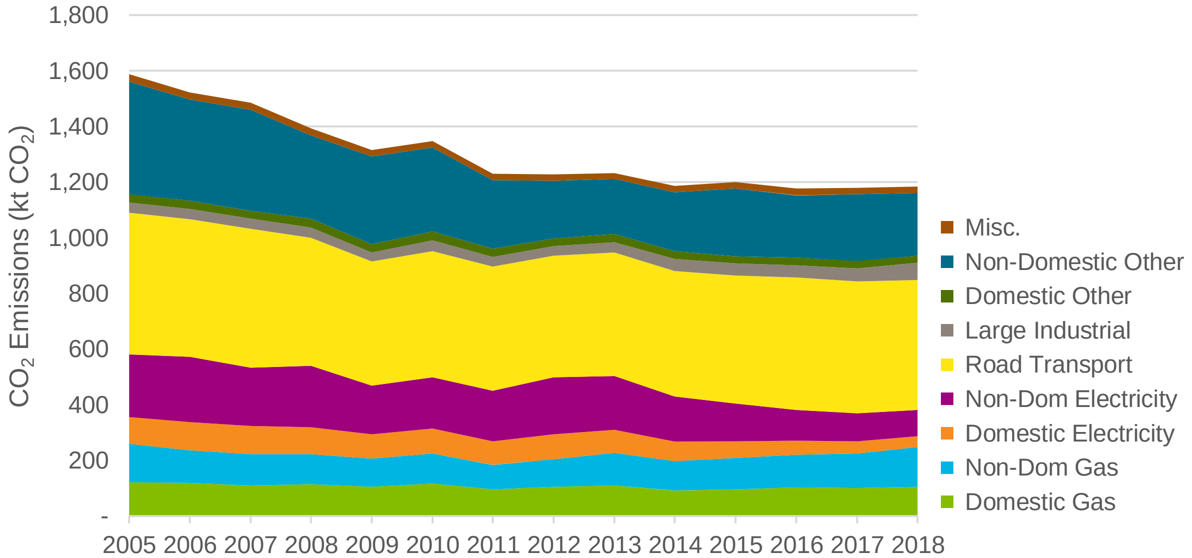
Technology	Target	Is the target considered achievable?	Comments
Wind energy	Expand wind energy capacity to 75 MW by 2050	Yes	This target could potentially be exceeded
Solar Photovoltaics (PV)	Expand PV capacity to 140 MW by 2050	Yes	This target could potentially be exceeded
Hydroelectric power	Up to 3.2 MW based on five potential sites	See notes	This may be technically possible but would require detailed feasibility studies
Biogas	Expand use of biogas to 21 GWh by 2050	See notes	Not recommended based on present technologies

Baseline Conditions

The most recent fuel consumption figures for North West Leicestershire indicate that petroleum products represent the majority (58%) of fuel use in the District. The majority of this is used for road transportation although a significant portion is also used in industrial & commercial buildings, with a small amount used for rail and domestic heating. Gas and electricity use in buildings represent 27% and 12% of the total fuel use respectively, while other fuels collectively account for around 3%. There has been an overall increase in fuel use in the past decade.



The Department of Business, Energy and Industrial Strategy (BEIS) statistics indicate that annual CO_2 emissions for the District as a whole are circa 1,183 ktCO_2. Despite the increase in fuel use, since 2005 there has been an overall 25% decrease in CO_2 emissions, which is primarily due to the decarbonisation of the national electricity grid. This decrease is lower than the national and regional averages.



As of Q1 2020 there were c. 341 licensed ultra-low emission vehicles (ULEVs) in the District and 16 public charging points, including 2 rapid charging points (43kW and above). Although uptake of ULEVs has increased in recent years, these still represent a tiny portion of vehicles overall. In the coming decades, ULEV uptake is expected to increase dramatically due to a combination of lower prices, Government regulations and consumer awareness. It is crucial for Local Authorities to support this shift by facilitating the delivery of charging infrastructure; one way of doing this would be to require EV charge points as part of all new developments.

The total installed capacity of LZC electricity technologies as at the end of 2018 was approximately 74 MWe, offering the potential to generate nearly 95,000 MWh of electricity per year. For context, this is roughly 17% of total electricity demand for the District.

The overwhelming majority of LZC installations by number of sites is PV, mostly smaller-scale roof mounted PV. However, large-scale PV farms contribute the largest proportion of the overall total renewable electricity within the District. There is also some contribution from onshore wind, anaerobic digestion, landfill gas and plant biomass. The Renewable Energy Planning Database (REPD) records show that there are additional large-scale solar farms and battery storage facilities awaiting construction.

LZC Opportunities

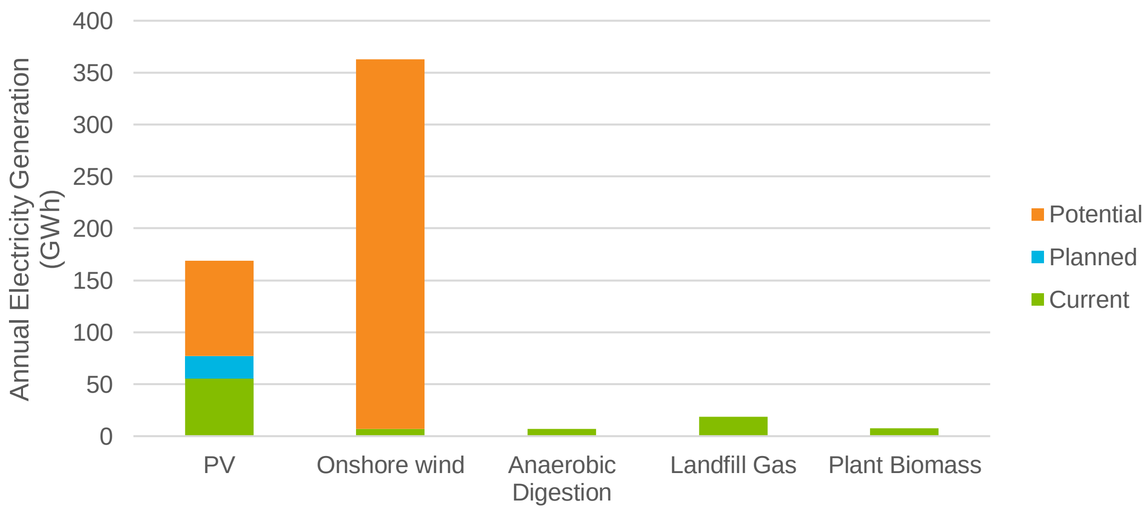
To assess future opportunities to deliver low and zero carbon (LZC) energy technologies in North West Leicestershire, our approach broadly follows the *'Renewable and Low-Carbon Energy Capacity Methodology'* published in 2010 by the former Department of Energy and Climate Change (DECC). In order to provide a comprehensive assessment of future LZC opportunities in North West Leicestershire, AECOM also carried out a technical review of various previous studies, including:

- The 'Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report' (2011) produced by the Centre for Sustainable Energy (CSE) and SQW;
- The 2016 Renewable Wind Energy Study and associated constraint maps produced by ASC Renewables; and
- Targets set out in the 2019 Zero Carbon Roadmap.

It is considered likely that the main opportunities going forward will be solar PV, wind energy and heat pumps. There is significant potential for both building-integrated and standalone PV installations, although it is difficult to quantify an upper limit for the latter. Onshore wind is currently one of the most cost-effective LZC technologies available and could deliver a significant portion of the District's energy demands; however, it should be noted that this is currently somewhat restricted by national policies. Heat pumps are expected to be crucial for decarbonising the heat sector by 2050 as they can be powered with renewable electricity and operate with much higher efficiencies than either boilers or direct electric systems. Previous studies have also identified potential opportunities for hydroelectric power at five sites around the District and NWLDC could consider undertaking more detailed feasibility studies to assess this opportunity.

Although there is a significant biomass resource in the District, this is not recommended for widespread adoption unless it is certain that the biomass can be locally and sustainably sourced. In future, this opportunity could increase if carbon capture and storage (CCS) technologies become more widely available but at present these are not at a sufficient state of maturity.

The chart below shows the estimated amount of annual LZC electricity generation based on operational and planned installations, along with an estimate of the future additional potential. Note that the figures for PV exclude future ground-mounted PV despite the considerable size of this resource because there is no method available for quantifying an upper limit at a District-wide level.



Design Approaches that Respond to Climate Change

Recognising the limits of the Local Planning Authority's ability to influence this area, and bearing in mind the rapidly changing policy context, NWLDC should aim to set the highest standards for energy and CO_2 performance that can reasonably and viably be implemented, both for new and existing buildings. This is crucial in order to achieve the decarbonisation target.

For new buildings, there is precedent to set a 19-20% CO_2 reduction target above Part L 2013, and the Government's Future Homes Standard (FHS) Consultation confirms that this is viable on a national scale. (NWLDC could refer to the FHS Impact Report to inform a local viability assessment.) However, this may soon be superseded by Building Regulations: the Government is now proposing a 31% CO_2 reduction target for new homes, and is consulting on a 22-27% CO_2 reduction target for non-domestic buildings.

In light of NWLDC's Climate Emergency Declaration, it is important to ensure that all new buildings are at least capable of *becoming* net zero carbon in operation, even if they are not constructed to that standard initially. Therefore, the Council should consider requiring developers to include futureproofing measures, including:

- High levels of fabric energy efficiency;
- Use of low carbon heating systems such as heat pumps and/or ensuring that the design is compatible with such systems, e.g. through provision of underfloor heating or other low temperature distribution systems; and
- Maximising on-site renewable electricity generation e.g. using roof-mounted PV.

An even higher target could potentially be set, which could include a requirement for any residual emissions to be offset via developer contributions (see Section 6). NWLDC could also consider introducing requirements for some or all developments to meet one of the various voluntary industry standards or third-party assessment schemes such as BREEAM. (A separate viability assessment would be required to determine the potential impacts this would have, which is beyond the scope of this report.)

For existing buildings, NWLDC should ensure that the Local Plan and associated guidance both emphasise the importance of undertaking energy retrofitting measures, and review opportunities to facilitate this, e.g. by issuing a targeted Local Development Order (LDO) that makes it easier to install measures such as PV, solar hot water, external wall insulation, air source heat pumps (ASHPs), energy efficient doors and windows, etc.

There are a range of other sustainability topics that could be introduced to future Local Plan policy wording or an SPD. These often overlap with other priority areas and developers will need to consider these topics holistically. Examples include:

- Minimising whole life cycle carbon emissions
- Futureproofing to facilitate retrofitting of LZC technologies
- Measures to reduce overheating
- Improving water efficiency
- Promoting and facilitating sustainable transport, including provision of EV infrastructure
- Sustainable material selection
- Lean design and reducing waste in construction

The existing Local Plan and Good Design SPD include a range of policies and guidance related to topics such as passive design, mitigating flood risk, sustainable drainage, and promoting walking and cycling. This should be retained although there are also opportunities to introduce stronger requirements if desired.

Carbon Offset Fund

Some Local Authorities permit developers to contribute towards a Carbon Offset Fund in lieu of achieving CO_2 reductions onsite. This report describes the potential scale of such a fund, based on projected new development figures for North West Leicestershire, and provides an overview of the key practical considerations that NWLDC would need to take into account in terms of administering the fund.

It should be noted that the main mechanism for Local Authorities to collect carbon offsetting payments is usually via an S106 agreement. This is an area that would potentially be impacted by the proposed changes to the planning system that were set out in the Government's recently published white paper, 'Planning for the Future.' If the proposed changes were introduced – which is not certain to occur – NWLDC might not be able to implement a Carbon Offset Fund.

EV Infrastructure Provision

To reach net zero emissions in transport, petrol and diesel vehicles will have to be phased out entirely by 2050 at the latest, being replaced mostly by ULEVs. These could be powered by either renewable electricity or hydrogen gas. It is anticipated that, due to a combination of price changes and Government regulations, uptake of ULEVs will increase dramatically in the coming years; the Government has confirmed that new cars running on conventional fuels (i.e. petrol and diesel) will be banned from 2035 at the latest (with the date potentially being brought forward to 2032 or earlier).

A large-scale shift to the use of electric vehicles must also be accompanied by a significant modal shift towards walking, cycling, ridesharing, and an increase in the use of public transport. This is necessary to reduce electricity demand – with added benefits in terms of air quality and, potentially, improving public health.

NWLDC will need to facilitate this transition wherever possible. At a strategic level, this would involve ensuring that the Local Plan spatial strategy helps to reduce the need for vehicle movements. Developers should be required to demonstrate that EV charging points will either be provided or that it is prohibitively costly to do so. Our research shows that the cost of retrofitting EV charging points is higher than installing during initial construction, so there is an opportunity cost if charging points are not installed. Charging facilities could potentially be co-located with LZC technologies (e.g. PV over parking lots).

The electrification of transport is expected to result in significant additional loads on grid infrastructure, which may require upstream reinforcements (e.g. increasing the capacity of upstream substations and cabling). This may result in significant extra capital costs associated with grid reinforcements which should be carefully considered when determining the location for charge point hubs. The National Grid ‘Future Energy Scenarios’ report indicates that, nationally, peak electricity demands could increase by 30-60% by 2050.

The Distribution Network Operator (DNO) in the region, Western Power Distribution (WPD) has developed an EV strategy which outlines how they aim to facilitate the uptake of EV charging infrastructure. As WPD is actively participating in the transition to EVs, engagement with them is recommended to gain their support and learn from the trials and existing installations they have implemented. Engagement with WPD is also recommended in order to gain understanding of where capacity exists on the network.

In addition, NWLDC should seek to:

- Implement plans and/or new policy that promotes walking and cycling;
- When undertaking repairs or upgrades to road layouts, seek to improve and provide new cycle lanes and pedestrian facilities (e.g. ‘pedestrian priority’ at junctions);
- Ensure that any transport planning, or road network expansion is required to quantify and take steps to significantly reduce emissions;
- Consider how NWLDC can use its licensing authority and other powers to promote sustainable transport modes, for instance by introducing low / zero emission zones or congestion charges; and
- Undertake assessments of where public EV charge points would best be located, and what type of charge points would be most appropriate (e.g. slow vs rapid chargers), working with Western Power Distribution.

Conclusion

This study has found that there are significant opportunities for North West Leicestershire and NWLDC to respond to the climate emergency by increasing LZC energy provision, improving the energy and CO_2 performance standards of buildings, facilitating a transition to low emission, sustainable transport, and potentially developing a carbon offsetting fund that can contribute to local environmental projects.

The scale of this challenge is vast, and rapid actions will be required in order to avoid the worst impacts of global climate change. The recommendations in this report cover a range of policy options and other opportunities to deliver on the decarbonisation target, building on the strong level of local ambition and commitment.

1 Introduction

1.1 Purpose of this report

AECOM has been commissioned by North West Leicestershire District Council (NWLDC) to provide technical support to assess low and zero carbon (LZC) energy opportunities across the District. Building on previous analytical work such as the Renewable Wind Study undertaken in 2016, and local targets and commitments such as those laid out in the 2019 Zero Carbon Roadmap, this study will form part of a technical evidence base to support the substantive review of the Local Plan.

1.2 Structure of this report

The report is structured as follows:

- **Section 1: Introduction**, purpose and structure of the report
- **Section 2: Background and Context** provides an overview of some key drivers for introducing climate change mitigation measures such as building design standards, ultra low emission vehicle (ULEV) infrastructure and LZC provision.
- **Section 3: Establishing the Baseline** describes the current baseline and recent trends in regard to fuel consumption, CO_2 emissions, ULEV uptake and LZC deployment in North West Leicestershire.
- **Section 4: Renewable Energy Assessment** presents our assessment of the potential to deliver additional LZC energy technologies in North West Leicestershire.
- **Section 5: Energy Performance and Design Approaches to Mitigate Climate Change** outlines various options for introducing higher performance standards in planning policy and describes sustainable design measures that could be implemented as best practice to contribute towards North West Leicestershire becoming a Zero Carbon District.
- **Section 6: Carbon Offset Fund** discusses the potential to establish a carbon offset fund for developers to make contributions in lieu of on-site carbon savings, outlining practical implications and potential next steps for NWLDC.
- **Section 7: Electric Vehicle Infrastructure Provision** provides a rough estimate of the potential change in fuel use that might arise due to ULEV uptake, along with broader commentary on future transport trends and actions that NWLDC can take to promote a shift towards sustainable transport modes.
- **Section 8: Conclusion** summarises key findings, recommendations and next steps.
- Relevant supporting information is provided in the **Appendices**.

2 Policy Background and Context

This section of the report summarises the key scientific consensus that is driving climate targets and the current and emerging climate policy context applicable to development across the District of North West Leicestershire. A selection of targets, policies and initiatives aimed at reducing CO_2 emissions generally are described below, particularly those related to decarbonising heat, energy and transportation.

Although it is not possible to fully capture the wide range of drivers for taking action to address the threat of climate change, environmental, social, and economic are some of the key drivers that have been used to inform the analysis that is presented in this report.

2.1 International Context

Climate change is one of the key challenges faced today, with its impact observed at global and local levels. Climate experts indicate that global temperature rise must be limited to 1.5°C above pre-industrial levels if we are to avoid potentially disastrous impacts for humanity and the planet's wildlife. With the rise in average global temperatures already recorded at 1.1°C, a united global response is required to combat the causes of climate change and mitigate its ongoing effects.

2.1.1 UNFCCC

Over the past 20 years the need to reduce the growth in global greenhouse gas (GHG) emissions has been gaining momentum on the international political agenda. The main vehicle for international cooperation on climate change mitigation is the United Nations Framework Convention on Climate Change (UNFCCC), particularly in being responsible for negotiations under the Kyoto Protocol and the Paris Agreement.

The UNFCCC is expected to hold an ongoing significance in relation to Climate Emergency declarations in recent months. Most countries have been setting targets for national carbon emissions reductions and this is expected to continue following international agreements at the 25th Conference of the Parties to the UNFCCC in December 2019. The UK is expected to host the 26th Conference of the Parties (COP26) to the UNFCCC.

2.1.2 The Paris Climate Agreement

On 12 December 2015, UNFCCC members, including the United Kingdom, reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The UK ratified the Paris Climate Change Agreement in November 2016. The Agreement's central aim *'is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C'.*[1]

For context, a study produced by the Tyndall Centre for Climate Change Research[2] considered how much carbon could be emitted by each Local Authority in the UK while still being compatible with the targets set out in the Paris Agreement, and found that, *'at 2017 CO_2 emission levels, North West Leicestershire would use this entire budget [6.6 million tonnes of CO_2] within 6 years from 2020'.*

2.1.3 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has explored the pathways needed to limit the global temperature rise as a result of climate change to no more than 1.5°C. These would require average global emissions to be reduced to between -0.4 and 1.7 tonnes CO_2 equivalent (tCO_2e) per person per year. The Climate Change Committee (CCC) advised Government that achieving Net Zero by 2050 would be the equitable role the UK would need to play in global efforts to limit average global emissions to 1.7 tCO_2e per person.[3]

[1] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[2] Tyndall Centre, 'Setting Climate Commitments for North West Leicestershire: Quantifying the implications of the United Nations Paris Agreement for Kensington and Chelsea' (July 2020). Available at: https://carbonbudget.manchester.ac.uk/reports/E09000020/
[3] Net Zero – The UK's contribution to stopping global warming. Climate Change Committee. May 2019.

2.1.4 Energy Performance of Buildings Directive

The European Energy Performance of Buildings Directive (EPBD) addresses the issue of climate change through energy performance improvement. It requires that by 31 December 2020, all new buildings should be 'nearly zero-energy buildings.' EU Directives are met by member states transposing the requirements into national legislation. The UK Government has previously met EPBD requirements for new buildings by transposing the requirements into Part L of the Building Regulations. The UK Government's position is that buildings which meet the standards set out in the consultation version of Part L 2020 (see Section 2.2.4) will fulfil the requirement of nearly zero-energy buildings.

2.2 National Context

2.2.1 UK Climate Change Act: 2050 Target Amendment Order (2019)

In 2019, the UK became the first country to declare a Climate Emergency, and subsequently, by amending the Climate Change Act (2008), legally committed to achieving Net Zero greenhouse gas emissions by 2050. In taking these actions, the UK has demonstrated international leadership with regards to its obligations under the Paris Agreement.

This Act legally commits the UK Government to reducing emissions by 100% by the year 2050, compared with a 1990 baseline.[4] As described by the UK Committee on Climate Change (CCC), *'The Act provides the UK with a legal framework including a 2050 target for emissions reductions, five-yearly 'carbon budgets' (limits on emissions over a set time period which act as stepping stones towards the 2050 target), and the development of a climate change adaptation plan.'*[5]

As noted in the CCC report *'Net Zero: The UK's contribution to stopping global warming'* (2019), this level of carbon reduction is achievable using known technologies and techniques,[6] such as:

- Reducing demand through resource and energy efficiency;
- Societal choices e.g. reducing meat consumption;
- Electrification of transport and heating;
- Development of hydrogen gas and carbon capture and storage (CCS) technologies; and
- Land use changes that promote carbon sequestration and biomass production.

The CCC's recent *'2020 Progress Report to Parliament'* assesses the progress in reducing carbon emissions in the UK over the past year. The report concludes that whilst steps have been made to approach climate change mitigation targets there remains much to be addressed if the UK is to meet its net zero carbon commitment by 2050. The Committee sets out recommendations to the Government, ongoing strategic priorities are defined as:

1. Low-carbon retrofits and buildings that are fit for the future;
2. Tree planting, peatland restoration, and green infrastructure;
3. Energy networks must be strengthened;
4. Infrastructure to make it easy for people to walk, cycle, and work remotely; and
5. Moving towards a circular economy.

It is expected that the Government's planned 2020 Heat Roadmap will respond to these areas in establishing an approach that will lead to the full decarbonisation of buildings by 2050.

[4] The original (2008) target of 80% was amended through subsequent legislation in 2019. *See 'The Climate Change Act 2008 (2050 Target Amendment) Order 2019'*: http://www.legislation.gov.uk/uksi/2019/1056/contents/made
[5] https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/
[6] Available at: https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

2.2.2 UK Clean Growth Strategy and Industrial Strategy (2017)

The UK Clean Growth Strategy[7] (CGS) was published in October 2017 and sets out the Government's vision for decoupling economic growth from carbon emissions.

It includes objectives for increasing the generation of energy from renewable sources, increasing the delivery of clean, smart and flexible power, and accelerating the shift to low carbon transport, smart grids and energy storage. The delivery of low carbon heating is identified as a priority, indicating that heat pumps, district heating networks and a hydrogen gas grid could all support the scale of change required, while acknowledging the significant technical and financial obstacles.

The Clean Growth Strategy also discusses the need to improve energy efficiency in buildings, particularly the existing stock. This includes a strategy of progressively increasing the minimum Energy Performance Certificate (EPC) ratings that will be considered permissible in order to allow the sale or rental of buildings, as required by the Minimum Energy Efficiency Standards (MEES) regulations. [8]

The UK Industrial Strategy,[9] published in November 2017, emphasises the themes of the CGS and describes a 'Grand Challenge' for maximising the advantages that the UK can gain from the global shift to a low carbon economy. Both documents note the potential for low carbon industries to deliver a high level of GDP growth compared with the current forecast.

2.2.3 National Planning Policy Framework

The National Planning Policy Framework (NPPF) sets out Government planning policy for England. It states that, *'the purpose of the planning system is to contribute to the achievement of sustainable development.'* It provides guidance for local planning authorities drawing up local plans and is a material consideration for those determining applications.

The NPPF further states, *'at the heart of the [National Planning Policy] Framework is a presumption in favour of sustainable development.'* It addresses topics that are relevant to the economic, environmental and social sustainability of development proposals, including but not limited to:

- Promoting sustainable transport;
- Making effective use of land;
- Achieving well-designed places;
- Protecting Green Belt land;
- Meeting the challenge of climate change, flooding and coastal change; and
- Conserving and enhancing the natural environment.

[7]HM Government *'Clean Growth Strategy'* (2017). Available at: https://www.gov.uk/government/publications/clean-growth-strategy

[8] The *'Energy Efficiency (Private Rented Property) (England and Wales)'* Regulations 2015 introduced the Minimum Energy Efficiency Standard (MEES) for buildings across the UK. For further information, see https://www.gov.uk/government/publications/the-private-rented-property-minimum-standard-landlord-guidance-documents

[9] HM Government, *'Industrial Strategy: Building a Britain Fit for the Future'* (2017). Available at: https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

2.2.4 Building Regulations (Part L)

Part L of Building Regulations is the key mechanism that prescribes standards for the conservation of fuel and power in new and existing[10] buildings in England & Wales, based on metrics such as the estimated level of energy demands and CO_2 emissions.

At the time of writing, the Ministry of Housing, Communities and Local Government (MHCLG) has recently consulted on proposed future standards (see box below) that would significantly reduce emissions from new domestic buildings in the UK when introduced in 2025. They have also consulted on interim updates to Part L of Building Regulations that are expected to be finalised in December 2021 and which would be enforced from June 2022.[11] These are aimed at delivering a CO_2 saving of 31% against the current Part L 2013 for homes and either a 22 or 27% reduction for non-domestic buildings depending on the responses to the consultation.

The Future Homes Standard

Under the Future Homes Standard (FHS), new buildings would be required to meet significantly higher targets for energy efficiency and carbon savings. The Government states that, *'As part of the journey to 2050 we have committed to introducing the Future Homes Standard in 2025. This consultation sets out what we think a home built to the Future Homes Standard will be like. We expect that an average home built to it will have 75- 80% less carbon emissions than one built to current energy efficiency requirements (Approved Document L 2013). We expect this will be achieved through very high fabric standards and a low carbon heating system. This means a new home built to the Future Homes Standard might have a heat pump, triple glazing and standards for walls, floors and roofs that significantly limit any heat loss.'*

- BEIS, *'The Future Homes Standard Consultation'* (2019)

2.2.5 Government Policies on Sustainable Transport

The UK Government has set a target that all new vehicles will be ULEVs by 2040. This means that new internal combustion engine vehicles (which use traditional fuels such as petrol and diesel) will not be permitted for sale beyond this date. This policy is supported by the Automated and Electric Vehicles Act 2018, which empowers the Government to require motorway services and large fuel retailers to install EV charge points that are 'smart' and practical for consumers.[12]

Since the passage of the Act in July 2018, the Government has expressed support for bringing forward, from 2040 to 2035, the date from which the sale of traditionally-fuelled new vehicles will be banned. The Government has recently consulted[13] regarding this change, and the Government has indicated that it may support an even earlier date for the ban, with 2032 suggested by the Secretary of State for Transport.[14] The consultation finished on 31st July 2020 although it is not clear when a response will be issued.

The Government has set up the Office for Low Emission Vehicles (OLEV) to help industry, local authorities, consumers and other stakeholders in their transition to ULEVs.[15] Examples of the support and resources that the OLEV provides include grants for new vehicles, grants for new workplace charging equipment, and funding for ultra-low emission buses. Additionally, the OLEV provides guidance, latest news, and research and statistics.

[10] New buildings – Parts L1a and L2a. Existing buildings – Parts L1b and L2b.
[11] For more information, see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956037/Future_Buildings_Standard_consultation_document.pdf and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956094/Government_response_to_Future_Homes_Standard_consultation.pdf
[12] https://services.parliament.uk/bills/2017-19/automatedandelectricvehicles.html
[13] https://www.gov.uk/government/consultations/consulting-on-ending-the-sale-of-new-petrol-diesel-and-hybrid-cars-and-vans
[14] https://inews.co.uk/news/politics/grant-shapps-ban-new-petrol-diesel-cars-12-years-1555687
[15] https://www.gov.uk/government/organisations/office-for-low-emission-vehicles

Definitions – Sustainable Transport

According to the Department for Transport, ULEVs are currently defined as producing less than 75 gCO_2 from the tailpipe for every kilometre travelled. However, there are two main types of vehicle which qualify as ULEV. These include:

- **Battery Electric Vehicles** (BEV) – these run solely on electricity, and require recharging from a charge point; and
- **Plug-in Hybrid Electric Vehicles** (PHEV) – these have both an internal combustion engine in addition to an onboard electric battery and motor which can be recharged from a charge point.

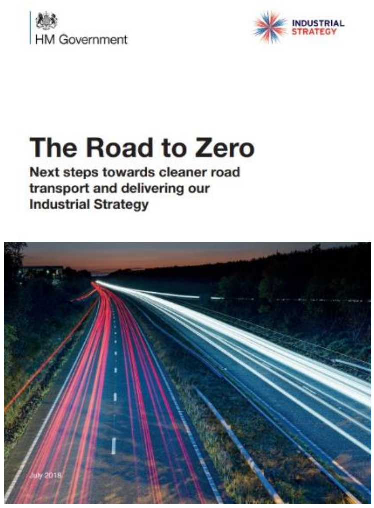
There are three main types of charge points:

- **Rapid** – these deliver the fastest rate of charge. Most of these chargers are Direct Current (DC), and deliver 50 kW, 100 kW or up to 350 kW for Ultra-Rapid chargers. There are some Alternating Current (AC) rapid chargers, with 43 kW AC being the most common size.
- **Fast** – these are AC only and commonly deliver power at 7 kW to 22 kW, depending on the unit.
- **Slow** – these AC units deliver the slowest rate of charge and deliver power at 3 kW to 6 kW.

The time it takes to charge a vehicle depends on the battery size and the power rating of the charge point, with the charging time in hours equal to [Battery size in kWh] ÷ [Power in kW]. So, a 40kWh battery EV would take roughly 10 hours to charge from empty using a 4kW charge point, 5-6 hours using a 7kW charge point, and less than 2 hours using a 22kW charge point. However, most users ‘top up’ the battery rather than charging it from empty.

In the context of this discussion, ‘smart’ charging refers to the ability of charge facilities to be flexible in the rate of charge that can be delivered, in response to the real-time capacity in the incoming supply.

The Road to Zero (2018)



The Road to Zero report[16], published in July 2018 sets out the Government’s core mission; ‘to put the UK at the forefront of the design and manufacturing of zero emissions vehicles and for all new cars and vans to effectively be zero emission by 2040.’ The strategy furthers the ambitions of the Air Quality Plan for NO_2[17] and Clean Growth Strategy (see following section) in defining key policies with a primary focus on the introduction of low and zero emission vehicles, with the aim that *‘at least 50%, and as many as 70%, of new car sales and up to 40% new van sales being ultra-low emission by 2030. By 2050 we want almost every car and van to be zero emission.’*

In supporting these longer-term ambitions, the strategy outlines supporting policy action toward the fulfilment of these broader goals, including:

- Reducing emissions from existing vehicles on the road;
- Extension of the Clean Vehicle Retrofit Accreditation Scheme (CVRAS) beyond its current scope to include both vans and black cabs; and
- Developing a strategy to tackle HGV and freight-related emissions through Highways England research.

The Government has stated that local action will be supported through new policies, including the provision of funding to extend ultra-low emission bus schemes and taxi charging infrastructure. Ongoing goals to encourage the uptake of clean new vehicles will be backed by developing electric vehicle infrastructure, offering funds and grants for provision of electric charge points.

[16] HM Government, *‘The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy’* (2018) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf
[17] Air quality plan for nitrogen dioxide (NO2) in UK (2017) https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017

2.2.6 Written Ministerial Statement on Wind (2015)

The Written Ministerial Statement on Wind (HCWS42, 2015) states that, when determining planning applications for wind energy development, planning authorities should only grant permission if:

- the development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood plan; and
- following consultation, it can be demonstrated that the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing.[18]

The statement goes on to explain:

> *'In applying these new considerations, suitable areas for wind energy development will need to have been allocated clearly in a Local or Neighbourhood Plan. Maps showing the wind resource as favourable to wind turbines, or similar, will not be sufficient.'*

In practical terms, the effect of HCWS42 has been to significantly limit the amount of onshore wind development in the UK, recognising that most Local Authorities have few, if any, site allocations for wind energy – although it is anticipated[19] that the Government will relax its position in future. North West Leicestershire is relatively unusual in having produced a set of maps showing acceptable locations for wind energy development (see Section 2.3.4 below) which will inform our analysis of future renewable energy opportunities.

2.2.7 'Planning for the Future' White Paper (2020)

The Planning for the Future consultation White Paper was published by the Ministry of Housing, Communities and Local Government on 6th August 2020. This consultation sets out a package of proposed measures that, if implemented, would comprehensively transform the current planning system in England. The stated aim is to streamline and modernise the planning process, including to improve design and sustainability outcomes.

The Consultation proposes the role of Local Plans to be simplified, with less repetition of national policy. Local Plans will instead focus on setting out clear rules limited to a core set of standards and requirements for development, including site-specific and area-specific requirements. It is also proposed that a National Model Design Code be introduced following the publication of the National Design Guide in October 2019, to be supplemented by local design guides and codes, although it is not clear what topics would be delegated to the latter.

Some of the proposed key changes in the consultation relevant to this study are outlined below.

- Local Plans would be significantly reduced in scope to include fewer policies. The majority of policies would be set nationally while Local Plans would primarily address development site allocations.
- Specifically, Local Plans would designate land as falling into the category of either 'protection', 'renewal' or 'growth'. Outline planning permission may automatically be granted for 'growth' areas and restricted in 'protection' areas, while areas suitable for 'renewal' would accommodate some forms of development such as infill / densification.
- Proposals would still need to adhere to locally specific Design Codes that set out more detailed requirements. The process for developing these would require significant community engagement and support, an issue that is strongly emphasised throughout the consultation document.
- The planning application system would be streamlined and digitised; in particular, the number of supporting application documents would be reduced.
- The current system of S106 contributions and the Community Infrastructure Levy would be replaced with a nationally standardised, flat-rate infrastructure levy based on development and land values.

The 'Planning for the Future' consultation closed on 29th October 2020. It is not clear when the government is intending to respond to the consultation or the timeline for implementation. Nonetheless, it should be borne in mind when considering the policy recommendations set out in this report.

---

[18] https://www.parliament.uk/documents/commons-vote-office/June%202015/18%20June/1-DCLG-Planning.pdf

[19] In March 2020, BEIS announced that onshore wind farms would be eligible to join the Contracts for Difference (CfD) scheme, reversing an earlier prohibition on subsidies for onshore wind, but as of June 2020, no changes have been announced that would lift the planning policy restrictions set by HCWS42. See BEIS, *'Contracts for Difference for Low Carbon Electricity Generation'* (2020). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/885248/cfd-ar4-proposed-amendments-consultation.pdf

2.3 Local Policies and Drivers

Since 2019, Local Authorities across the country have been supporting the action on climate change by formally passing 'Climate Emergency Declarations.' North West Leicestershire District Council made an individual climate emergency declaration on 25th June 2019 setting out intents to support the Government's net zero target to 2050 and aims to achieve carbon neutrality for the Council's own emissions by 2030.

2.3.1 North West Leicestershire Local Plan (November 2017)

The North West Leicestershire Local Plan is a strategic document which sets out the current planning framework for development within the District. The Local Plan sets out the future development of the District from 2011 looking ahead to 2031 and includes planning policies for new development. The Local Plan was adopted in November 2017 and is currently in the process of review.

NWLDC set out key objectives for the Local Plan, including *Objective 8, "prepare for, limit and adapt to climate change."* The plan includes the following key policies relevant to climate change mitigation and adaptation:

- *Policy Cc1 Renewable Energy* sets out the Council's approach to planning applications for renewable energy infrastructure. The policy sets out criteria for the suitability of sites for development of large-scale renewable energy in line with the National Planning Policy Framework 2014.
- *Policy Cc2 Flood Risk* approaches the Council's role in minimising vulnerability to the impacts of climate change through the implementation of flood risk mitigation measures. The policy defines both master-planning strategies and on-site measures which address flood risk associated with development proposals.
- *Policy Cc3 Sustainable Drainage Systems* expands upon Policy Cc2 to specify the integration of Sustainable Drainage Systems (SuDS) within new development in line with national and local policy standards.

In addition, *Policy D1 Design of New Development* of the Local Plan broadly addresses the need for new development to acknowledge sustainable design and construction methods. Supplementary policy wording emphasises the priority to improve energy efficiency in buildings to support the reduction of carbon emissions. A range of sustainable intervention measures are outlined, providing practical suggestions of design considerations to be made by developers to mitigate and adapt the effects of climate change in new development.

The Council encourages developers to integrate sustainable and environmental measures to deliver developments which exceed the performance standards set out in Building Regulations. This is supported by NWLDC's *Good Design SPD* adopted in April 2017.

The Local Plan is supported by a variety of evidence documents including the NWLDC Renewable Wind Energy Study (2016) which was used to generate maps of areas that would be considered suitable for wind energy development. It is understood that this exercise was carried out in order to comply with the requirements of HCWS42. The Renewable Wind Energy Study is discussed in more detail in Section 2.3.4.

2.3.2 North West Leicestershire Local Plan Review

The adopted North West Leicestershire Local Plan is currently under review, with the Partial Review submitted to the Planning Inspectorate in February 2020 and an Examination took place in September 2020. This first stage of review seeks solely to amend *Policy S1 Future housing and economic development needs* which currently defines the total new development required within the District across the current Local Plan period from 2011 to 2031.

A Substantive Review is taking place in parallel to the Partial Review which will consider revisions to the remainder of the adopted Local Plan. The Local Plan Substantive Review will take into account policy and context changes since adoption including publication of the revised NPPF and the outcomes from (or proposals contained in) consultation versions of Building Regulations Part L and the Future Homes Standard (FHS).

This report will support the evidence base for the new Local Plan for NWLDC, providing evidence on the technical potential for renewable and low carbon energy across the District.

2.3.3 North West Leicestershire District Council Zero Carbon Roadmap (2019)

Following NWLDC's Climate Emergency declaration in June 2019, the Council commissioned a study to develop a response to the need to reduce both the council's own and district-wide carbon emissions. The Zero Carbon Roadmap and Action Plan were formally adopted in March 2020 and are expected to inform the focus and trajectory of policy in the new Local Plan.

The Roadmap report explores the pathway to net zero carbon with consideration given to a range of sectors and energy end uses. It explains that significant change will be required in the following eight key areas:

- **Buildings** – to improve the energy efficiency of new and existing buildings and supply these with decarbonised heat, to be supported by building-mounted PV arrays. Increasing consideration of embodied carbon for new buildings and of public realm energy usage such as street lighting.
- **Power** – a key focus on provision of renewables and low carbon generation plus investigation of the creation of a 'smart grid' and the potential of hydrogen as an alternative fuel.
- **Waste** – to increase recycling rates to limit landfill waste, by separation of biodegradable waste streams. Increasing consideration of a circular economy to design out waste.
- **Transport** – to instigate the electrification of organisational vehicles and support private uptake through provision of infrastructure to support electric vehicle charging. Continue to support other sustainable means of travel such as rail and cycling and explore emerging options including hydrogen.
- **Forestry and Land Use** – to maintain existing wetlands and heathlands and encouraging afforestation. Influencing local diet to support crop-based agriculture.
- **Industry** – to address emissions arising from industrial and construction processes in the District.
- **Aviation** – to consider the emissions resulting from the East Midlands Airport through aviation and shipping.
- **F-Gases** – to address the proportional impact of other greenhouse gases (GHGs) such as fluorinated gases.

The Action Plan quantifies the investigation undertaken by the Zero Carbon Roadmap to set out the distinct steps required from NWLDC to meet key outcomes in reducing carbon emissions:

- A Net Zero Carbon Council by 2030
- A Net Zero Carbon District by 2050

The GHG emissions baseline described in the Roadmap draws, in part, from the Local Authority CO_2 emissions dataset published annually by BEIS.[20] This is supplemented with estimates of other GHG emissions from waste, aviation, and fluorinated gases (known as F-gases) although the Roadmap does not set out detailed sources and methodology for establishing those estimates. Section 3 of this report presents more recent CO_2 emissions information from BEIS which will be used to provide context and assess any recent trends since the completion of the Roadmap report.

The Roadmap also provides an assessment of the current level of renewable energy generation in the District, based on the BEIS Regional Renewable Statistics (RRS) dataset. It also proposes future targets for increasing such provision with reference to a previous Low Carbon Energy Opportunities Study[21] carried out in 2011, which was carried out in line with guidance[22] produced by the former Department of Energy and Climate Change (DECC). This will be discussed in more detail in Section 4 where we will provide an updated assessment.

[20] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2017
[21] Land Use Consultants, Centre for Sustainable Energy and SQW, '*Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report'* (2011)
[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

2.3.4 North West Leicestershire Renewable Wind Energy Study (2016)

In 2016, following the publication of HCWS42, a study was undertaken to identify locations within the District that might be suitable for wind energy development.[23] The assessment was carried out in line with DECC (2010) guidance on renewable energy opportunities mapping[24] and covered both small scale[25] and medium / large scale[26] turbines. GIS mapping was used to assess locations based on the following key constraints:

- Wind speed – The threshold for suitability was set at 4.5 m/s at 25m above ground for small scale turbines and 5 m/s at 45m above ground level for medium / large scale turbines.
- Environmental and landscape designations – Ancient Woodland, Semi Natural Ancient Woodland, Scheduled Ancient Monuments and Registered Parks and Gardens. The study states that, *'Any other environmental and landscape designations can be investigated further during the planning process where the appropriate consultees can determine the significance of potential impacts.'*
- Proximity to residential properties – Recognising that the impacts on adjacent properties depend on the scale of turbine, for the purpose of the study a buffer was applied to represent the minimum distance required for safety, which was set at 50m + 10% for smaller scale turbines and 130m + 10% for medium / large turbines.
- Proximity to East Midlands airport was also taken into account due to potential impacts on safety (e.g. interference with radar); although it is acknowledged that some forms of wind turbine could be acceptable within those zones recognising that there are already two 45m turbines located at the airport.

Based on the fact that this mapping followed DECC guidance, with due consideration given to the local context and precedent, in our view the Renewable Wind Energy Study is compliant with the requirements of HCWS42 and could be retained as part of the new Local Plan. From a policy perspective, it provides useful flexibility (in terms of where wind turbines could be located) while also accounting for safety requirements, amenity and environmental considerations. This will be discussed in more detail in Section 4.

[23] https://www.nwleics.gov.uk/files/documents/renewable_wind_energy_study/North%20West%20Leicestershire%20Local%20Plan.pdf
[24] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf
[25] https://www.nwleics.gov.uk/files/documents/map_showing_areas_potentially_suitable_for_small_scale_wind_energy/2017Small%20Wind%20Energy%20Map.pdf
[26] https://www.nwleics.gov.uk/files/documents/map_showing_areas_potentially_suitable_for_mediumlarge_scale_wind_energy/2017Large%20Wind%20Energy%20Map.pdf

3 Establishing the Baseline

In order to provide context for our assessment of future low and zero carbon (LZC) opportunities that will be presented in Section 4, this section summarises the current baseline fuel consumption and CO_2 emissions for North West Leicestershire, highlighting areas where these differ from the figures provided in the Zero Carbon Roadmap. It also provides an estimate of the current level of LZC deployment, ultra low emission vehicles (ULEV) uptake and charge point provision across the District.

Note: The analysis presented below considers the District-wide fuel consumption and emissions as agreed with NWLDC during a call on 4th August 2020.

3.1 Fuel Consumption

Fuel consumption figures are taken from the BEIS publication *'Sub-national total final energy consumption statistics: 2005-2017'* (published in 2019).[27] The dataset includes a breakdown of emissions by sector and fuel type where data is available and can be meaningfully disaggregated to a Local Authority level, i.e. it does not include aviation or national navigation. 2017 is the most recent year for which such data is available. Further details of the methodology used to calculate these figures can be found in the *'Sub-national methodology and guidance booklet'* (BEIS, December 2018).[28] Results are shown in the table below.

Note that it is not possible to differentiate between electricity use in buildings and electricity used for charging vehicles or public transport (such as electrified rail), as the public datasets do not capture this information. Therefore, fuel use for 'road transport' and 'rail' only include petroleum products. 'Road transport' includes all vehicle movements within the geographic boundary of North West Leicestershire regardless of origin or destination.

Table 1. Fuel Consumption (2017 data)

	Non-domestic (GWh)	Domestic (GWh)	Road transport (GWh)	Rail (GWh)	Bioenergy & waste (GWh)	Total (GWh)	*% of total*
Gas	682.3	552.2	-	-	-	1,234.5	*27%*
Electricity	394.9	173.6	-	-	-	568.5	*12%*
Petroleum Products	951.32	27.6	1,664.6	47.4	-	2,690.8	*58%*
Coal	21.3	18.9	-	-	-	40.2	*1%*
Manufactured fuels	45.3	10.0	-	-	-	55.3	*1%*
Bioenergy & waste	-	-	-	-	28.1	28.1	*1%*
Total by sector	**2,095.1**	**782.2**	**1,664.6**	**47.4**	**28.1**	**4,617.3**	
% of total	*45%*	*17%*	*36%*	*1%*	*1%*		

Petroleum products represent the majority (58%) of total fuel use within the geographic boundary of the District. Within this category, the majority (around 60%) of petroleum products are used for road transportation although a significant portion is also used in industrial & commercial buildings, with a small amount used for rail and domestic heating. This means that some of the emissions from petroleum may be entirely outside of NWLDC's ability to control as they relate to vehicles travelling through the District from elsewhere. Gas and electricity use in buildings represent 27% and 12% of the total fuel use respectively, while other fuels collectively account for around 3%. This is shown in Figure 1 below.

[27] https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level
[28] Note that, for the purpose of this report, BEIS statistics for 'industrial & commercial' fuel consumption, 'public sector' fuel consumption and 'agriculture' fuel consumption are collectively referred to as 'non-domestic' uses. 'Bioenergy & waste' is not reported by sector. Electricity used for transport, (i.e. rail or ULEVs) is incorporated into the total figures for electricity. For further information see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/771895/Sub-national_Methology_and_Guidance_Booklet_2018.pdf

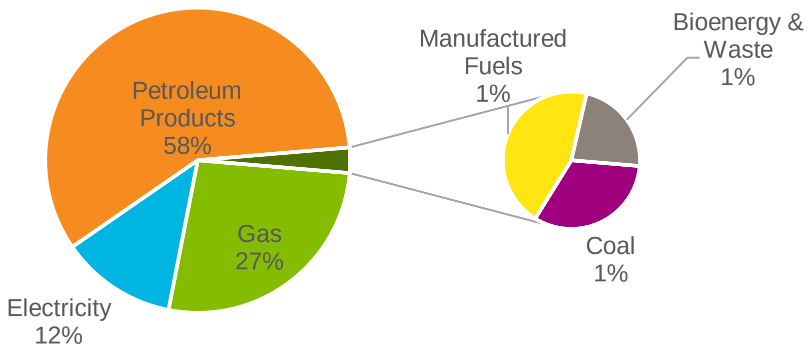


Figure 1. Split of Fuel Consumption by Fuel Type (2017 data)

Figure 2 shows a more detailed breakdown of fuel use by sector. The non-domestic sector represents the highest portion of fuel consumption (45%), followed by road transportation (36%). The domestic sector accounts for only 17%; this primarily comprises gas (used for heating, hot water and cooking) and electricity.

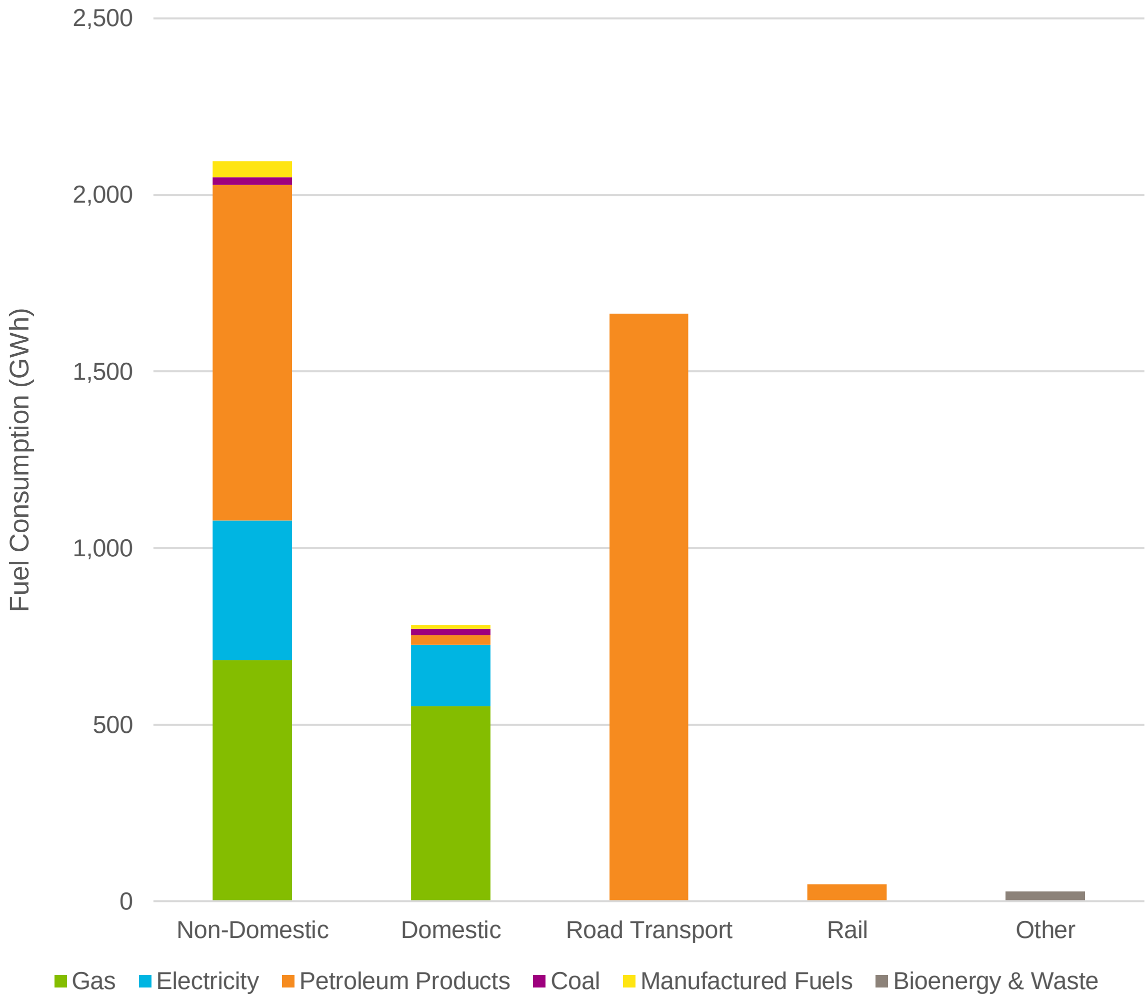


Figure 2. Fuel Consumption by Sector and Fuel Type (2017 data)

Considering road transportation in more detail, the majority of fuel use is for petrol and diesel cars, which represents around 49% of the total. A further third is used in heavy goods vehicles (HGVs) (32%) while the rest (17%) is predominantly used for light goods vehicles (LGVs).

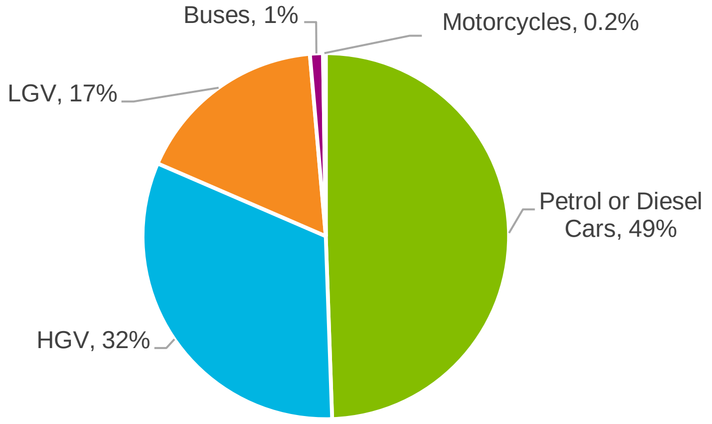


Figure 3. Use of Petroleum Products in Road Transportation (2017 data)

Figure 4 below shows trends in fuel consumption by sector since 2005. Fuel use has generally risen since 2012. The most significant changes are due to the increase in consumption of gas and petroleum products in the non-domestic sector and road transport. It is not possible to definitively state the cause of this change because fuel use is linked to so many factors, including weather, consumer behaviour, energy efficiency, and so on.

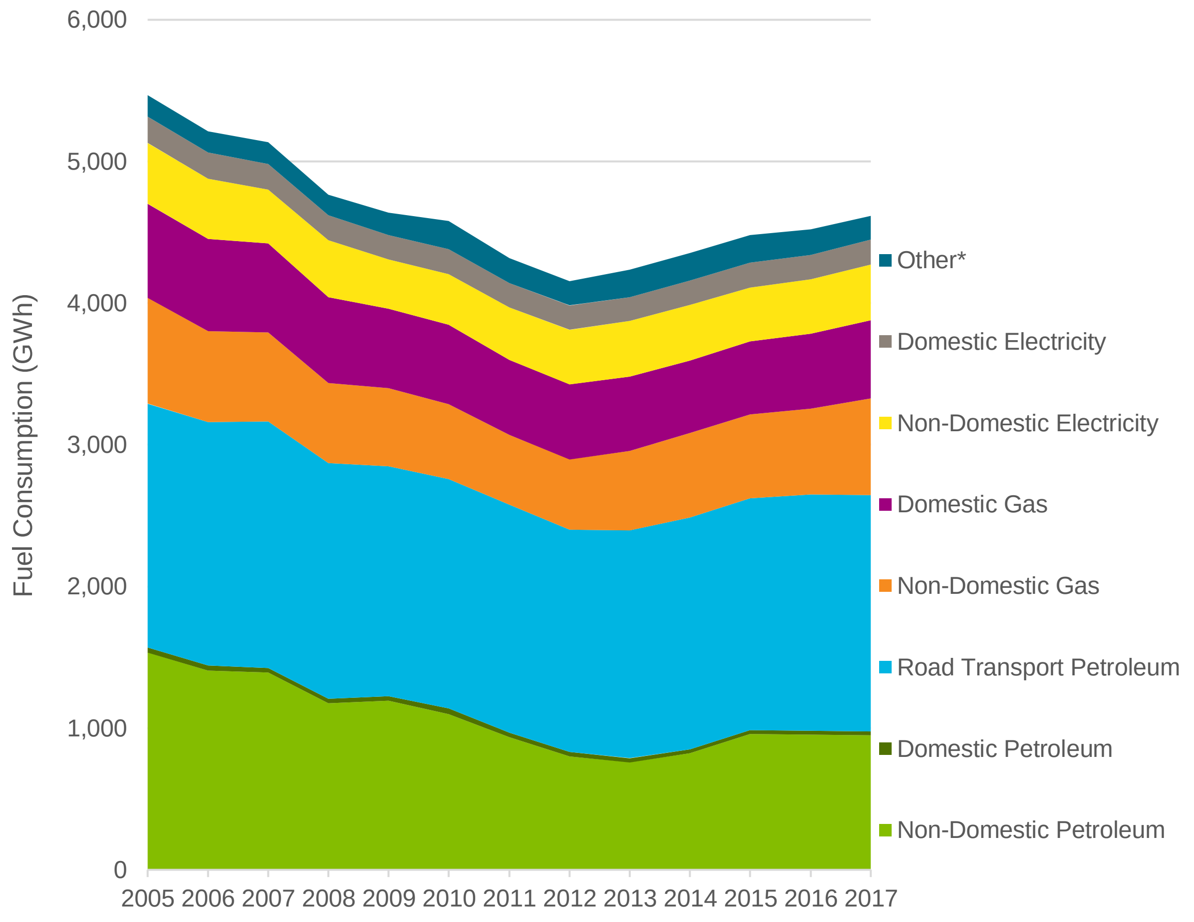


Figure 4. Trends in Fuel Consumption (2005-2017)

** Includes coal, manufactured fuels, bioenergy & waste, and petroleum products used for rail. These categories have been consolidated for clarity as they make up a small proportion (3-4%) of the total.*

3.2 CO_2 emissions

The Zero Carbon Roadmap estimates that the emissions baseline for North West Leicestershire is 1,281 kt CO_2e. The report authors drew from several sources of information to arrive at this figure:

- CO_2 emissions estimates for North West Leicestershire were taken from the *'UK local authority and regional carbon dioxide emissions national statistics'*. This time series dataset is updated annually two years in arrears; the Zero Carbon Roadmap uses emissions data from 2016. At the time of writing the BEIS dataset is the most comprehensive source for information about CO_2 emissions at a sub-national level and furthermore can be used to monitor trends over time. The Roadmap reports that these emissions accounted for 1,153 kt CO_2 of the total 1,281 kt CO_2.

- In addition, the Zero Carbon Roadmap included estimates of emissions from waste, aviation and F-gases, although the authors noted that, *'these are usually excluded from sub-national emissions reporting'* (Zero Carbon Roadmap, p. 17). These were estimated on the basis of UK-wide totals, allocated to North West Leicestershire by population, and their inclusion increased the total estimated GHG baseline by roughly 10%. In this report we have not sought to update those figures as no details of the methodology were provided to enable a like-for-like comparison.

The diagram below illustrates the difference between the CO_2 emissions estimate presented in the Zero Carbon Roadmap and a new estimate based on publication of more recent data from BEIS which reports 1,183 kt CO_2 in 2018. Our intention here is not to suggest that the Zero Carbon Roadmap is incorrect or should be revised, but merely to provide context for our own analysis and understand whether there have been any significant changes since the Roadmap was published.

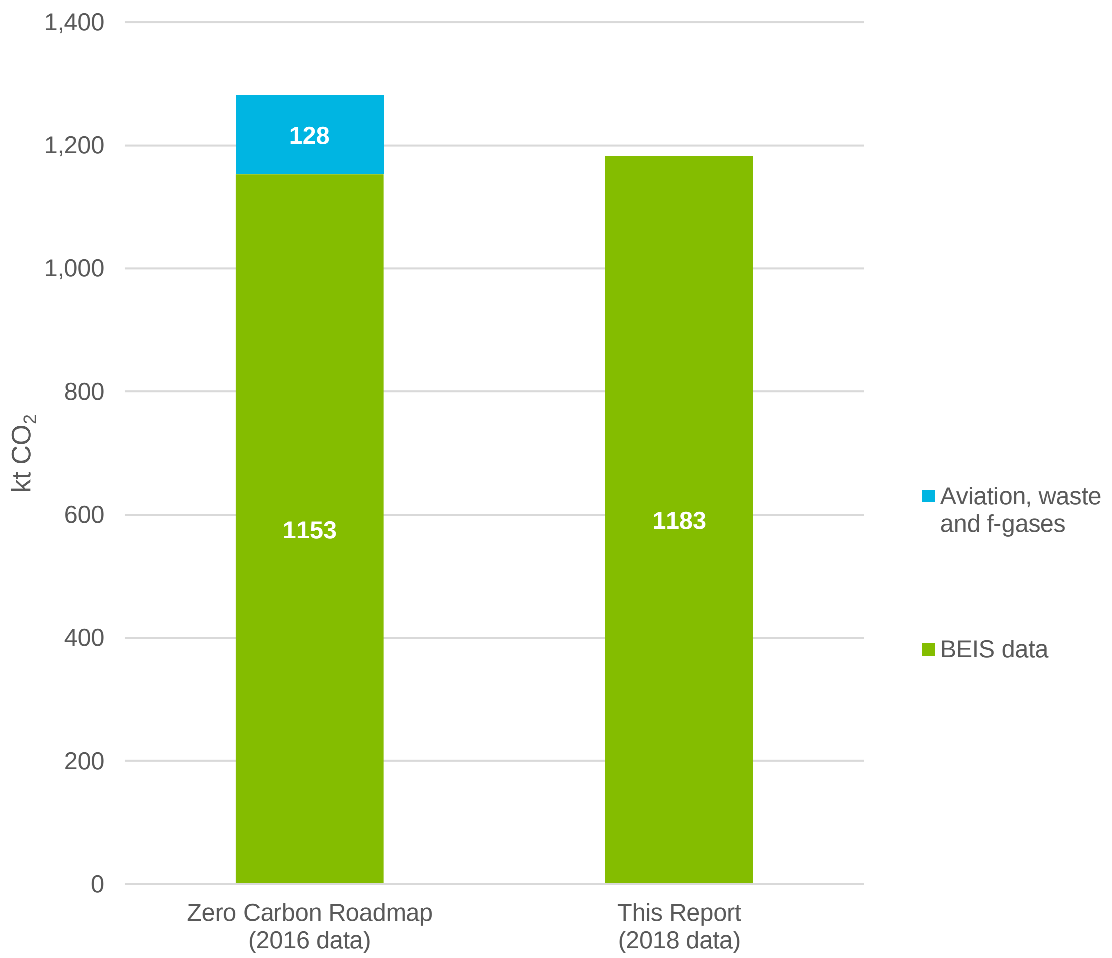


Figure 5. Comparison of CO_2 emissions estimates and data sources

Note: Scope of the Greenhouse Gas Emissions Reporting

For the purpose of greenhouse gas (GHG) reporting, emissions are divided into three categories:

- Scope 1 – Direct emissions that arise from burning fuels in North West Leicestershire. This primarily includes fuel used in boilers to provide heating and hot water, fuel used in any vehicles while they are driving within District boundaries, and fuels (other than electricity) used for cooking.
- Scope 2 – Indirect emissions associated with the use of electricity in North West Leicestershire.
- Scope 3 – Indirect emissions that result from other activities outside the border of North West Leicestershire, but that take place as a result of the actions of people or organisations within North West Leicestershire, e.g. emissions from commuting, shipping, or aviation.

This report only quantifies Scope 1 and 2 CO_2 emissions, as these are the categories reported within publicly available datasets produced by BEIS. This covers a range of sectors and fuel types but does not cover *all* potential sources of GHG emissions within the Local Authority area.[29] For example, considering air conditioning units, the dataset includes the CO_2 emissions from the electricity used, but excludes other greenhouse gases emitted by refrigerants (e.g. hydrofluorocarbons). At the time of writing such information is not published by BEIS at a Local Authority level.

For further information, see *'Technical Report: Local and Regional Carbon Dioxide Emissions Estimates for 2005-2018 for the UK'* (BEIS, June 2019).[30, 31]

The 2018 CO_2 emissions data breakdown for North West Leicestershire based on the BEIS dataset is shown in Table 2 and is further illustrated in Figure 6. (Note that the CO_2 emissions data is reported using slightly different categories than the fuel consumption data presented in Section 3.1, and fuel consumption data for 2018 is not yet available, so it is not possible to make a direct comparison, but the fuel consumption figures nonetheless provide useful context.)

Table 2. CO_2 Emissions (2018 data)

	Emissions - Non-Domestic (kt CO_2)	Emissions – Domestic (kt CO_2)	Emissions – Transport (kt CO_2)	Removals - LULUCF* (kt CO_2)	Total (kt CO_2)	% of total emissions (excl. removals)
Gas	142	105	-	-	247	*21%*
Electricity	94	40	-	-	134	*11%*
Large Industrial Installations	62	-	-	-	62	*5%*
Agriculture	8	-	-	-	8	*1%*
Road Transport	-	-	468	-	468	*39%*
Diesel Railways	-	-	12	-	12	*1%*
Other / Not Specified	217	26	21	(-11)	253	*22%*
TOTAL	**522**	**171**	**501**		**1,183**	
% of total emissions (excl. removals)	*44%*	*14%*	*42%*	*n/a*		

** Note: The adjustment for Land Use, Land Use Change and Forestry (LULUCF) reflects the fact that certain land use activities, such as cutting down or planting trees, result in CO_2 being added or removed from the atmosphere. In North West Leicestershire the net emissions from LULUCF are negative, i.e. more CO_2 is removed from the atmosphere than is emitted from these activities.*

[29] The Kyoto Protocol covers six GHGs: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

[30] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812146/Local_authority_CO2_technical_report_2017.pdf

[31] BEIS, *'Local and Regional Carbon Dioxide Emissions Estimates 2005-2017: Technical Report'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812146/Local_authority_C02_technical_report_2017.pdf

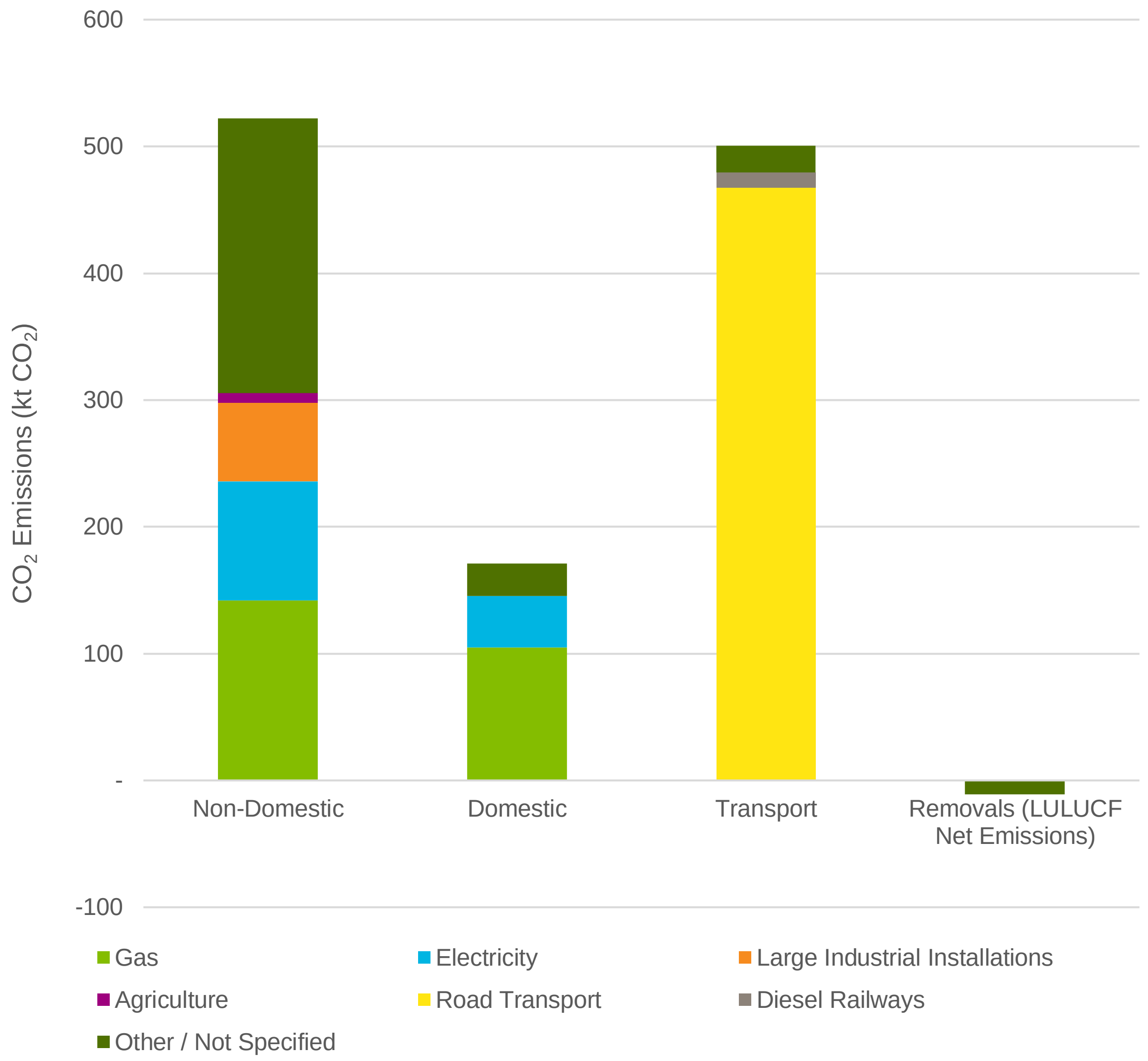


Figure 6. CO_2 emissions by Sector and Source / Fuel Type (2018 data)

Among the sectors reported, the non-domestic sector accounts for the largest proportion of CO_2 emissions (44%). This includes emissions from fuels used in buildings, and therefore encompasses energy used for activities such as lighting, heating and cooling the space, but would also include fuels used for industrial processes themselves. As noted in the Zero Carbon Roadmap, industrial emissions are regionally high. The transport sector represents around 42% of CO_2 emissions and this is strongly dominated by the use of petroleum products for road transport. Fuels used in domestic buildings account for only around 17% of total emissions, mostly due to the use of gas for heating, hot water and cooking.

As noted previously, the transport emissions include journeys that take place within North West Leicestershire regardless of where those journeys start and end, so it is not easy to assess the proportion that are likely due to the movements of occupants of (or organisations based in) North West Leicestershire versus the overall total. However, as a rough proxy, it is worth considering that the split of transport fuel consumption is roughly 51% for personal travel and 49% freight, and 61% is used on motorways while only 39% is used on other roads, so a significant portion of emissions could potentially be associated with journeys passing through the District.

Figure 7 shows the recent trends in CO_2 emissions by sector and fuel type as reported by BEIS. Since 2005 there has been an overall 25% decrease in emissions, which is lower than the UK average (which saw a 35% decrease) and the regional average (29%). There has been relatively little change in emissions in the District since 2013. Nationally, most of this decrease is associated with decarbonisation of the electricity supply; however, in North West Leicestershire this makes less difference proportionally due to the high emissions from the non-domestic (commercial and industrial) sectors. As discussed previously, there has been an overall increase in fuel use in the last decade that is reflected in the CO_2 emissions figures– a trend that needs to be understood and mitigated in order for the Net Zero target to be met.

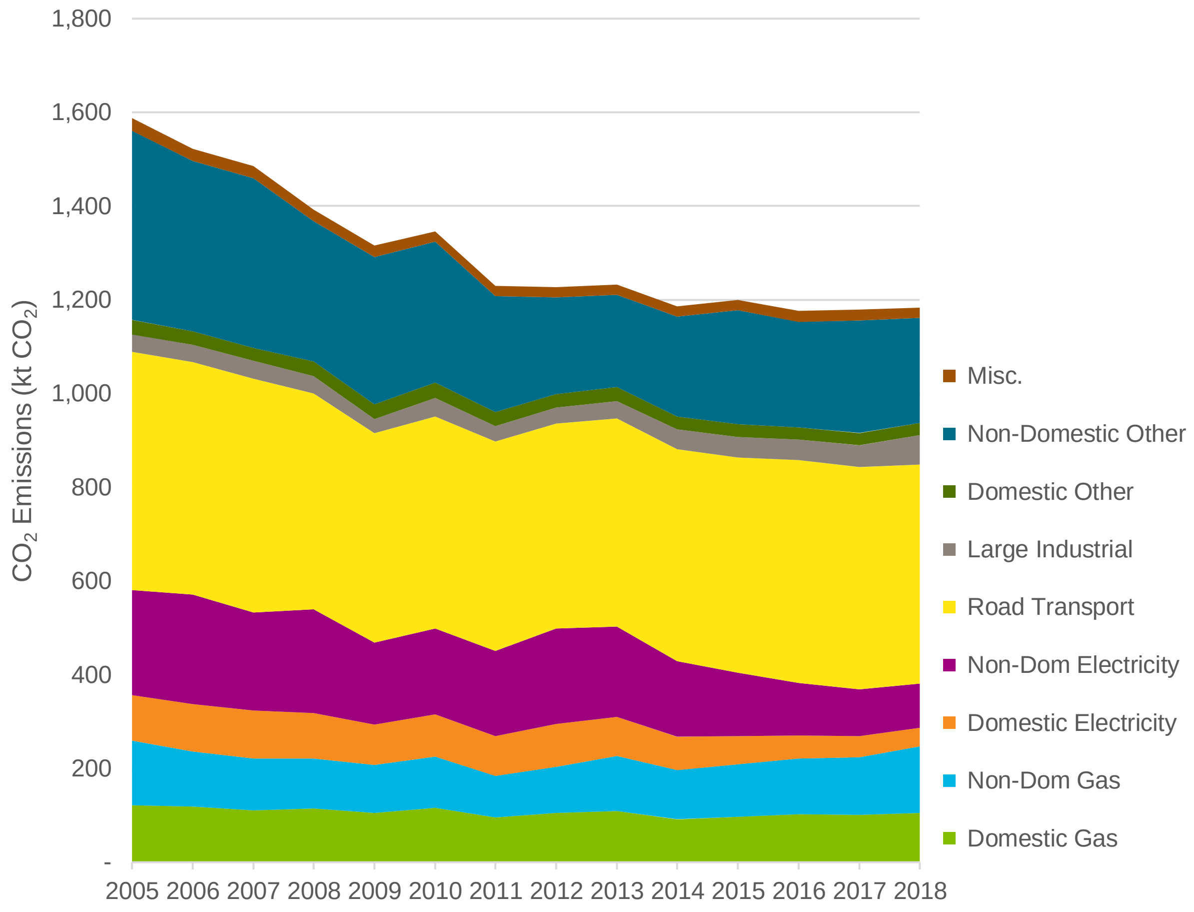


Figure 7. Trends in CO_2 Emissions (2005-2017)

3.3 Electric Vehicles

3.3.1 Data Sources

Estimates for the current number of vehicles (including ULEVs) in North West Leicestershire are taken from *'VEH0105: Licensed vehicles by body type and local authority'* and *'VEH0132: Licensed ultra low emission vehicles by local authority'* (2019) which are published by the Department for Transport (DfT). [32,33] These datasets record the number of vehicle registrations in each Local Authority from 2011 onwards. The DfT also publishes an online map of public electric vehicle charging points in each Local Authority which has been used to estimate the current number in North West Leicestershire. [34]

Note: For the purpose of this report, we have used the DfT definition of 'ultra low emission vehicle' (ULEV) which refers to *'vehicles that emit less than 75g of carbon dioxide (CO_2) from the tailpipe for every kilometre travelled. In practice, the term typically refers to battery electric, plug-in hybrid electric and fuel cell electric vehicles.'*

3.3.2 Current Baseline and Recent Trends

The table below shows the estimated number of ULEVs that are currently registered in North West Leicestershire, along with the number of public EV charge points in the District. Note that, while the Zero Carbon Roadmap specifically considers the Council's own vehicle fleet, these figures are for the District as a whole.

Table 3. Uptake of ULEVs and estimated number of public charging points in North West Leicestershire

Description	Baseline Estimate
Number of licensed ULEVs (as of Q1 2020)	341
ULEVs as % of total vehicles (at end of 2019)	<0.5%
Total public charging devices	16
Total public rapid* charging devices	2
Charging devices per 100,000 population	16

** DfT statistics classify charge points of 43kW and above as 'rapid'.*

As shown in Figure 8, there was a more than fifty-fold increase in the number of ULEVs registered in North West Leicestershire between 2011 and 2020, with 341 as of Q1 2020. Nonetheless, these represent a very small portion (<0.5%) of the more than 74,600 total vehicles licensed in the District. This is slightly below the proportion for the East Midlands (c. 0.6%) and for the United Kingdom as a whole (c. 0.8%)

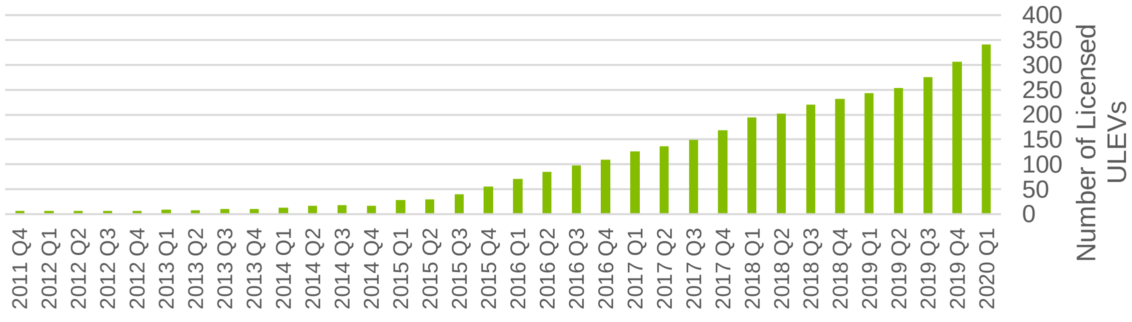


Figure 8. Ultra low emission vehicle (ULEV) registrations in North West Leicestershire, 2011-2020

The national picture shows a big variation in the provision of charge points per head of population. On a regional basis, London (49), Scotland (32) and the North East of England (28) have the highest number of public charge points per 100,000 of population, while Yorkshire & the Humber (12), the West Midlands (14), East of England (15) and the East Midlands (15) having the lowest number per 100,000 of population.[35]

[32] Department for Transport, *'VEH0105: Licensed vehicles by body type and local authority'* (December 2019). Available at: https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#licensed-vehicles
[33] Department for Transport, *'VEH0132: Licensed ultra low emission vehicles by local authority'* (December 2019). Available at: https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#licensed-vehicles
[34] Department for Transport, *'Table 1: Publicly available electric vehicle charging devices by local authority'* (October 2019). Available at: http://maps.dft.gov.uk/ev-charging-map/
[35] Department for Transport, *Electric Vehicle Charging Device Statistics October 2019*, December 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850417/electric-vehicle-charging-device-statistics-october-2019.pdf

3.4 Renewable and Low Carbon Energy

3.4.1 Data Sources

The total number and type of electricity-generating LZC technologies within North West Leicestershire is recorded in *'Regional Renewable Statistics: Renewable energy by local authority'* (henceforth referred to as RRS).[36] This was cross-checked against the Renewable Energy Planning Database[37] (REPD) which provides a quarterly record of all operational or planned LZC energy schemes that have been submitted for planning approval in the UK.

Regarding LZC technologies that generate only heat, there is less publicly available information. In order to provide an estimate of the number and type of these technologies, data was retrieved from the Renewable Heat Incentive (RHI) database.[38] It should be noted that these figures primarily focus on the total *number* of accredited installations; the figures are not disaggregated by technology type and figures for installed capacity are estimates based on nation-wide totals.

Limitations

Note that the amount of publicly available information varies depending on the technology in question, and therefore this information represents a 'best estimate' rather than a definitive list of every renewable energy installation in the District.

Most of the data relating to renewable energy technologies is based on records of installations that have been registered under an accreditation scheme or similar measure. Technologies that are not supported by such schemes or that are not registered for some other reason are therefore likely to be underrepresented in this analysis. This includes renewable heat technologies that are not RHI accredited, and small scale electricity generating technologies (particularly PV) that would previously have been registered under the Feed-in Tariff incentive scheme, which closed to new registrations in 2019.

3.4.2 Existing and Planned Provision

The total installed capacity of LZC electricity technologies as at the end of 2019 was approximately 68.5 MWe, offering the potential to generate nearly 91,000 MWh of electricity per year. According to the REPD (accessed November 2020), planning permission has been granted for a further 20 MW of ground-mounted PV, 4 MW of roof-mounted PV, and one additional large-scale battery storage installation.

Table 4. LZC electricity installations in North West Leicestershire- as at end of 2018

	PV	Onshore Wind	Anaerobic Digestion	Landfill Gas	Total
Number of sites (#)	1,587	11	2	2	1,602
Installed capacity (MW)	59.7	3.3	1.3	4.3	68.5
Electricity generation (MWh/yr)	56,038	6,911	7,027	20,60	90,635

These results show that the largest number of installations are PV panels. It is likely that the majority of PV installations are small-scale domestic roof-mounted systems, but most of the capacity is attributed to large-scale ground-mounted PV farms. The REPD contains a record of one wind farm (4no. 250kW wind turbines with a combined 1MW capacity) which suggests that the rest of the wind energy capacity listed in the RRS is likely to comprise smaller turbines. There are also two anaerobic digestion (AD) plants, two landfill gas plants and one record of a plant biomass installation. Overall, the RRS figures suggest that these generate nearly 95 GWh of renewable electricity per year, the majority of which is associated with PV. This broadly aligns with the findings of

[36] Available at: https://www.gov.uk/government/statistics/regional-renewable-statistics
[37] Available at: https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[38] For non-domestic installations, see *'Table 1.4 - Number of accredited applications and installed capacity by local authority'* and *'Table 1.1 - Number of applications and total capacity by technology type'*. For domestic installations, see *'Table 2.1 - Number of applications and accreditations by technology type'* and *'Table 2.4 - Number of accreditations by local authority'*. Available at: https://www.gov.uk/government/statistics/rhi-monthly-deployment-data-february-2020

the Zero Carbon Roadmap (p. 44) which referred to some of the same Government data sources, although the Roadmap does not provide a detailed estimate or source for each technology.

The chart below shows the estimated capacity of operational LZC electricity generation and storage technologies in North West Leicestershire, plus the capacity of installations that have been granted planning permission, based on our review of the RRS and REPD records.

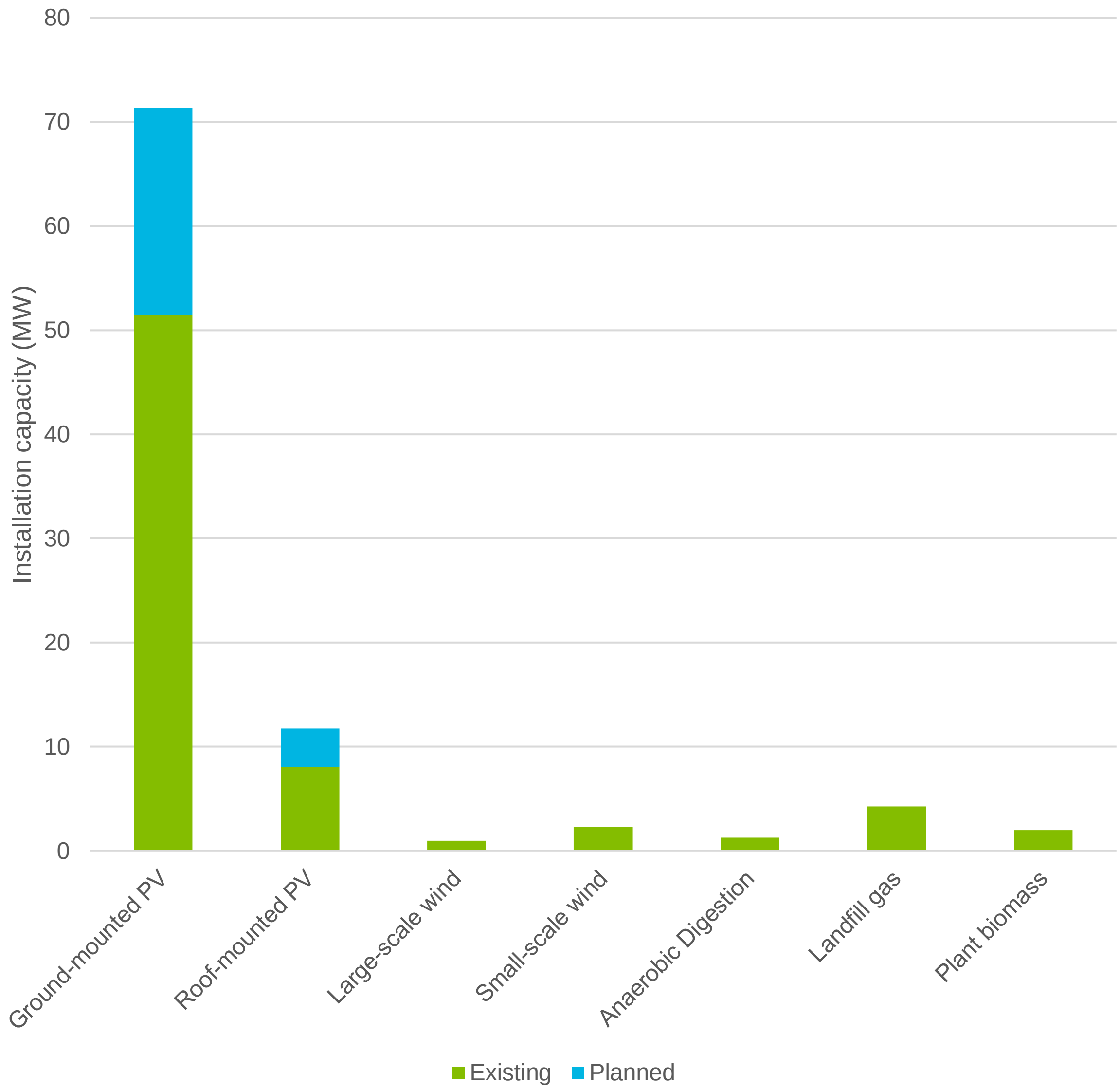


Figure 9. Estimated capacity of operational and planned LZC electricity technologies

** Note: An additional battery installation has been granted planning permission, but the proposed capacity of that system was not reported in the REPD.*

In addition to the renewable *electricity* technologies described above, the Renewable Heat Incentive (RHI) Database indicates that there are 24 accredited non-domestic RHI installations in North West Leicestershire with a capacity of roughly 4 MW, and 454 domestic RHI installations. These may include heat pumps, solar thermal technologies, and technologies utilising biomass or biogas, but further details are not publicly available.[39] The RHI database does not provide a breakdown of installations for each Local Authority by technology type and installed capacity. However, by looking at the RHI data for the UK as a whole, in general terms it is observed that:

- The majority of non-domestic accredited installations are biomass boilers; around a quarter use biomethane, and the remainder comprises a mixture of technologies, most notably combined heat and power (CHP) or ground source heat pumps.

[39] Source: BEIS Renewable Heat Incentive Monthly Deployment Statistics (June 2020), *'Table 2.4 - Number of accreditations by local authority'* and '*Table 2.6 - Average capacity and design SPF values'*.

- The majority of domestic accredited installations are air source heat pumps, with the remainder primarily split between ground source heat pumps, biomass boilers and solar thermal technologies.

As shown on p. 61 of the Zero Carbon Roadmap, the 2011 Census showed that the majority of domestic properties in North West Leicestershire are heated with gas boilers, although there are some that use electricity, oil, solid fuel, and hybrid systems – and a small minority have no central heating. It is possible that some of those that list 'solid fuel' or 'electric' heating systems could be using biomass boilers or electric heat pumps.

Large LZC Installations in North West Leicestershire

The table below shows the list of large-scale LZC installations recorded in the REPD (accessed August 2020).

Table 5. Existing large scale LZC installations in North West Leicestershire. Source: REPD

Type		Site Name	MW	Status
Landfill Gas		Lount/Smoile	1.1	Operational
Solar PV	Ground-mounted	Packington Solar Farm	13.9	Operational
		Walnut Yard (Phase 1)	1.8	Operational
		Walnut Yard (Phase 2)	6.2	Operational
		Prestop Park Farm	16.0	Operational
		Land at Whatton Road	1.5	Operational
		Lount Solar Farm	2.8	Operational
		Ashby Solar Farm	5.0	Operational
		Land at Ingles Hill Farm	3.0	Operational
		Land at Hill Farm	1.2	Operational
		Lockington Solar Park	15.0	Planning Permission Granted
		Pretoria Road	4.9	Planning Permission Granted
		Lower Fields Mushroom Farm	0.3	Planning App. Submitted
	Roof-mounted	East Midlands Distribution Centre	6.1	Operational
		Amazon - BHX2	3.7	Planning Permission Granted
Battery		Hill Farm - Energy Barn	10.0	Operational
		Beveridge Lane Battery Storage ** Capacity not reported in the REPD*	*	Planning Permission Granted
Wind Onshore		East Midlands Airport	1.0	Operational
Anaerobic Digestion & CHP		AB Produce, Measham	1.0	Operational

4 Renewable Energy Assessment

4.1 Scope and Methodology

The Government acknowledges[40] that, *'there are no hard and fast rules about how suitable areas for renewable energy should be identified'* when developing an evidence base for local planning policies. To assess future opportunities to deliver low and zero carbon (LZC) energy technologies in North West Leicestershire, our approach broadly follows the *'Renewable and Low-Carbon Energy Capacity Methodology'* published in 2010 by the former Department of Energy and Climate Change (DECC).[41]

Our assessment has considered the following technologies:

- Wind turbines
- Solar photovoltaics (PV) roof-mounted and ground-mounted;
- Ground, air and water source heat pumps (GSHPs, ASHPs and WSHPs) – *Note that, although these do not generate renewable electricity or fuel, they can reduce CO_2 emissions by lowering primary energy demands and facilitating a switch towards less carbon-intensive fuels.*
- Hydroelectric power
- Energy from waste (EfW)
- Biogas (landfill and sewage gas)
- Biomass
- Heat networks – *As with heat pumps, this technology does not necessarily provide renewable electricity or heat but can offer greater efficiencies and facilitate a shift towards LZC heat sources where available.*

Technologies that are not relevant to the geographic context of North West Leicestershire, such as tidal power, have been excluded from this analysis. Emerging technologies such as hydrogen fuel cells are also excluded due to uncertainty associated with their performance and limited information about practical constraints; however, both hydrogen and battery technologies are discussed from a qualitative perspective in Section 4.2.9.

The DECC (2010) methodology involves estimating the total naturally available energy resource in a given geographic area, which is narrowed down sequentially based on technical constraints, physical constraints, and planning or regulatory constraints, as illustrated in Figure 10. An indicative quantitative estimate of capacity is provided for each technology where possible, along with a discussion of key practical considerations and other issues relevant to planning.

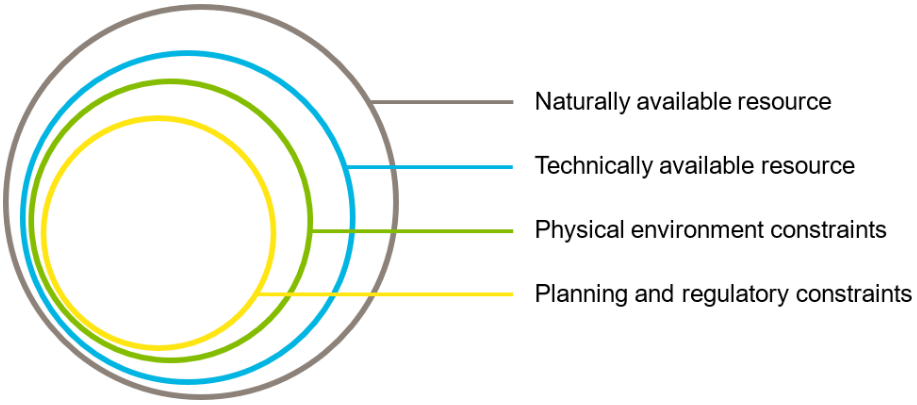


Figure 10. Sequential approach to assessing LZC opportunities, based on DECC (2010)

This methodology has informed multiple studies undertaken in the past decade that have examined LZC energy opportunities in North West Leicestershire, which include the following:

[40] Department for Communities and Local Government, *'Planning practice guidance for renewable and low carbon energy'* (2015). Available at: https://www.gov.uk/government/collections/planning-practice-guidance
[41] DECC, *'Renewable and low carbon energy capacity methodology'* (2010). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

- The *'Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report'*[42] which was produced in 2011 by the Centre for Sustainable Energy (CSE) and SQW, the same company that developed the DECC methodology.
- The CSE (2011) report was used to develop some of the renewable energy targets set out in the Etude Zero Carbon Roadmap (see Section 2.3.3).
- The guidance was used by ASC Renewables to develop wind constraints maps as part of the 2016 Wind Energy Study (see Section 2.3.4).

We also note that an earlier area-wide renewable energy study was conducted in 2008 by IT Power, titled *'Renewable Energy Opportunities for Blaby, Harborough, Hinckley and Bosworth, Melton, North West Leicestershire, Oadby and Wigston and Rutland'*.[43] This study took a similar approach although was produced prior to the Government methodology being published and therefore uses slightly different technology assumptions.

In order to provide a comprehensive assessment of future LZC opportunities in North West Leicestershire, AECOM carried out a technical review of these previous studies. Results have been incorporated, updated or supplemented with new information where appropriate.

It is important to understand that not all opportunities will be captured using an area-wide assessment technique. In locations where constraints are identified, it may be possible to remove or mitigate these through careful design and planning. Conversely, there may be practical barriers or other reasons why LZC development would be difficult even in areas that are identified as being 'less constrained'.

Electrical capacity vs. generation

Capacity: The maximum electrical output a technology can produce when it is in operation under specific conditions; usually measured in kilowatts (kW)

Generation: The electrical power that is actually produced by a technology in a set period, usually measured in kilowatt-hours (kWh)

For example, there are 8760 hours per year. If a roof-mounted PV installation could generate electricity under optimal conditions all year, it would generate 8760 hours x 4 kW = 35,040 kWh in a year, enough to power several homes. However, because the sun does not shine at night, and due to other factors, such as weather, a PV array of that size might only generate 3,500-4,000 kWh in a year in the UK, which is roughly the amount needed for a single home.

The output of a given LZC energy installation (that is, the amount of electricity produced per unit of capacity, or kWh per kW) varies considerably depending on the type of technology – for instance, the output of wind turbines is 2-3 times higher than PV. It is also specific to each individual installation, and will vary over time.

[42] CSE, SQW and Land Use Consultants on behalf of the East Midlands Councils, *'Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report'* (2011). Available at: https://www.emcouncils.gov.uk/write/Emids-low-carbon-energy-opportunities-Final-Report-07-2011-update.pdf
[43] IT Power, *'Renewable Energy Opportunities for Blaby, Harborough, Hinckley and Bosworth, Melton, North West Leicestershire, Oadby and Wigston and Rutland'* (2008). Available at: http://www.melton.gov.uk/downloads/download/840/planning_for_climate_change_renewable_energy_opportunities_for_blaby_harborough_hinckley_and_bosworth_melton_northwest_leicetershire_oadby_and_wigston_and_rutland_2008

4.2 Estimate of Future Provision

Table 6 summarises the theoretical future LZC opportunities in North West Leicestershire. It also briefly indicates whether, based on available evidence, the targets set out in the Zero Carbon Roadmap are considered achievable. Results are reported in units of megawatts (MW) of electrical power capacity and megawatt hours (MWh) of energy generation.

Note that these estimates are based on the current technical performance of each technology and do not account for anticipated technological changes (e.g. efficiency improvements). These estimates also do not consider the available capacity of the electrical power network which could be a major barrier to deployment.

Table 6. Potential future LZC opportunities in North West Leicestershire

Technology	Theoretical future added capacity (MW)	Theoretical future added generation (MWh p.a.)	Comments	Zero Carbon Roadmap Target	Is the target considered achievable?
Commercial -scale wind *(Based on turbine heights of 65m, 90m and 135m)*	170+ (see notes)	300+ GWh (see notes)	Capacity figures from CSE (2011). Generation figures revised based on actual output of turbines in NWL. Note that the theoretical upper limit is much higher. See Section 4.2.1.	Expand wind energy capacity to 75 MW by 2050	Yes
Small-scale wind *(Based on turbine height of 15m)*	Up to 40	Up to 56 GWh	Based on CSE (2011). See Section 4.2.1.	n/a	n/a
Building-mounted PV	98.6	91,675	Assessment based on DECC methodology and satellite images measurements. Note that the Zero Carbon Roadmap target could potentially be met using roof-mounted PV alone. See Section 4.2.2 and Appendix A for details.	Expand PV capacity to 140 MW by 2050	Yes
Domestic (existing)	22.6	20,982			
Commercial (existing)	6.6	6,089			
Industrial sites (existing)	51.1	48,468			
New dwellings	14.1	13,101			
New non-domestic buildings	3.3	3,035			
Large-scale PV	Not quantified	n/a	Upper limit not determined but potentially enough to exceed 100% of annual (2017) electricity demands. See Section 4.2.2.		
ASHPs	Not quantified	n/a	Potential to retrofit into most existing buildings (per DECC methodology) and install in all new buildings. See Section 4.2.3 and Appendix A.	n/a	n/a
GSHPs				n/a	n/a
WSHPs	Not quantified	n/a	Not quantified but some potential along River Trent, based on the DECC *'National Heat Map'* (2015). See Section 4.2.3.	n/a	n/a

Technology	Theoretical future added capacity (MW)	Theoretical future added generation (MWh p.a.)	Comments	Zero Carbon Roadmap Target	Is the target considered achievable?
Hydroelectric power	Up to 3.2 MW based on five potential sites	Up to 11.66 GWh	Various estimates presented in CSE (2011), the Zero Carbon Roadmap (2019) and IT Power (2008). See Section 4.2.4.	Up to 3.2 MW based on five potential sites	Subject to detailed feasibility studies
Energy from Waste (EfW)	0	0	Not recommended for widespread adoption. See Section 4.2.6.	n/a	n/a
Sewage gas	0	0	No sewage treatment plants in the District. See Section 4.2.7.		
Landfill gas	0	0	Although there is are currently two landfill gas plants in operation, this resource naturally diminishes over time. See Section 4.2.7.	Expand use of biogas to 21 GWh by 2050	Not recommended based on present technologies,
Biomass *(including managed woodland, waste wood, energy crops, straw, poultry litter and animal waste)*	255.8 (electricity) 226.3 (heat)	434,330 (electricity) 489,250 (heat)	Results from CSE (2011) are shown for information only. Biomass is no longer expected to form a significant part of North West Leicestershire's future additional LZC energy mix. See Section 4.2.5.		

Overall, our analysis suggests that the targets in the Zero Carbon Roadmap for wind and solar energy are likely to be achievable. There may be opportunities to deliver hydropower in a small number of locations, but although these could potentially generate a large amount of electricity, this cannot be determined without site-specific feasibility studies. The use of biomass (either for combustion or conversion to biogas) is not recommended for widespread adoption at this time due to uncertainty related to the sustainability of the supply chain overall. It is considered likely that the main opportunities going forward will be solar PV, wind energy and heat pumps.

Figure 11 (right) shows the estimated current, planned and potential additional renewable energy generation in the District. Note that the 'potential' PV does not include ground-mounted PV farms as an upper limit cannot be quantified, but it is likely that this could deliver a very large portion of the total electricity demand for the District.

The remainder of this section provides further details about the key constraints and opportunities for each technology, and other considerations relevant to Local Plan development.

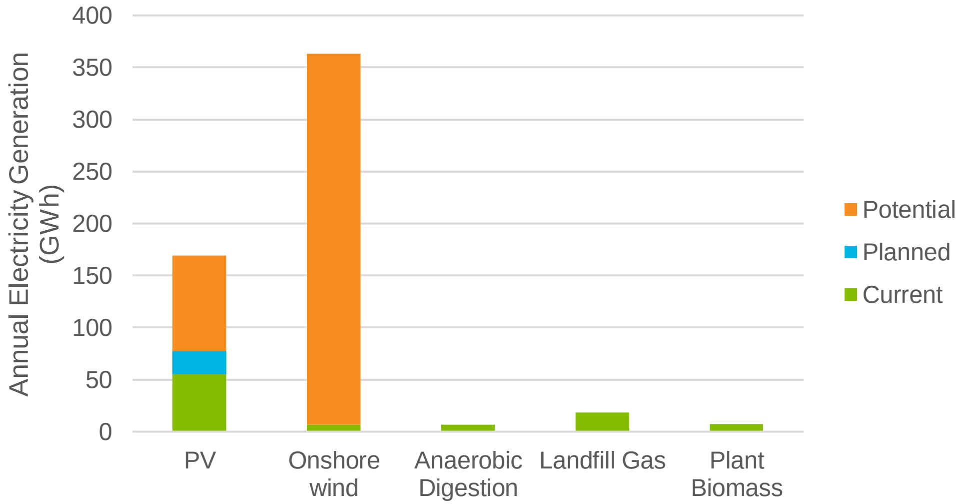


Figure 11. Current, planned and potential additional LZC electricity generation. ***Note: Ground-mounted PV is not included because there is no standard method for quantifying the technically accessible upper limit on a District-wide basis.***

4.2.1 Wind

Wind turbines convert kinetic energy from the wind into mechanical power or electricity.

Commercial-Scale Wind Energy

The technical potential for commercial-scale[44] onshore wind energy depends primarily on wind speed at the turbine's hub height and land use constraints. The DECC (2010) method for assessing wind energy opportunities at a regional scale is to assess the average annual wind speed at 45m above ground level; as a rule of thumb, locations with average annual wind speeds of at least 5-6 m/s are more likely to be financially viable. The NOABL (Numerical Objective Analysis of Boundary Layer) database, which provides modelled estimates of wind speed across the UK, indicates that all areas in North West Leicestershire meet this threshold.[45] However, the model does not account for local surface roughness (e.g. the presence of tall trees or obstacles) and in practice site-specific assessments would need to be carried out to determine suitability.

DECC (2010) lists the following additional factors to consider when evaluating a potential site:

- Proximity to residential properties;
- Flood zones;
- Exclusion areas around airports, airfields and MOD sites (to be determined in consultation with the relevant bodies depending on the nature of the project);
- Proximity to infrastructure e.g. roads, railways, powerlines, and gas pipelines;
- Practical considerations e.g. grid connections, access and site spacing;
- Areas that have been designated for their ecological or historic interest, such as:
  - Ancient woodland;
  - International and national nature conservation designations (including National Nature Reserve, RAMSAR site, Special Area of Consideration, Special Protection Area, and Site of Special Scientific Interest); and
  - Sites of historic interest (including Listed Buildings, Scheduled Ancient Monuments, Registered Parks and Gardens and Registered Historic Battlefields).

In addition to technical and practical constraints, it is also important to consider the current policy context. The Written Ministerial Statement on Wind (HCWS42, 2015) states that, when determining planning applications for wind energy development, planning authorities should only grant permission if:

- the development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood plan; and
- following consultation, it can be demonstrated that the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing.[46]

The statement goes on to explain:

> *'In applying these new considerations, suitable areas for wind energy development will need to have been allocated clearly in a Local or Neighbourhood Plan. Maps showing the wind resource as favourable to wind turbines, or similar, will not be sufficient.'*

Although it is anticipated[47] that the Government will relax its position in future, for the time being the requirements of the Written Ministerial Statement (WMS) significantly limit opportunities for onshore wind energy development. However, NWLDC has identified potential areas that are suitable for wind energy in the Wind Energy Opportunities Map[48] which is not simply restricted to considering the potential wind resource across the district.

---

[44] This can refer to various types of wind turbine / wind farm but for the purpose of this assessment is based on wind turbines of 65m+ in height and 0.5MW+ capacity.
[45] The NOABL map can be viewed online at: https://www.rensmart.com/Maps#NOABL
[46] https://www.parliament.uk/documents/commons-vote-office/June%202015/18%20June/1-DCLG-Planning.pdf
[47] In March 2020, BEIS announced that onshore wind farms would be eligible to join the Contracts for Difference (CfD) scheme, reversing an earlier prohibition on subsidies for onshore wind, but as of June 2020, no changes have been announced that would lift the planning policy restrictions set by HCWS42. See BEIS, *'Contracts for Difference for Low Carbon Electricity Generation'* (2020). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/885248/cfd-ar4-proposed-amendments-consultation.pdf
[48] ALC Renewables on behalf of NWLDC, *'Medium and Large Scale Wind Mapping'* (2015). Available at: https://www.nwleics.gov.uk/files/documents/medium_to_large_scale_turbines/North%20West%20Leicestershire%20District%20-%20Medium%20and%20Large%20Scale%20Overview%20%28no....pdf

Therefore, it is considered that the first requirement of the WMS has been satisfied; we have assumed that the WMS does not in itself restrict the amount of wind energy development that could, theoretically, be delivered.

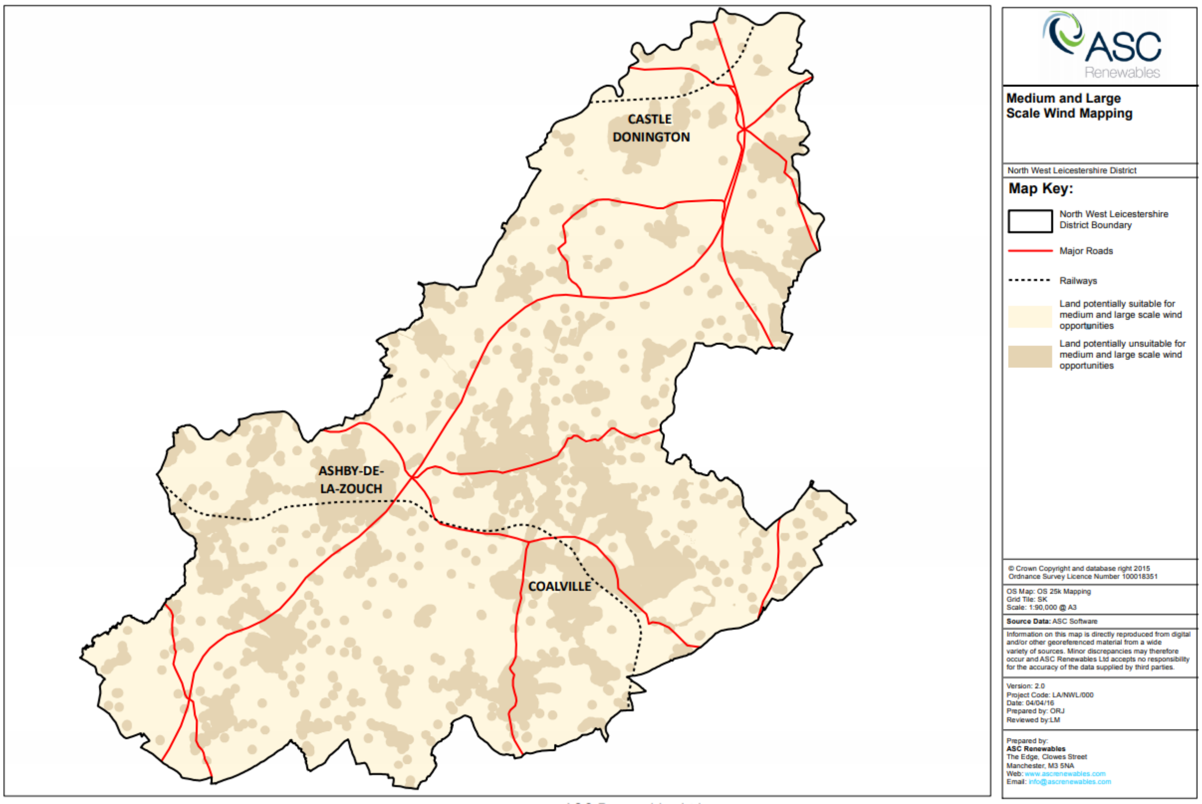


Figure 12. Large and Medium Scale Wind Energy Constraints Map. Source: ALC Renewables (2015)

From a technical perspective, there is considerable potential for wind energy across the District. The Zero Carbon Roadmap sets a target of expanding from the current 3.3 MW capacity to 75 MW by 2050. The constraints-based assessment carried out by CSE in 2011 assessed opportunities for commercial turbines of three different sizes, which in combination were found to offer up to 140 MW of capacity.[49]

In fact, this may be a conservative estimate. The 140MW figure is based on applying a 400-600m buffer around all residential properties, depending on the size of turbine, which is used as a proxy for addressing both safety concerns as well as amenity concerns (e.g. noise, shadow flicker, visual impact). Those factors are highly site-specific and can potentially be mitigated depending on site conditions, so in principle it may be possible to locate wind turbines closer to residential buildings in some cases.

The 2016 map (above) only applied a safety buffer around residential properties. It indicates there is up to 191 km^2 of land area in the District that is 'potentially suitable' for medium and large-scale wind, which likely represents a maximum theoretical limit. Using the rules of thumb set out in DECC (2010), which take account of the need for spacing between turbines, if all of this land was used to deliver wind farms, this would offer over 1,700 MW of wind energy capacity – ten times more than the CSE estimate and far more than would be needed to meet the annual electricity demands of the District. **This does not mean that it would be desirable, practical, or financially viable to deliver this amount of wind energy– only that there is, in principle, enough physical and spatial resource in the District to do so.** The actual figure could fall somewhere between these two estimates, although probably would be closer to the CSE estimate when considering the need for wind energy developments to gain community support.

For the purpose of spatial planning, in our view it is appropriate to use the 2016 Wind Energy Study maps because this offers greater flexibility in terms of where wind energy could be sited, which will be useful to facilitate the scale of LZC uptake that will be needed in order for the UK to reach Net Zero by 2050. In practice a site-specific feasibility study would be required for any potential development sites, so the adoption of these maps does not necessarily indicate that wind turbines would definitely be located at any given point. Assessment

[49] The 2016 study used a minimum distance for safety (i.e. separation distance from roads, railways and other infrastructure), while the CSE study used a larger buffer as a proxy for addressing safety along with other potential concerns related to amenity, noise, shadow flicker, and so on.

criteria are set out in the adopted Local Plan Policy Cc1 and it is recommended that this approach be retained in the new Local Plan.

For context, to gain a sense of the potential scale of renewable energy uptake that might be required in the District, consider that the 2017 electricity consumption for North West Leicestershire was 568.5 GWh. This could be delivered using approximately 274 MW of wind capacity, or around 100-120 large turbines. Wind farms of this size would occupy around 30km^2 of land area overall, which is around 16% of the total 'potentially suitable' area in Figure 12. This could be co-located with other land uses such as agriculture. This suggests that, at least in theory, there is enough wind resource in the District to make a significant contribution to the overall energy mix.

Needless to say, there are practical barriers to delivering this scale of additional LZC energy capacity. These include, but are by no means limited to:

- Competition with other land uses and priorities e.g. housing and employment development, food production, biodiversity, amenity, etc.;
- Cumulative impacts of large-scale LZC development on issues such as landscape character;
- Ensuring that there is a robust consultation process to obtain support from the local community, organisations, businesses and other stakeholders;
- Practical considerations e.g. gaining access to the site and the ability to connect to power infrastructure;
- Lack of financial or other incentives to promote uptake; and
- In general, a low level of Local Authority ability to influence the types of projects that are brought forward.

It is understood that some concerns have been raised about the potential impacts that wind energy development might have on heritage assets such as Listed buildings. Again, it is important to understand that the maps only represent areas that could be viable for wind energy technically speaking, but further work would need to be undertaken as part of the planning process to show that any potential negative impacts have been satisfactorily mitigated.

Small-Scale Wind Energy

Small-scale wind turbines can be installed on or near buildings, although they tend not to perform very well in urban areas where there is more disruption to wind flow. Therefore, it is usually assumed that these will be more suitable for rural locations where there are fewer obstacles and wind speeds are higher. They may also be suitable for industrial sites and business parks where there is less concern about visual impact.

The DECC (2010) methodology assumes that small-scale (6kWp) turbines could be installed at all address points located in rural areas (as defined by DEFRA) where the average annual wind speed at 10m above ground level is at least 4.5 m/s. On this basis, CSE (2011) found that North West Leicestershire could accommodate up to 40 MW of small-scale wind, which could provide around 55,870 MWh per year of electricity. The constraints map for small scale wind energy produced as part of the 2016 Wind Energy Study is replicated in Figure 13.

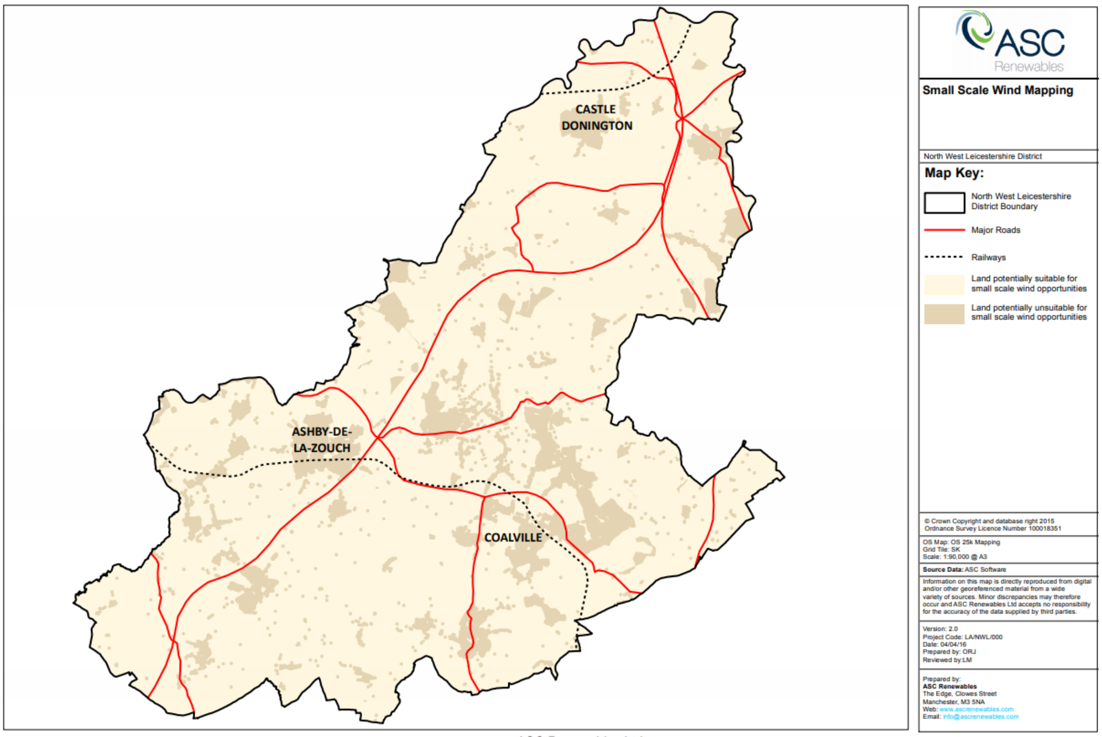


Figure 13. Small Scale Wind Energy Constraints Map. Source: ALC Renewables (2015)

It is worth noting that, due to their lower output, small-scale turbines are significantly more expensive than large-scale turbines in terms of cost per unit of electricity generated. Furthermore, it would take dozens of smaller turbines to match the output of a single large-scale turbine, which would result in cumulative impacts. For these reasons, if wind energy is planned within North West Leicestershire, it may be preferable to install fewer, larger turbines. This is illustrated in Figure 14 below, which is taken from the CSE (2011) report.

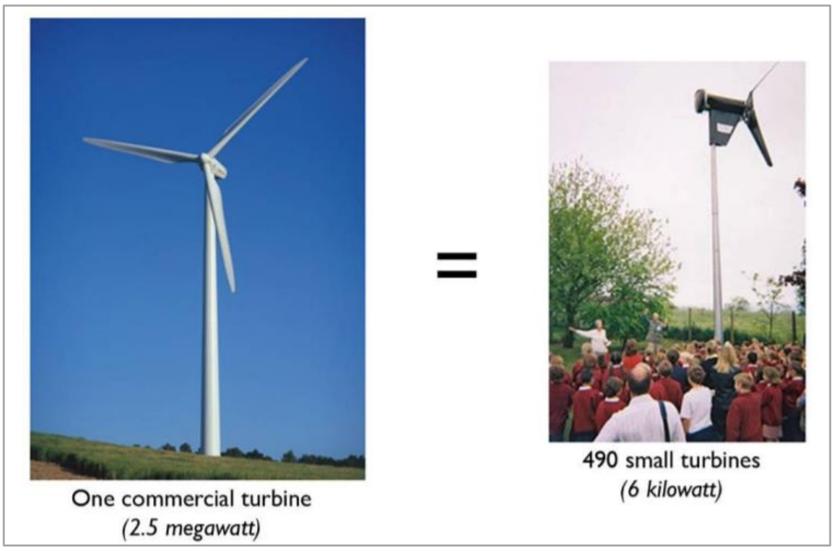


Figure 14. Image showing relative outputs from large- versus small-scale wind turbines. Source: CSE

4.2.2 Solar technologies

Roof-Mounted PV and Solar Water Heating

Solar technologies convert energy from the sun into either electricity or thermal energy (e.g. hot water). Both building mounted solar photovoltaics (PV) and solar water heating (SWH) depend largely on two site-specific factors: available roof space, and the solar exposure of the roof area (which relates to orientation, pitch, overshading, etc). SWH systems are typically sized to meet a certain proportion of annual hot water demand, since the heat is used on site.[50] PV can be sized more flexibly, subject to the amount of available roof space, since electricity can be stored using batteries or, where agreed, exported to the grid.

From a planning perspective, the main considerations for roof-mounted solar technologies are due to the visual impacts and potential 'modernising effect' they may have. Therefore, their use is often restricted in sensitive locations such as Conservation Areas and Areas of Outstanding Natural Beauty (AONBs). However, these are policy constraints rather than technical barriers, and the impact can be minimised depending on factors such as whether they can be seen from the street and the size of the installation relative to the roof area.

Although roof-mounted PV is not the cheapest way to generate renewable electricity, it should be understood as a key opportunity for North West Leicestershire, both because it arguably has a smaller visual impact on the wider landscape than large-scale PV or wind turbines, and because the total amount of roof space, considered cumulatively, is relatively large. Our estimates (see Appendix A for calculation details) suggest that, based on the current number of existing buildings and Local Plan development projections, it may be possible to install approximately:

- 81 MW of roof-mounted PV on existing buildings
- 14 MW on new dwellings; and
- 3.2 MW on new employment sites.

This would not require every square meter of roof space to be covered but is based on rules of thumb for the amount of typical roof area that is available for different building types. Note that it does not account for the structural condition of those roofs, which in practice might require reinforcement or upgrading.

The following types of sites may provide better opportunities to deliver roof-mounted solar technologies:

- In general, greenfield and large new development sites may offer greater potential for solar energy generation; the relative lack of design constraints provides more opportunities to maximise sustainable design measures from the outset.
- Similarly, industrial sites may be more suited to solar technologies as they tend to have large roof areas and there is generally less concern about the visual impacts of solar panels.
- Schools, hospitals, leisure centres and other public sector buildings are often relatively large and can be suitable for community energy projects; these may be easier for the Council to influence compared with private commercial and industrial buildings.
- Another key opportunity would be to install PV canopies on structures such as car parks. If co-located with battery storage and EV charge points, this would provide a local source of renewable electricity while also helping to decarbonise transport.

It should be noted that the Strategic Infrastructure Study[51] conducted by Arup, which assessed potential strategic development sites, indicated that for all sites under consideration, impacts on the electricity grid were *'considered likely to be mitigatable, but will require significant new [infrastructure] provision.'* The report states that:

> *'Demand for electricity arising from new development could be affected by a number of wider regulatory and demand changes in the future, helping to address climate change. The provision of solar photovoltaic panels within new development would decrease grid electricity demand, whereas increased electric vehicle usage and a switch away from gas boilers for heating would result in increased demand.*
>
> *Because the potential implications of each are based on a number of externalities, we have not included these within the calculations set out above. However, the potential implications of each on electricity*

[50] For context, in domestic properties a typical SHW system size would be 4-5 m^2 according to the Energy Saving Trust; the system would not be compatible with combi boilers if there is no hot water tank. See https://energysavingtrust.org.uk/renewable-energy/heat/solar-water-heating
[51] Arup, *'Potential Strategic Sites Infrastructure Study'* (2020). Available at: https://www.nwleics.gov.uk/files/documents/potential_strategic_sites_infrastructure_study/Potential%20Strategic%20Sites%20Infrastructure%20Study.pdf

> *demand […] could be considered further as regulatory requirements and/or any new policy intentions in the Local Plan begin to emerge.'*

It is recommended that, going forward, assessment of infrastructure constraints for new developments should take into account the need for a step change in uptake of building-integrated and standalone renewable energy technologies, as well as the electrification of both heat and transport.

Note: Installing roof-mounted PV on industrial sites

Large non-domestic buildings, such as those that contain industrial facilities, can provide significant opportunities for installing roof-mounted solar energy technologies. For example, compared with domestic buildings or those in urban centres, they tend to be larger, with simpler geometries and potentially less risk of being overshaded by adjacent structures. This is why the quantitative estimate provided in Table 6 suggests that, based on roof areas, orientation, and typical installation sizes, industrial buildings could theoretically accommodate more PV than all domestic buildings combined, despite there being far more domestic buildings. (The estimate is based on DECC 2010 methodology; see Appendix A for details.) However, in addition to the general practical considerations described previously, there are some considerations that are specific to industrial buildings that should also be taken into account. Notably, these include:

- **Structural constraints** – Industrial buildings such as warehouses are often designed to have a wide roof span, with few columns. Although the resulting geometry of the roof may provide a large area that could be fitted with PV, without the need for installing a ground-mounted array, the structure might not be able to accommodate the additional load of the technology. This is an issue in existing buildings, which might require reinforcement, but it is also potentially an issue for the structural design of new buildings. Additional steel columns and reinforcement may have a major impact on the build costs for industrial sheds.
- **Condition** – As with any existing buildings, industrial buildings may be old and therefore, regardless of the original structural design, might not in good enough condition to accommodate roof-mounted solar technologies without additional reinforcement. (Some may also have asbestos roofing materials that could pose a health hazard if disturbed.)
- **Balance of electricity supply and demand** – Depending on the use of the industrial building, electricity demand might be low compared with the amount of electricity that could be produced by covering available roof space in PV. For example, warehouses use relatively little energy per unit of floorspace, while data centres and certain types of manufacturing facilities may use a large amount. The financial returns on selling power to the grid are relatively poor, so it is generally preferable for renewable electricity to be used onsite if possible, thereby displacing the need to import electricity from the grid. This means that even if there is a large roof area that *could* accommodate PV, there may be less of a financial incentive to utilise all of the available space. Technical options for managing this could include, for instance, using batteries to store excess electricity, using the electricity to charge vehicles, or selling the excess power to third parties via a Power Purchase Agreement.

The solutions needed to address these issues, such as upgrading the roof, adding reinforcements or providing additional battery storage, can result in higher project costs which may affect viability. On the other hand, costs of PV and battery storage have decreased significantly in recent years (and are expected to continue to do so), so these barriers may present less of a challenge going forward, and deploying onsite LZC technologies can help to decarbonise the industrial sector, which is a key challenge for reaching net zero emissions.

Figure 15 below shows key planning constraints for roof-mounted solar technologies. Appendix A contains further details of the DECC (2010) methodology for estimating roof-mounted solar potential.

Figure 15. Roof-mounted PV Constraints

(Note that this map shows the *curtilage* of Listed buildings, so at this scale only the largest sites will be visible. Therefore, there are more Listed buildings than are shown on this map.)

Large-Scale / Ground-mounted PV

In principle, PV can be delivered anywhere where there is a suitable surface with adequate solar access (i.e. minimal overshading and favourable orientation and pitch).

DECC (2010) does not set out criteria for large-scale ground-mounted PV farms. However, to provide a rough indication of the potential scale of PV opportunities relative to the total land area of North West Leicestershire, we have considered the amount of PV capacity that would be needed to deliver 100% of the annual electricity demands for the District based on recent consumption levels. As stated previously, the 2017 electricity consumption was 568.5 GWh, which could be delivered using roughly 611 MW of PV (c. 20-50 large PV farms). This would occupy around 8km^2 of land area, around 2.7% of the District total.[52] In practice, there are considerable practical and financial barriers to overcome for this to be delivered. Nonetheless, it demonstrates that there is considerable solar resource within the District. It also suggests that the target set out in the Zero Carbon Roadmap, which aimed for 140MW of PV capacity by 2050, is theoretically achievable.

Given that PV farms are among the most cost-effective ways of generating renewable electricity, and can be installed more flexibly than many other LZC technologies, this should be considered a key opportunity that can provide renewable energy for North West Leicestershire at a strategic scale.[53]

As with building-mounted PV, from a planning perspective, visual impact is generally the key issue. Solar farms also have significant spatial requirements, which raises the issue of competing land uses.[54] Therefore, the Government has recommended that priority should be given to installations on brownfield sites and lower grade agricultural land – or, alternatively, that PV should be incorporated into the existing built environment (e.g. on the roofs of commercial and industrial buildings as discussed previously).[55]

Within North West Leicestershire, the National Forest designation means that in some areas it may be preferable to use lower grade agricultural land for woodland creation rather than renewable energy development. Another option would be to utilise land that would be unsuitable or challenging to use for either agriculture or new development, such as historic landfill sites or disused quarries.

On the following page, Figure 16 highlights some key opportunity areas that could accommodate larger amounts of roof- and ground-mounted PV, which include (but are not limited to) areas of low grade agricultural land, industrial sites, historic landfills, and potential new development sites. Figure 16 distinguishes between 'more constrained' and 'less constrained' areas that could potentially be suitable for large-scale PV farms; the 'more constrained' areas are located within the National Forest where it is assumed that tree planting might be prioritised above PV farms, but this does not represent an absolute constraint to development.

[52] Based on the PV farm spatial requirements listed previously, and typical output figures for NWL taken from BEIS RRS. Note that, since there are more constraints applied to large-scale wind than to large-scale PV, it is expected that more land in the District could be used for the latter.
[53] International Renewable Energy Agency, *'Renewable Power Generation Costs in 2018'* (2018). Available at: https://www.irena.org/publications/2019/May/Renewable-power-generation-costs-in-2018
[54] Empirical data suggests that c.0.8-1.0 MW of PV capacity can be accommodated per hectare of solar farm.
[55] In the Written Ministerial Statement HCWS488, published in 2015, the Government emphasises the need to protect the natural environment while avoiding competition for use of the 'best and most versatile agricultural land'. For further details, see https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2015-03-25/HCWS488/

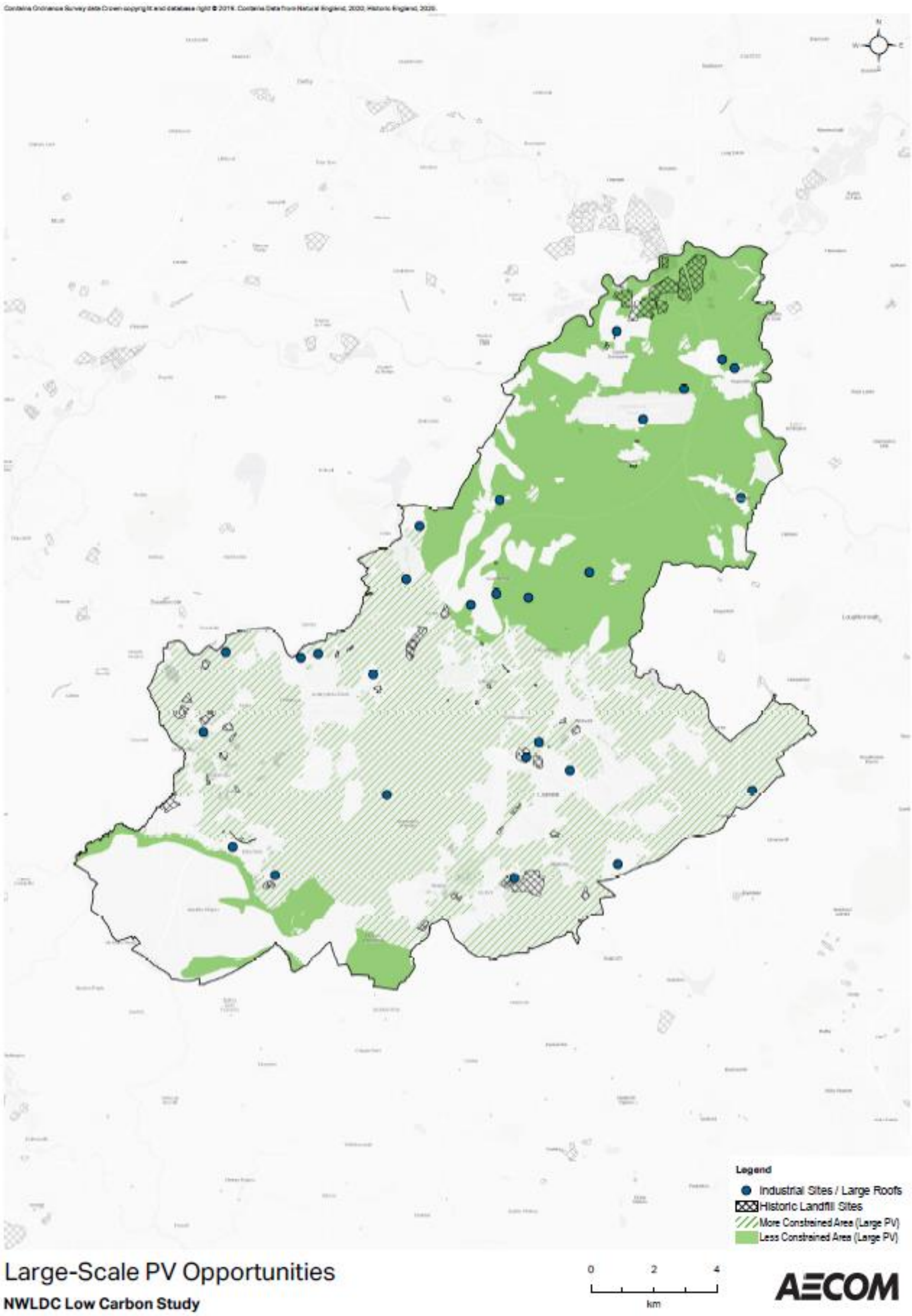


Figure 16. Examples of PV Opportunity Areas

4.2.3 Heat Pumps

A heat pump is a device that extracts heat from the natural environment (e.g. the air, ground or water), compresses it, and then uses it to provide space heating or hot water. Heat pumps do not generate heat or electricity, but instead *use* electricity to transfer heat from one place to another using refrigerant liquids. DECC (2010) assumes that all buildings could, in principle, accommodate either a ground or air source heat pump (GSHP or ASHP).

In practice, these tend to be more expensive to install than either gas boilers or direct electric heating (DEH), both due to the cost of the equipment itself and the need to upgrade the building fabric and services to ensure compatibility. At present, they are not commonly used, but they are expected to become significantly more common in the coming decades if there is a move to greater use of electricity for heating to replace gas boilers. This shift will be influenced by regulatory factors (i.e. changes to UK Building Regulations) and wider market trends including the capacity for the electrical infrastructure to accommodate the scale of transition required.

In broad terms, while all heat pumps are designed to be more efficient than either gas boilers or DEH systems, ground and water source heat pumps generally have a higher coefficient of performance (COP) than ASHPs. However, these are more expensive to install, and rely on detailed feasibility work being carried out to ensure that the site is suitable. Therefore, in practice, ASHPs are likely to be more common, both in new buildings and retrofitted into existing ones. For context, national domestic Renewable Heat Incentive (RHI) data indicates that there are more than four times as many accredited ASHP installations as there are GSHP installations.[56]

Air Source Heat Pumps

Air Source Heat Pumps (ASHPs) work by extracting heat from the outside air and transferring it to the heating and hot water circuits of the building. This requires a unit with a fan to be located outside the building (see right). As a result, in some instances ASHPs could be considered to have a negative visual impact, which would be particularly relevant in Conservation Areas or in proximity to Listed buildings.

The design and siting of ASHPs should also consider the potential noise or vibrations from fans, although this depends to some extent on the precise model of heat pump that is installed.

Further design challenges include sourcing the electrical capacity to introduce these technologies at scale. Provided that these issues are adequately addressed, ASHPs can in principle be integrated into many types of new development or retrofitted into existing buildings.

For a map of ASHP constraints relating to visual impacts, refer to the PV constraints map (Figure 15) in Section 4.2.2.

Figure 17. Example of a typical ASHP. Source: Wikimedia Commons

Ground Source Heat Pumps

Ground Source Heat Pumps (GSHPs) work by extracting heat from the earth underneath or around a building. There are two main types: closed loop and open loop systems. In a closed loop system, liquid circulates through a closed network of pipes that are placed into the ground either horizontally (in shallow trenches) or vertically (in boreholes). The mixture in the pipes absorbs heat from the ground and then is pumped across a heat exchanger, transferring heat to the heating and hot water circuits of the building. In an open loop system, groundwater is pumped up from aquifers, heat is transferred to the building via the heat pump, and the water is then re-injected to the ground at a lower temperature.

To heat a typical house, horizontal GSHPs require a relatively large land area (equivalent to a large garden of approximately 400-800m^2 depending on the heating demand). Boreholes are more compact but can be expensive to drill.

[56] https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/contacts-guidance-and-resources/public-reports-and-data-domestic-rhi

In order to determine whether it is possible to install a GSHP on a specific site, detailed analysis must be undertaken, which is beyond the scope of this report. Our assessment has therefore sought to map some of the major constraints on a District-wide basis, where GIS data was available.

Different constraints apply depending on the specific technology in question, i.e. whether the GSHP is horizontal or vertical, open or closed loop. In all cases, however, the most important considerations relate to excavations, drilling and ground conditions rather than visual impact.

According to the Environment Agency's *'Environmental good practice guide for ground source heating and cooling'* (2011), an environmental impact assessment should be carried out to assess whether the site is:

- Within a defined groundwater Source Protection Zone 1 (as per DEFRA's online mapping resource)[57]
- Within 50m from a well, spring or borehole used for potable water supply
- On land affected by contamination e.g. historic landfill sites[58]
- Close to a designated wetland site
- Within 10m of a watercourse
- Close to other GSHP schemes (depending on uptake, proximity to other open-loop GSHPs could become a constraint due to the potential for thermal interference)
- Adjacent to a septic tank or cesspit

These factors would indicate that the location is potentially sensitive to a GSHP installation. Additional factors that need to be taken into account include:

- Location of buried infrastructure e.g. gas pipelines, sewers, cables
- Other site designations e.g. Archaeological Notification areas, Regionally Important Geological Sites, Sites of Special Scientific Interest, etc.

Figure 18 below shows a map of some constraints impacting GSHPs. However, not all of the data listed above was available during this study, so this is only a partial assessment. No data on wells, springs, boreholes, septic tanks, cesspits and existing GSHP schemes was available at the time of writing. Additional feasibility studies would be required to determine whether a GSHP would be appropriate on a given site.[59]

[57] https://data.gov.uk/dataset/3d136e9a-78cf-4452-824d-39d715ba5b69/drinking-water-protected-areas-surface-water and https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/SourceProtectionZonesMerged&Mode=spatial
[58] Maps available at https://data.gov.uk/dataset/contaminated-land
[59] Further guidance is available at: https://www.gov.uk/guidance/open-loop-heat-pump-systems-permits-consents-and-licences

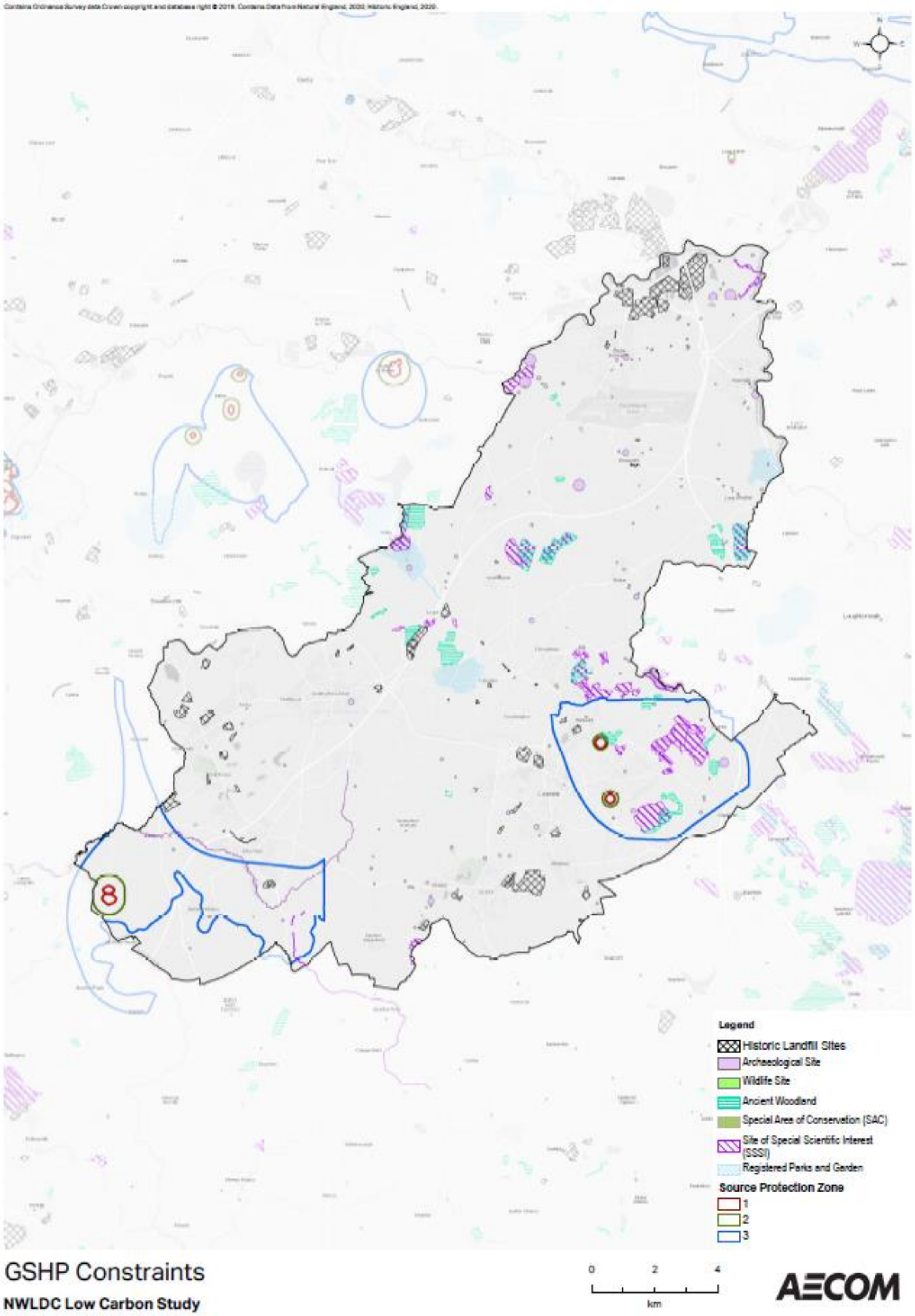


Figure 18. GSHP Constraints Map

Water Source Heat Pumps

Water Source Heat Pumps (WSHP) are similar in operation to GSHPs but work by extracting heat from a water source (pond, river or canal) near the building. As with GSHPs, these can be open- or closed-loop systems.

There are relatively few examples of water source heat pumps (WSHPs) in the UK. Detailed feasibility studies would be required to assess the potential for WSHPs on any given site, which would also require consultation with the Environment Agency. Environmental designations that could potentially act as constraints include:

- Sites of Special Scientific Interest
- Special Protection Areas
- Special Areas of Conservation
- RAMSAR sites
- CAMS water resource status
- Freshwater fisheries status
- Water Framework Directive Waterbodies

A report[60] published by DECC in 2015, which provided a high-level assessment of river heat capacity for all of England, suggests that the River Trent (which skirts the northern edge of the District) is among those with the largest heat capacities in England. This is shown in Figure 19 below.

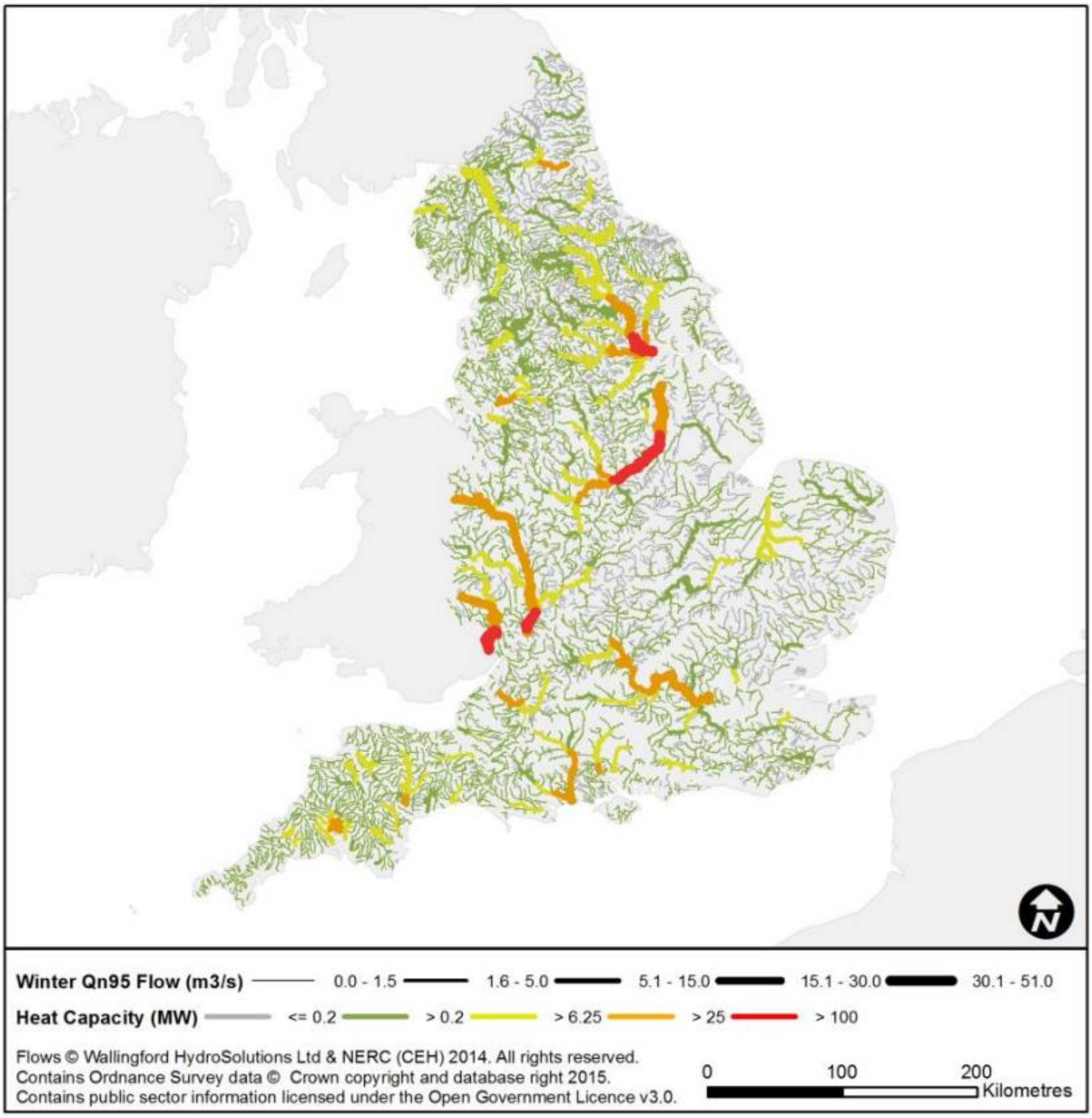


Figure 19. Total heat capacity from rivers in megawatts for urban areas. Source: DECC (2015)

[60] For more information, see DECC, *'National Heat Map: Water Source Heat Layer'* (2015). Available at: https://www.gov.uk/government/publications/water-source-heat-map-layer

Although the DECC report highlights areas with the greatest WSHP opportunities, smaller water bodies can potentially provide low carbon heat for smaller developments (or individual properties) if the site conditions are suitable. Therefore, this technology could be considered for any development located within close proximity of a waterbody or watercourse, including rivers, lakes and canals.[61]

Other opportunities

The above has highlighted the potential to utilise river courses as a source of heat. However, it may also be possible to deploy WSHPs in other resources. For example, wastewater treatment works (WWTWs) represent a large and renewable source of heat which could be used for a WSHP. No attempt has been made to quantify the potential capacity of WSHPs that source their heat from WWTWs, as this is beyond the scope of the current study, and the use of WWTWs for this purpose is still in its infancy. However, it is recommended that this is investigated in the future, particularly where there are large developments planned within the District, as it represents a key sustainable option for delivering low carbon heating to developments.

General comments

Retrofitting heat pumps incurs a variety of technical and practical challenges. For example:

- To ensure that the systems operate efficiently it is necessary to undertake energy efficiency upgrades to ensure that the building is well insulated and reasonably airtight.
- It may be necessary to upgrade the entire heating system to be compatible with a low temperature distribution system, which requires either larger radiators or underfloor heating, and the use of a hot water cylinder. (This presents a potential challenge particularly if there is no space for one.)
- In the case of GSHPs, the level of excavation or drilling work depends on the type of system that is installed, but it either requires boreholes or excavation of a large area if using horizontal trenches
- ASHPs need to be located outside, which has a visual impact and can result in noise due to the fans used. The appearance is similar to a typical external air conditioning unit.

In some cases, cost constraints in the short term may continue to see gas boilers as a preferred heat source for new homes. To ensure that new buildings are able to accommodate heat pumps easily in future, the following design measures should be strongly encouraged as part of either a Local Plan policy or SPD:

- The space heating system must be capable of delivering required heat load with a flow temperature ≤45°C (e.g. underfloor heating or large radiators);
- Individual houses must have space for a hot water cylinder (apartments with a communal heating system the flow temperature must be ≤60°C);
- Houses should not include gas for cooking and instead electric induction hobs and ovens are required;
- External space must be allocated for an air source heat pump capable of providing space heating and hot water load required by property; and
- Allocated space for air source heat pumps must be shown to meet the noise planning requirements for neighbouring new and existing properties (this applies to new properties that are proposing to install new air source heat pumps).

It is important to understand that even if new buildings are constructed with gas boilers and then retrofitted with heat pumps, in addition to the financial costs there will also be a significant environmental cost because of the carbon emissions emitted during the interim period.

4.2.4 Hydroelectric power

Hydroelectric power is generated by water flow through a turbine and depends on the volumetric flow rate and available head (i.e. the vertical distance of the water surface above the turbine).

[61] It is difficult to establish a rule of thumb, because the viability will depend on the scale of heat capacity of the water body and heat demand of the development, but in general this would be more appropriate for sites that are no more than 100-200m from the waterbody.

Our review of existing LZC installations in North West Leicestershire (Section 3.4) found no operational or planned hydroelectric power installations. However, there are five sites (on existing weirs and locks) identified within the Zero Carbon Roadmap as having potential to accommodate hydro schemes, based on earlier studies undertaken by IT Power (2008) and a 'Hydropower Resource Assessment' undertaken by DECC in 2010.[62]

Table 7. Opportunities for hydroelectric power, as per the Zero Carbon Roadmap (2019)

Location	Estimated annual electricity generation (GWh)
Trent Lock Weir	5.57
Ratcliffe Power Station Weir	3.00
Sawley Cut Weir	1.90
Kegworth Lock	0.66*
Ratcliffe-on-Soar	0.53
TOTAL	**Up to 12**

** Note: In the original 2008 study that the Zero Carbon Roadmap uses as a reference, this site listed as offering up to 1 GWh of electricity generation per year.*

The CSE (2011) study presented slightly different figures which may be due to the fact that it was a regional study; some of these waterways are located on the border between different Districts or Counties, and therefore may have been allocated to other areas.

It is assumed that the Environment Agency would be averse to any additional barriers being created across waterways, which would limit the availability of new sites. Considering the relatively high cost of the technology, and the need to carry out more detailed environmental assessment work compared with other types of LZCs, in practice it is likely that future uptake will be limited. Nonetheless, in line with the recommendations set out in the Zero Carbon Roadmap, feasibility studies could be carried out for some of these sites, particularly those that can offer higher levels of electricity generation, as this is a potentially significant resource.

4.2.5 Biomass

Biomass covers a diverse range of fuels derived from plants, animals or human activity. Examples include:

- Managed woodland
- Energy crops
- Agricultural arisings (straw)
- Waste wood
- Poultry litter
- Wet organic waste (from livestock)

Biomass can be converted to energy via combustion, pyrolysis, gasification or anaerobic digestion (AD).

- **Combustion**: A chemical reaction that releases heat and (typically) light, i.e. burning.
- **Pyrolysis and gasification**: These are related processes that can be used to convert organic matter into a gas. When biological material is subjected to high heat in an environment with low or no oxygen, this causes the material to thermally decompose in a process that can form synthetic gas and / or liquid fuel.
- **Anaerobic digestion**: A process where biomass is broken down by bacteria without the presence of air to produce biogas and fertiliser.

Biomass or biogas combustion can be used to provide electricity, heat, or both. If processed in an anaerobic digestion plant, the resulting biogas can either be burned to provide electricity and / or heat, or compressed and used to power internal combustion engines in vehicles.

Biomass fuels have the potential to have net zero CO_2 emissions, assuming that the amount of CO_2 that is released will be equivalent to the amount that is absorbed from the atmosphere as resource grows. (A simple example would be a tree that absorbs CO_2 during its lifetime, and then re-emits that CO_2 when it is burned.) If combined with carbon capture and storage technologies (BECCS), biomass has the potential to be 'carbon negative', i.e. removing more CO_2 from the atmosphere than it emits.

[62] DECC, *'England and Wales Hydropower Resource Assessment: Annex 3'* (2010). Available at: https://www.gov.uk/government/publications/hydropower-resource-assessment-england-and-wales

However, it can be difficult to establish the overall environmental benefits of biomass-derived fuels using a broad-brush approach. A 2018 report by the Committee on Climate Change considered the role of biomass in supporting the UK's decarbonisation targets, and found that:[63]

> *'Biomass can be produced and used in ways that are both low-carbon and sustainable. However, improved governance will be essential to ensure this happens in practice. If this is achieved, biomass can make a significant contribution to tackling climate change. If this is not achieved, there are risks that biomass production and use could in some circumstances be worse for the climate than using fossil fuels.'*

The same report stated that, to provide the greatest reduction in GHG emissions, *'the greatest levels of GHG abatement from biomass currently occur when wood is used as a construction material in buildings to both store carbon and displace high carbon cement, brick and steel.'* If and when BECCS technologies become widely available, these could provide further benefits, but those technologies are not considered mature enough to offer a large-scale solution.[64] As a final option, the CCC report suggested that, *'the remaining [biomass] resource would be best used to displace residual fossil fuel emissions where other low-carbon alternatives do not exist (e.g. in aviation).'*

This suggests that the most appropriate use of biomass as fuel would be if there is an existing source of sustainably and locally sourced waste biomass – *provided that waste reduction measures are also in place*. This could include, for example, anaerobic digestion plants that are co-located with agricultural facilities that have a high energy demand. It is difficult to assess these types of opportunities on an area-wide basis although there is precedent within the District:

Case Study: Westminster Industrial Estate

In 2015, planning permission was granted for the construction of an AD plant at Westminster Industrial Estate. The 500 kWe system uses potato peelings as a feedstock to produce biogas, which is then used to power a Combined Heat and Power (CHP) system that provides both heat and electricity.

Prior to the AD system being put in place, the potato and vegetable processing site produced wastewater that contained suspended solids (vegetable matter) that were pumped into storage lagoons, with negative impacts on water quality and smell. The AD system helps to manage that waste product while providing low carbon energy on site; surplus electricity is exported to the grid. The process also produces fertiliser as a by-product.

More information can be found at: http://politics.leics.gov.uk/mgConvert2PDF.aspx?ID=110610

CSE (2011) found that there was significant potential for biomass to provide both heat and electricity in North West Leicestershire if suitable markets for those fuels could be created. Our review of that study indicates that the key variables affecting those estimates are unlikely to have changed significantly in the last decade. For instance, recognising that the utilisation rate of agricultural land has remained stable, we assume that the

[63] Committee on Climate Change, *'Biomass in a Low Carbon Economy'* (2018). Available at: https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
[64] For more information, see Appendix B.

potential to convert this for use as energy crops is roughly the same. However, in light of the above considerations, biomass and biogas are not recommended for widespread adoption in North West Leicestershire.

Note: Direct combustion (burning) to produce electricity or heat is often the most viable approach to energy conversion from a technical and economic standpoint. However, biomass burning emits particulate matter (PMx) and therefore DEFRA's position is to not encourage this practice in or near urban areas or Air Quality Management Areas (AQMAs) due to air quality concerns.[65] Instead, as suggested by the CCC, the best opportunity from a carbon reduction perspective may be to use biomass (wood) in construction as a carbon sink.

4.2.6 Energy from Waste (EfW)

'Waste' covers municipal solid waste (MSW) and commercial and industrial (C&I) waste. Both can be diverted from landfill to EfW facilities and used to derive power via combustion, pyrolysis, gasification or anaerobic digestion (see Section 4.2.5 for a description of these processes).

In line with waste reduction principles, it is considered preferable for this resource to diminish rather than increase. There are additional concerns related to air quality impacts if waste streams are disposed of through combustion. Therefore, this technology is not recommended for widespread adoption in North West Leicestershire. However, if there are existing or planned[66] facilities, EfW should be considered in preference to letting the heat go to waste, if it can be used to displace a more carbon-intensive fuel.

The aim is typically to maximise the generation of electrical power; however, it is in practice impossible to convert all available energy into electricity. There is much waste heat from such a facility that must be discharged to the environment. Although the environmental impact of the heat is minimal, it does offer a significant opportunity to reduce fuel consumption for heating in buildings and homes. Opportunities to utilise this heat should be considered and prioritised to maximise carbon reduction.

4.2.7 Biogas (Sewage and Landfill gas)

DECC (2010) provides a method for estimating the potential availability of both sewage and landfill gas, which can be used to generate either electricity or heat. Sites that could provide opportunities for biogas include:

- Material recovery facilities;
- Landfill sites;
- Waste transfer stations; and
- Sewage (sludge) treatment centres (STCs).

Regarding sewage gas, Severn Trent Water is the water and sewerage company that serves NWL and the surrounding area. All of the sludge managed by Severn Trent Water is processed in anaerobic digestion (AD) facilities, which results in the production of biogas. However, Ofwat records indicate that none of these facilities are located in NWL.[67] Although Severn Trent Water has announced an intention to increase energy recovery from sewage,[68] in practice these facilities are more economically feasible for larger STCs.[69] As a result, sewage gas is not expected to play a significant role in NWL's energy mix unless Severn Trent Water chooses to develop new STCs in the area.

Regarding landfill gas, although there are currently two operational landfill gas plants in the District (see Section 3.4), this resource naturally diminishes over time as the organic portion of the waste biodegrades. DECC (2010) states: *'Current landfill sites have a limited useful lifetime as sources of bio-gas and will be exhausted by around 2020. There is unlikely to be much new landfill gas resource due to the EU Landfill Directive which caps landfill, especially post-2014, and due to policies to promote other waste management processes such as anaerobic digestion, composting and recycling, which will reduce significantly the biodegradable fraction of landfill waste.'*

[65] DEFRA, '*The Potential Air Quality Impacts from Biomass Combustion*' (July 2017). Available at: https://uk-air.defra.gov.uk/library/reports?report_id=935
[66] For example, we note that there is an EfW site under construction near the M1 (Junction 23) in Charnwood Borough.
[67] Severn Trent Water, *'Bioresources Market Information'* (2020). Available at: https://www.ofwat.gov.uk/regulated-companies/markets/bioresources-market/bioresources-market-information/
[68] Severn Trent Water, *'Press release: Severn Trent invests £15m in three new biomethane gas to grid plants'* (published 11/29/2020). Available at: www.stwater.co.uk/news/news-releases/severntrentinvestsinthreenewbiomethanegastogridplants/
[69] Severn Trent Water, *'Response to Government Consultation: Future Support for Low Carbon Heat'* (2020). Available at: https://www.stwater.co.uk/content/dam/stw/regulatory-library/future-support-for-low-carbon-heat-consultation-response-for-severn-trent-water.pdf The company's aim is to install energy recovery systems at larger STCs which can operate more efficiently. For more information, see the Severn Trent *'Bioresources Strategy'* (2019). Available at: https://www.stwater.co.uk/content/dam/stw/about_us/pr19-documents/sve_appendix_a6_embracing_markets.pdf

Therefore, landfill gas is also not expected to provide significant *additional* renewable electricity generation for North West Leicestershire going forward.

4.2.8 District Heat Networks (DHNs)

The Leicestershire Heat Networks Study, produced by the Centre for Sustainable Energy in 2017, assessed the potential for DHNs in Leicestershire County. The report was not available at the time of writing, but it is understood that the main opportunities highlighted for NWL were the town centre of Coalville and two Council estates that are off the gas grid. This present report has not sought to further quantify the potential for DHNs in North West Leicestershire as doing so relies to a wide range of technical, practical and financial considerations that are outside the scope of this study to assess in detail. However, the text below briefly describes when DHNs might be suitable for different types of development.

The delivery and expansion of heat networks relies upon the connectivity of potential heat loads. In general, suitable developments will be those of mixed usage types and those with a sufficiently high density of heat demand. A common rule of thumb is that Combined Heat and Power (CHP) DHN schemes are likely to be economically feasible for developments above 50 dwellings per hectare.[70] Other key opportunity areas may arise in built-up urban areas, or in proximity to significant waste heat sources, such as, from industrial sites, leisure centres, hospitals, prisons, crematoria, and other high energy users. (It is acknowledged that there are no hospitals, prisons or crematoria in NWL.)

New development can facilitate the creation of heat networks if buildings are designed to connect to an existing network or with the ability to connect to it in the future. Depending on the location of the new development the potential for the scheme to facilitate the decarbonisation of adjacent heat loads is worth considering. This is usually the case where there is a cluster of large existing loads near to a new development providing the opportunity to omit or reduce the existing fossil fuel consumption.

For commercial buildings, the costs associated with ensuring designs can facilitate their connection to a heat network in the future should be no greater than the alternative approach. Design considerations are likely to include the location of the plant room, the provision of space within the plant room for a heat exchanger, provision of capped off connections to the flow and return pipework, lower temperature heating systems and the choice of control systems. For residential buildings, there could be additional construction costs associated with the communal heating network within blocks of flats if compared to individual heating systems although whole life cycle cost of individual systems may be greater.

In short, for a rural District such as NWL, the key opportunities are likely to be in more densely built areas (e.g. town centres) or where there is a major mixed-use new development planned, particularly if this is adjacent to a source of low carbon energy or waste heat.

4.2.9 Future Low Carbon Technologies

Hydrogen

Hydrogen gas, H_2, can be produced via two main routes. The first and most commonly used in commercial production is steam-methane reforming: Methane (CH_4) is reacted with steam which results in H_2 gas being produced along with Carbon Monoxide (CO). The second and more environmentally friendly way is electrolysis. This is where water (H_2O) is split using electricity produced from the grid, which is rapidly decarbonising; forming H_2 and O_2 gas as the products. From each process the H_2 gas is then compressed and stored, ready for use, i.e. combustion. When hydrogen is burned as fuel to provide heat, the product is water.

As discussed earlier in relation to EVs, hydrogen is considered to potentially have a significant role to play in decarbonisation efforts in the UK. While hydrogen can be used as a fuel for transportation, there are also significant opportunities for utilising renewably-sourced and low carbon hydrogen as a replacement fuel in systems that currently rely on natural gas.

Whilst the expansion of renewable electricity capacity is expected to reduce the UK's reliance on natural gas as a means of producing electricity, and in doing so aid the decarbonisation of grid electricity, the displacement of natural gas from other uses is expected to be more challenging. Much of the gas is transported via the gas grid, with high pressure transmission pipelines feeding into medium and low pressure distribution networks.

[70] See, for example, Energy Saving Trust (2014) *CE299: The applicability of district heating for new dwellings.*

In principle, hydrogen can be injected into the gas grid, so that the gas received by customers is a blend of natural gas and hydrogen. (This principle also applies to the injection of biogases into the gas grid. These are synthetic hydrocarbon gases produced in facilities such as anaerobic digesters, and which, because of the short carbon cycle associated with their production, help to reduce net carbon emissions to the atmosphere.) Since hydrogen was a major component in 'town gas' (which was created from coal and used extensively throughout the UK before the discovery of natural gas and oil reserves in the North Sea in the 1960s), it is considered technically feasible for hydrogen to become a major component in the gas network in the future.

Customers' appliances can, in many cases, run on blends of gas with a high hydrogen content, and the Government is working with the heating industry to trial the rollout of hydrogen in the gas network. For example, Keele University in Staffordshire is testing the viability of using a blended gas of 20% hydrogen : 80% natural gas in a project called HyDeploy.[71] At this blend ratio, no changes are expected to be required to the majority of boilers in the UK. The potential to run a 100% hydrogen network is being explored in a project called Hy4Heat, where positive results have been achieved to date.[72] Boiler manufacturers would need to ensure that boilers can operate safely with 100% hydrogen, though the major manufacturers are working on prototypes which can be switched to hydrogen-only fuels relatively simply.

The main challenges associated with delivering a hydrogen gas grid will be upscaling commercially viable hydrogen production capacity, and the upgrading of the gas distribution infrastructure. Current hydrogen production capacity in the UK is low, and is considered uneconomic in the current environment. This is mainly due to the relatively high cost of the electricity needed to produce hydrogen via electrolysis. This process, which is referred to as 'green' hydrogen if the electricity is renewable, is expected to become more commercially viable once the capacity of renewable electricity generation is expanded to a point where there are large surpluses in grid generation for significant periods of time. Surplus generation results in very low real-time wholesale power prices, which potentially can be used to power the production of large quantities of commercially-viable green hydrogen. This has the added benefit of ensuring demand for renewable electricity during periods when generation exceeds demand.

The gas distribution network is likely to require significant investment before hydrogen can be distributed in large volumes. New hydrogen meters and sensors would need to be fitted for each customer, which is likely to require significant administrative and organisational resources to deliver. The network itself may require some upgrades to reduce the incidence of leakage from and the failure of pipework. Any upgrades of the network would likely need to be led by Cadent.

It is recommended that NWLDC should note the development of trials aimed at establishing the feasibility of hydrogen networks, such as the HyDeploy trials underway at Keele University.

Batteries

Batteries are expected to play a key role in the transition to a grid which is dominated in the future by renewable sources of electricity generation. By their nature, most renewable energy sources (particularly those which are most relevant to North West Leicestershire, i.e. PV and wind) are intermittent, due to their being dominated by local weather conditions. This means that, with evermore renewable capacity coming online, the real-time generation of electricity may at times dip below the real-time demand. This could lead to brown-outs, where certain loads need to be dropped (i.e. the supply needs to be cut to loads which are deemed less critical) in order to preserve supply capacity for the most critical loads (e.g. hospitals and residential customers). In severe cases, black-outs may occur, where the supply is significantly below demand, causing the whole local network to shut down.

Large 'grid-scale' or 'utility-scale' batteries (MW+), and other forms of energy storage, enable a surplus of supply to be stored during periods when generation exceeds demand. This surplus energy is released onto the grid when demand exceeds real-time generation. Hydroelectric generators have provided this kind of 'grid balancing' service for many years, and there are new concepts coming forward for innovative storage facilities, such as deploying weights within abandoned mine shafts that rise and fall when grid conditions result in oversupply or excess demand on the grid respectively. However, with the increasing penetration of renewables onto the grid, and the reduction in fossil fuel-based generation capacity (which are able to act as modulating generation in order to 'top up' the supply in response to demand levels), storage assets are expected to become an essential part of the energy balance in the future. Applications for large batteries are increasingly coming forward, as the market and the regulatory environment matures.

[71] https://hydeploy.co.uk/
[72] https://www.hy4heat.info/

Units typically come in self-contained 'modular units', which means that capacity can be increased with relative ease, with additional units being delivered and integrated into existing facilities if required. Each MW unit is approximately the size of a shipping container. The capacity of upstream grid infrastructure (e.g. substations, incoming cables, etc.) needs to be assessed and potentially upgraded in order to facilitate connection.

It is recommended that NWLDC note the development of large-scale battery systems, and engage with DNOs regarding applications for new large-scale batteries in the District.

4.3 Transmission and Distribution Network Capacity

The viability of new LZC generation projects depends on the ability to be able to deliver the generated power to customers via new or existing Transmission and/or Distribution network infrastructure. The existing Distribution Network in North West Leicestershire is owned and operated by WPD. WPD operates the network at voltages from 132 kV at sub-transmission, down to 400 V for domestic distribution.

The following table, developed by WPD, details the proposed connection voltage, depending on the size of the proposed renewable electricity installation. In general, the higher the connection voltage, the higher the cost of the connection infrastructure.

Table 8. Connection Sizes and Voltages

Size of Generation Installation	Location	Typical Connection Voltage
0-0.25 MW	Rural	400 V
0-0.5 MW	Urban	400 V
0.25-4.0 MW	Rural	11 000 V
0.5-7.0 MW	Urban	11 000 V
4.0-20.0 MW	Rural	33 000 V
7.0-20.0 MW	Urban	33 000 V
+ 20.0 MW	Urban + Rural	132 000 V

Domestic and small-scale commercial PV installations are commonly installed in developed areas where the distribution network already exists and is relatively suitably sized. Rural areas, in contrast, are usually identified for larger scale installations due to the increased availability of land. However, the network in these areas is often significantly undersized to accommodate large-scale generation installations. Therefore, when considering potential large-scale installations, it is prudent to consider the proximity of the proposed location to the existing network infrastructure. Minimising the required network expansion to connect the LZC generator will increase the viability of the development.

Figure 20 below is an extract from the WPD Network Capacity Map which *'provides an indication of the network's capability to connect large-scale developments to major substations.'* Each WPD substation is colour-coded to represent whether a connection could potentially be achieved without significant reinforcement; green indicates 25% or more capacity is available, amber indicates limited additional capacity (10-25%), and red indicates that there is very limited additional capacity (<10%), as advised by WPD.[73]

Note that the data is updated continually by WPD and is therefore subject to change.

[73] WPD Network Capacity Map Data https://www.westernpower.co.uk/our-network/network-capacity-map/

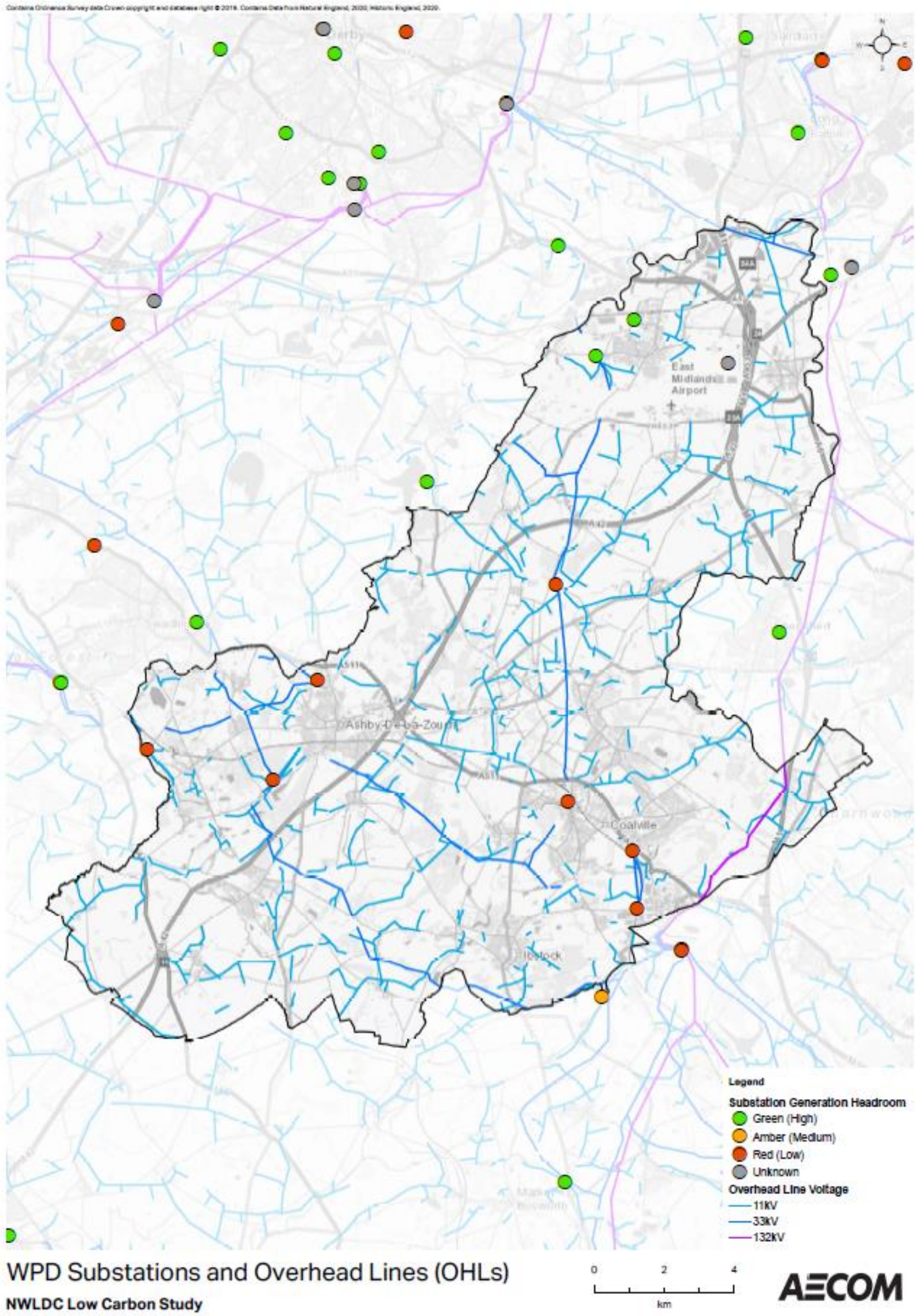


Figure 20. Existing substation capacity in North West Leicestershire. Source: WPD

Substations that are coloured green have a 'high' level of capacity to accommodate the connection of large-scale (5 to 20+ MW) energy *generation* installations. (Note that this is not the same as whether the substations can accommodate additional energy *demand* from new developments.) From a technical perspective, areas that are close to these substations and associated distribution lines may be more suitable for LZC energy development.

The map shows that, at present, there are two substations with 'high' capacity located north of Castle Donington; WPD guidance[73] indicates that, in these areas, *'a connection is more likely to be achieved without significant reinforcement.'* We note that the Ratcliffe-on-Soar Power Station is just outside the northern boundary of NWL, where there is a substation with 'high' capacity, and this is served by a high voltage power line that skirts the western edge of the District, though this is due to close in 2025. Substation capacity is currently 'low' elsewhere.

Whilst it is beyond the scope of this report to identify specific sites for large-scale LZCs, schemes are, in general, more likely to be viable where they are in close proximity to:

- Urban areas or large energy users; and
- Existing power infrastructure – larger sites would require higher voltage connections and sub-stations with greater capacity headroom to accommodate additional generation.

As detailed in Table 8 above, the size of the generation installation will dictate the required connection voltage.

The map shown in Figure 20 can be used as a starting point for considering potential areas of search for large-scale renewable energy installations. In particular, if NWLDC landholdings are in close proximity to existing infrastructure and lie within these opportunity areas, they could be considered potential candidates to deliver LZCs, thereby contributing towards the Council's Net Zero ambitions. However, because the viability of large-scale renewable developments depends on site-specific factors (including scale, distance from substations and required grid capacity enhancements), it is not possible to give a general rule of thumb as to appropriate distances from these features.

4.4 LZC Technologies on New Development Sites

The constraint maps shown above can inform an initial high-level indication of whether there are any major constraints to using LZC technologies on committed or proposed new development sites. **This is not a definitive assessment of whether any particular technology would be suitable for any of these sites, which would require detailed feasibility studies to assess, but can provide a starting point for further investigation.**

In broad terms, our observations are as follows:

- It is assumed that environmental constraints such as SSSIs and other designations do not present significant constraints since large-scale developments are unlikely to be brought forth in these areas.
- Roof-mounted solar technologies and ASHPs can be incorporated into the design of new developments fairly easily although this may require additional electricity grid reinforcement. Visual impacts, noise and amenity considerations are not likely to pose major obstacles because new developments are generally subject to fewer design constraints (e.g. site layout and geometry) than existing buildings, and can more easily be designed to minimise any unwanted impacts.
- The northern part of the District is an area that is considered to have fewer policy constraints on large-scale PV, so potentially there could be ground-mounted solar farms located nearby.
- At present, areas that are considered 'potentially suitable' for large-scale wind have been identified using a buffer around residential properties. Because these are based in part on applying a buffer around built-up areas, these maps would need to be updated if there are any large-scale new developments outside of existing built-up areas.
- Some new developments may be located on or near historic landfill sites. This could limit opportunities to utilise GSHPs due to the potential risk of contamination.[74] The same applies for archaeological sites and groundwater source protection zones.
- Depending on the size of the new development, if new wastewater infrastructure is being constructed then this could provide an opportunity to use wastewater heat recovery systems or energy from sewage gas.

[74] For more information, see the Environment Agency publication, *'Environmental good practice guide for ground source heating and cooling'* (2011). Available at: https://www.gshp.org.uk/pdf/EA_GSHC_Good_Practice_Guide.pdf

5 Design Approaches that Respond to Climate Change

5.1 Energy and CO_2 Performance Standards

This section of the report considers the performance standards that could be set within Local Plan policy to reduce energy demand and CO_2 emissions in new domestic and non-domestic developments.

5.1.1 Background

The UK has a legal commitment to reduce greenhouse gas emissions by 100% (i.e. achieve Net Zero emissions) by 2050. This goal cannot be met without a significant reduction in CO_2 emissions from all sectors. It is estimated that fuel use in buildings currently accounts for roughly 58% of total emissions in North West Leicestershire, and emissions from new development would be expected to result in a significant increase, which will make the decarbonisation target more difficult to achieve. The best way to mitigate this increase will be to introduce ambitious energy and CO_2 performance standards for new buildings in the District.

The environmental and financial cost of delay is significant, even if standards are increased progressively over time. For example, a study conducted on behalf of the Committee on Climate Change found that the lifetime carbon emissions (over 60 years) of a house built with a gas boiler in 2020 and then retrofitted with a heat pump in 2030 would be around three times higher than if a heat pump was fitted at the outset.[75] This is illustrated in Figure 21 below (source: Figure E.1 of the CCC report). At a national level, the report found that, *'each year of delay in adopting lower-carbon heat technologies could result in several million tonnes of avoidable carbon emissions.'*

Any new buildings that are *not* constructed to meet a Net Zero standard will also add a potential burden on the public purse in the future, as financial assistance may be needed to enable homeowners, occupants and landlords to implement sustainability measures.

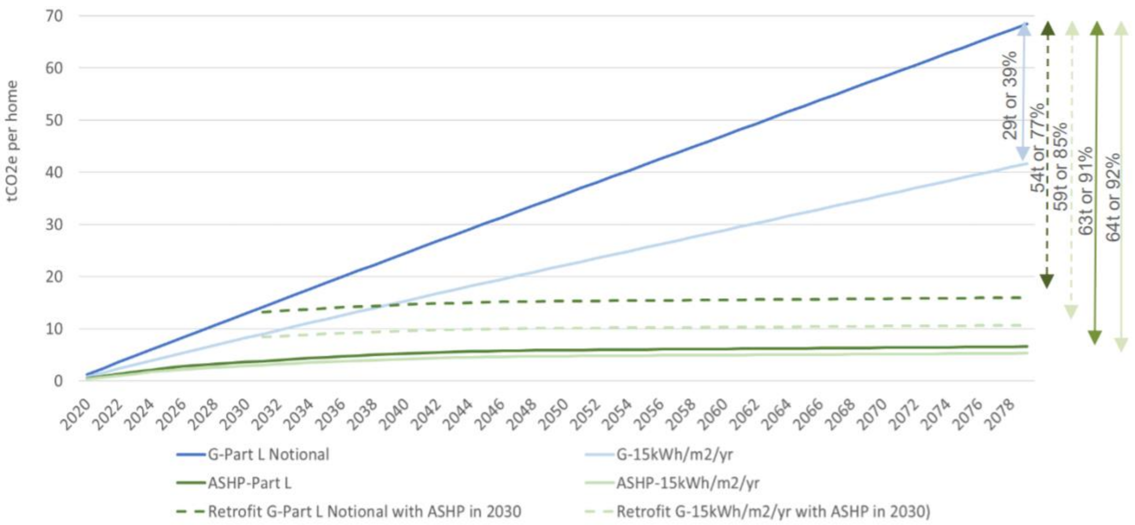


Figure 21. Comparison of cumulative CO_2 emissions from a house built to different energy performance standards. Source: CCC (2019)

NWLDC should therefore look to set the highest level of building performance standards for new buildings that can reasonably be implemented, and should do so as soon as possible. In addition, the Council should consider opportunities to improve the performance of the existing building stock, as this represents a high share of total emissions.

[75] Currie Brown and AECOM on behalf of the Committee on Climate Change, *'The costs and benefits of tighter standards for new buildings'* (2019). Available at: https://www.theccc.org.uk/wp-content/uploads/2019/07/The-costs-and-benefits-of-tighter-standards-for-new-buildings-Currie-Brown-and-AECOM.pdf

5.1.2 Policy Context

The Zero Carbon Homes Policy announced by the Government in 2006 would have required all new homes to be Zero Carbon by 2016; however, the policy was withdrawn in 2015. The Housing Standards Review undertaken in 2014/15 proposed to standardise performance requirements nationally, and this was codified by the Deregulation Act (2015), but the relevant provision was never enacted. In March 2019, new Planning Policy Guidance was issued, which confirmed that:

- For domestic buildings, Local Authorities can require new buildings to achieve up to a 19% improvement in CO_2 emissions compared with Part L 2013, equivalent to the (now defunct) Code for Sustainable Homes Level 4; and
- For non-domestic buildings, Local Authorities are ‘not restricted or limited’ in the energy standards they can set.[76]

In January 2021 the Government reiterated that, ‘local planning authorities will retain powers to set local energy efficiency standards for new homes’ for the time being.[77] They also noted, however, that the as yet unpublished new planning reforms that were consulted on in the Planning for the Future white paper will clarify the longer-term role of local planning authorities in determining local energy efficiency standards. Therefore, although Local Authorities are currently able to set higher standards of building energy performance than those outlined in the Building Regulations, it is unclear whether this will remain the case. According to the Government’s Future Homes Standard (FHS) Consultation document:[78]

> *‘As we move to the higher energy standards required by Part L 2020 and the Future Homes Standard, there may be no need for local authorities to seek higher standards and the power in the Planning and Energy Act 2008 may become redundant.’*

In addition, as discussed in Section 2.2.7, the proposals set out in the Government’s Planning White Paper would also potentially have a significant impact in terms of the future Local Plan for North West Leicestershire.

Therefore, although this section will address different options for introducing building performance standards, it is important to note that they **may not be enforceable in the future**. There are however other measures that NWLDC can take to ensure that buildings are futureproofed and to ease the transition to a low carbon built environment that will also be addressed. Those are discussed in Section 5.2.

5.1.3 Industry Standards and Assessment Methods

Mandatory standards for energy use and CO_2 emissions are set out in Part L of the Building Regulations. These are progressively updated and, despite the current policy uncertainty, will generally include more ambitious standards over time as the UK moves towards a Net Zero economy. In addition, there are various voluntary industry standards and assessment methods that set higher targets. These include, for instance, the Building Research Establishment Environmental Assessment Method (BREEAM), which sets out a range of holistic environmental measures that can be implemented when designing non-residential buildings, and the Home Quality Mark (HQM) which is relevant to domestic buildings. Examples of voluntary energy standards include the Passivhaus Standard (predominantly applied to new buildings), EnerPHit and Energiesprong both of which are aimed at retrofit projects.

NWLDC could consider requiring or encouraging developers to meet some of these higher standards as part of a future Local Plan policy. This is an approach that has been widely adopted elsewhere in the UK. The use of these standards can help deliver buildings where energy efficiency is a key driver for the design and where as-built performance is more likely to align with the design intent.

Table 9 (see overleaf) presents a brief overview and comparison of some of these standards, focusing on those that are most commonly in use in the UK.[79] The table also includes the current Part L 2013 requirements and

[76] https://www.gov.uk/government/speeches/planning-update-march-2015
[77] Ministry of Housing, Communities & Local Government, *‘The Future Homes Standard: Consultation on changes to Part L and Part F of the Building Regulations for new dwellings: Government response’* (2021). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956094/Government_response_to_Future_Homes_Standard_consultation.pdf
[78] Ministry of Housing, Communities & Local Government, *‘The Future Homes Standard: Consultation on changes to Part L and Part F of the Building Regulations for new dwellings’* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/852605/Future_Homes_Standard_2019_Consultation.pdf
[79] CIBSE, *‘TM60: Good Practice in the Design of Homes’* (2018)

those that are laid out in the FHS consultation. These standards vary significantly in scope, calculation methodology, and assessment / validation procedures. Targets can be set based on metrics such as:

- Demand for space heating and / or cooling;
- Primary energy demand;
- Total energy consumption;
- CO_2 emissions;
- Amount of renewable energy generated on-site (for instance, in Passivhaus Plus); or
- Energy efficiency rating (in the case of BREEAM Domestic Refurbishment schemes).

Table 9. Comparison of building design standards

	Part L 2013	Future Homes Standard Option 1 *	Future Homes Standard Option 2	BREEAM 'Outstanding'	Home Quality Mark (HQM)	Energiesprong	Passivhaus	Passivhaus Plus	EnerPHit
Description	Current performance standard of UK Building Regulations (2013).	Would equate to roughly a 20% improvement on Part L 2013, likely to be achieved through very high fabric efficiency standards.	Would equate to roughly a 31% improvement on Part L 2013 through fabric energy efficiency measures (not as high as in Option 1) plus the use of LZC technologies.	BREEAM 'Outstanding' requires a reduction in regulated CO_2 emissions, compared with Part L 2013 standards. Additional credits can be achieved for a 100% reduction (i.e. Net Zero) regulated emissions.	HQM was developed by the BRE as a rating system that can signal to householders how well the building performs based on various sustainability indicators, including energy use and CO_2 emissions.	Originally developed by the Dutch government to promote energy efficient retrofitting, this is a performance standard for new build and refurbishment.	Originally developed in Germany, this is a performance standard that aims to meet annual heating requirements with very low energy input.	Similar to the Passivhaus Standard, this scheme also requires renewable energy generation on-site or nearby, resulting in Net Zero emissions.	This is the Passivhaus Institute standard aimed at energy efficiency refurbishment schemes, which can achieve energy and CO_2 savings of 75-90%.
Relevant building types	Domestic and non-domestic	Domestic only	Domestic only	Non-domestic only [separate standards for domestic refurbishment]	Domestic only	Domestic only	Domestic and non-domestic	Domestic and non-domestic	Domestic and non-domestic retrofits
Scope	Regulated energy use only	Regulated energy use only	Regulated energy use only	Core requirements relate to regulated energy use, but additional credits can be achieved for reducing unregulated energy use. There is consideration of lifecycle CO_2 emissions from certain materials, but no set target.	Regulated and unregulated energy use .	Regulated and unregulated energy use	Regulated and unregulated energy use	Regulated and unregulated energy use	Regulated and unregulated energy use
Target values	Based on a notional building with a similar built form, targets are set for: • CO_2 emissions • Fabric energy efficiency • Minimum performance standards for building elements and fixed services	Typical 20% improvement on Part L 2013 CO_2 emission rates. New targets based on: • Primary energy • CO_2 emissions • Householder affordability • Minimum performance standards for building elements and fixed services	Typical 31% improvement on Part L 2013 CO_2 emission rates, or around a 22% improvement in typical flats (due to less roof space for LZCs) New targets as for Option 1 (see left)	A bespoke metric is used which accounts for its regulated operational heating and cooling energy demand, primary energy consumption and CO_2-eq emissions	A bespoke metric is used which accounts for fabric performance, system efficiency and Total resulting CO_2 emissions.	Space heating demand <30 kWh/m^2/yr Net zero delivered energy over the course of the year	Space heating demand <15 kWh/m2/yr Primary energy demand <60 kWh/m^2/yr	Space heating demand <15 kWh/m^2/yr Primary [renewable] energy demand <45 kWh/m^2/yr	Compliance can be achieved via a 'component' method which uses Passivhaus-certified products, or via the 'energy demand' method which sets a space heating target dependant on climate zone. In North West Leicestershire the target would be 25 kWh/m^2/yr
Fabric energy efficiency standard	Typically, 45-50 kWh/m^2/yr for flats and 55-60 kWh/m^2 /yr for houses	Fabric energy efficiency target to be replaced by those listed above	As for Option 1 (see left)	None	None	Minimum performance standards for building elements and fixed services	Space heating demand <15 kWh/m^2/yr	Space heating demand <15 kWh/m^2/yr	As for Passivhaus (see left) – but only if seeking compliance via the 'energy demand' method
Renewable energy requirement?	No	No	No, but this would typically be required to meet the targets	No	No	No	No, but this would typically be required to meet the targets	Yes, renewable energy generation >60 kWh/m2/yr of building footprint	No

** Note: In January 2021 the Government confirmed that they will pursue Option 2 for the interim update to Part L of Building Regulations for new homes in 2021.[77]*

It is important to understand that not all emissions associated with buildings are captured by the standards described above. Part L (2013), the Future Homes Standard and BREEAM only address CO_2 emissions resulting from the use of fixed services and appliances, i.e. heating, cooling, ventilation, hot water, and lighting. These are referred to as 'regulated' CO_2 emissions (see row 4 in Table 9). 'Unregulated' CO_2 emissions are those that result from the use of other (typically electrical) appliances (such as fridges, home entertainment systems, etc.). There are additional emissions associated with the production, manufacture, construction, maintenance, repair and demolition of buildings. These are known as 'embodied' CO_2 emissions, and can represent 30-70% of the total CO_2 emissions, as illustrated in Figure 22 below, which is adapted from the UK Green Building Council report.[80]

To reach Net Zero across the whole of the UK, it will be necessary to implement policies that address a broader range of emissions that occur over the building's lifecycle, at all stages of the supply chain. The need to address the embodied emissions associated with the construction of new buildings should therefore be considered at a policy level and encouraged for all new development. This is affirmed in the CCC report *'UK Housing: Fit for the Future?'* which emphasises that embodied carbon emissions must be considered at the outset of any planning and building design process.

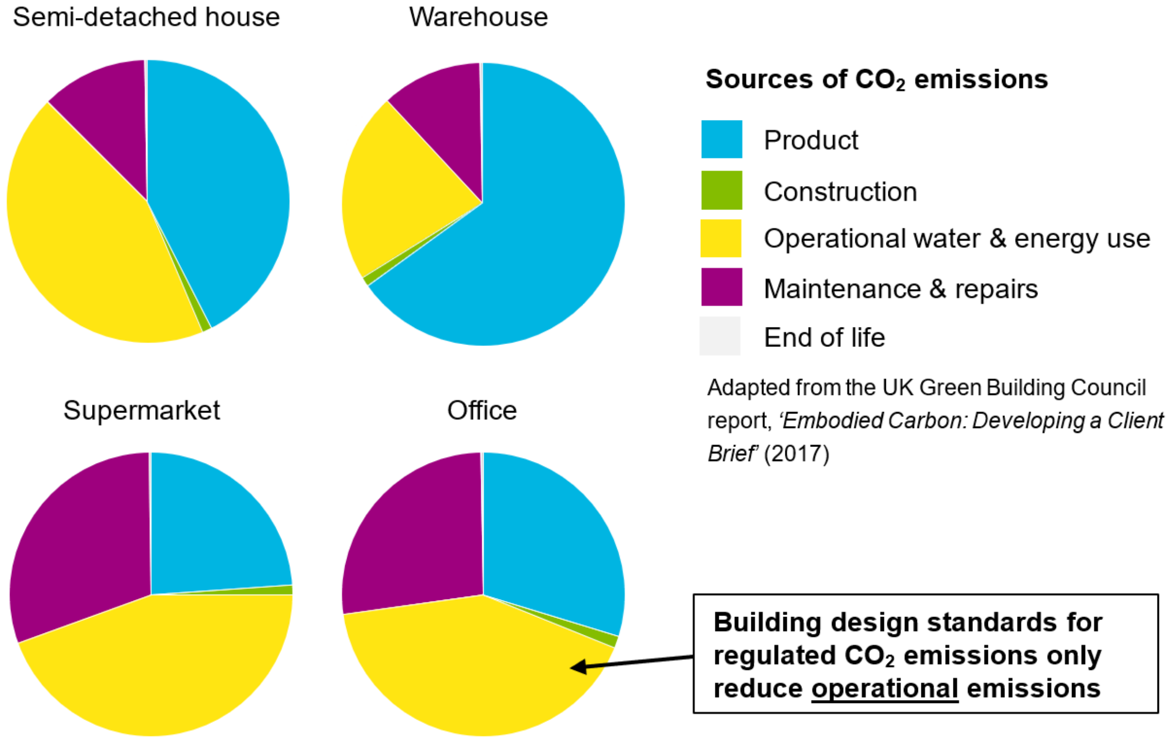


Figure 22. Illustration showing the relative proportion of CO_2 emissions from operational carbon (in yellow) compared with embodied carbon over a 30-year period. Source: UK-GBC (2017)

Furthermore, it should be noted that most compliance calculations rely on modelled estimates of the building's energy demands and CO_2 emissions, but that, in real-world operation, these tend to be significantly higher than design estimates suggest. For example, research undertaken by Innovate UK, which examined the in-use performance of a selection of low carbon development schemes, found that, even though CO_2 emissions were significantly lower than in typical buildings, in-use CO_2 emissions from domestic buildings were typically 2-3 times higher than predicted, and those from non-domestic buildings were nearly 4 times higher.[81,82]

In addition to setting higher building design standards, therefore, NWLDC should consider requiring developers to undertake post-construction monitoring. This will be crucial in order to help bridge the 'performance gap' described above (between predicted or modelled emissions and those in-use emissions observed in the real world) and ensure that the levels of CO_2 reduction as indicated prior to construction are actually achieved.

[80] UK Green Building Council, *'Embodied Carbon: Developing a Client Brief'* (2017).
[81] Innovate UK, *'Building Performance Evaluation Programme: Findings from domestic projects'* (2016). Available at: https://www.gov.uk/government/publications/low-carbon-homes-best-strategies-and-pitfalls
[82] Innovate UK, *'Building Performance Evaluation Programme: Findings from non-domestic projects'* (2016). Available at: https://www.gov.uk/government/publications/low-carbon-buildings-best-practices-and-what-to-avoid

5.1.4 Costs of Meeting Higher Standards

Analysis previously carried out by AECOM and Currie Brown on behalf of the Committee on Climate Change (CCC, 2019) considered the cost implications of achieving energy performance standards roughly equivalent to those listed in Table 9 for a range of building types.[83] The study found that, for new buildings, the uplift in cost for achieving 'ultra-high energy' efficiency standards ranged from around 1%-4% of the total build cost. Note that, if certification is being sought from an independent scheme, there will be additional costs compared with achieving standard Part L compliance (e.g. design, assessment and validation).

An impact report produced as part of the Future Homes Standard Consultation[84] indicates that the proposed new standards would result in the following increase in build costs for new homes:

Table 10. Future Homes Standard Consultation – Uplift in typical build costs for different building types

	Option 1 (20% uplift) *	Option 2 (31% uplift)
Detached house	£4,200	£6,520
Semi-detached house	£2,560	£4,850
Mid-terraced house	£2,200	£4,740
Flats	£2,070	£2,260
Average (based on build mix)	£2,870	£4,620

** Note: In January 2021 the Government confirmed that they will pursue Option 2 for the interim update to Part L of Building Regulations for new homes in 2021.*[77]

These costs should be weighed against the wider benefits of reducing energy demand and CO_2 emissions, including potential savings on energy bills. In the FHS Impact Assessment, the Government estimates that Option 1 would save occupants of a typical semi-detached home £60 per year on energy bills, compared with £260 savings with Option 2.

Consideration should also be given to the opportunity costs that may occur if new buildings are *not* capable of meeting these requirements. The costs of retrofitting buildings to an equivalent standard are significantly higher than those for new buildings (although still lower than the cost of demolishing and rebuilding a house).

For **domestic buildings**, the cost of installing energy efficiency measures and low carbon heating systems can be three to five times higher if they are retrofitted, compared with installing them in new homes. The cost depends on which measures are installed, but can range from around £16,000 per home (CCC, 2019) to upwards of £75,000 per home, as in the case of Energiesprong deep energy retrofitting projects.[85]

Non-domestic buildings exhibit a wider range of outcomes, but as a rough estimate, the costs of installing energy saving measures and technologies may be 3 to 10 times higher when they are retrofitted than when they are installed in a new building (CCC, 2019).

This indicates that some form of incentive scheme and regulatory change will almost certainly be required in order to improve the existing building stock to the level that would be required in order to reach Net Zero emissions.

5.1.5 Practical Considerations

It is generally feasible for new developments to achieve a c. 19-20% CO_2 reduction against Part L 2013. Indeed, this is the less ambitious of the two targets proposed within the FHS consultation and the Government has confirmed that this is viable on a national scale as part of the Future Homes Standard Consultation. Various Local Authorities in the UK have set this target to apply to all new developments so there is ample precedent for setting

[83] AECOM and Currie Brown, 'The Costs and Benefits of Tighter Standards for New Buildings' (2019). Available at: https://www.theccc.org.uk/publication/the-costs-and-benefits-of-tighter-standards-for-new-buildings-currie-brown-and-aecom/
[84] See *'Table 5: Additional Capital Costs'* of the Future Homes Standard Consultation Impact Assessment (2019)
[85] Evidence gathered as part of the Energiesprong programme indicates that costs have decreased radically over time, and research by the Green Alliance suggests that these could come down to around £35,000 per home on average. Green Alliance, *'Reinventing Retrofit: How to scale up home energy efficiency in the UK'* (2019). Available at: https://www.green-alliance.org.uk/resources/reinventing_retrofit.pdf

a target at this level.[86] Therefore, in our view a 20% improvement target would be reasonable. NWLDC could refer to the Government's FHS Impact Report (see above) to inform a viability assessment. However, recognising that this target may soon be superseded by changes to national regulations, NWLDC may wish to consider either (a) trying to set a more ambitious target or (b) wording the policy so that the target is set to increase over time. Options for developing a more ambitious policy could include:

- Adopting a 31% CO_2 reduction target for new homes (i.e. Option 2 of the FHS) ahead of the Government's schedule – note that this is now the standard recommendation from the UK Green Building Council (UKGBC)[87]
- Requiring an additional reduction in CO_2 emissions to be achieved through use of on-site LZC energy technologies
- Setting a higher target with any shortfall to be met through contributions towards a carbon offsetting fund (discussed in Section 6)
- Requiring developers to calculate, and take steps to reduce, lifetime CO_2 emissions including operational emissions and embodied carbon
- Requiring developers to participate in a BREEAM, HQM or other environmental assessment scheme

In practice, it is often the case that Local Authorities will only set higher energy and CO_2 performance targets (or BREEAM / HQM requirements) for major developments, or certain types of schemes that are known to have fewer technical and viability constraints (e.g. large developments on greenfield sites).

From a monitoring and enforcement perspective, third-party assessment schemes such as BREEAM, HQM and Passivhaus can be advantageous because developers can submit evidence that a scheme has undergone a pre-assessment and / or achieved accreditation, which reduces the amount of time that planning officers need to spend evaluating the details of each proposal.

If any of the above standards were to be introduced in North West Leicestershire, this would need to be tested through the normal Local Plan viability and consultation process.

5.1.6 Ensuring Compatibility with Net Zero Standards

In light of NWLDC's Climate Emergency Declaration, it is important to ensure that all new buildings are at least capable of *becoming* net zero carbon in operation, even if they are not constructed to that standard initially. Therefore, regardless of whether or not a CO_2 improvement target is set, the Council should strongly consider requiring developers to include futureproofing measures, such as the following:

- **High levels of fabric energy efficiency** – This is important for reducing energy demands and also to provide optimal operating conditions for heat pumps. The Government's FHS Consultation sets out an indicative fabric specification that would enable new homes to achieve a 20% CO2 reduction primarily through energy efficiency measures.
- **Designing heating systems to be compatible with heat pumps**, if these are not installed at the outset – This would include use of underfloor heating or larger radiators, which can provide the same amount of space heating, but which require a lower distribution temperature improving the heat pump's efficiency. Additionally, it is beneficial to provide hot water cylinders, as these can be 'charged' at night when electricity prices and demand are lower.
- **Maximising on-site renewable electricity generation**, for instance by requiring all new developments to include PV – This can help occupants save on energy bills and reduces the need to deliver additional LZC technologies off-site.

5.2 Other Opportunities to Respond

This section of the report identifies some of the other sustainable design measures that could be incorporated into the Local Plan to respond to climate change. Although there is considerable crossover between different

[86] UKGBC, *'The Policy Playbook: A Resource for Local Authorities'* (2020). Available at: https://www.ukgbc.org/wp-content/uploads/2020/03/The-Policy-Playbook-v.1.5-March-2020.pdf
[87] UKGBC, *'New Homes Policy Playbook'* (2021). Available at: https://www.ukgbc.org/wp-content/uploads/2021/01/New-Homes-Policy-Playbook-January-2021.pdf

topics, these have been divided into three categories: (a) climate change mitigation, (b) climate change adaptation, and (c) other cross-cutting measures.

The focus is on topics that are *not* already addressed within either the 2017 Local Plan or the Good Design SPD, so the following are excluded from this discussion:

- Passive design measures
- Flood risk and sustainable drainage
- Large-scale renewable energy projects
- Biodiversity and green space

Unless otherwise stated, it is recommended that the future Local Plan and any associated guidance should seek to retain or expand / strengthen the existing wording relating to the topics listed above.

5.2.1 Climate Change Mitigation

Minimising whole life cycle carbon emissions

As discussed in Section 5.1.3, if regulated energy demands in buildings are driven down through more efficient fabric and services, these will represent an increasingly small proportion of the total or 'whole life cycle' carbon emissions of the building. One way of addressing this would be for NWLDC to require applicants to undertake a lifecycle carbon assessment (LCA) or otherwise demonstrate that they have taken steps to minimise these emissions.

LCAs involve a holistic assessment of both operational and non-operational / embodied emissions. LCA is a multi-step procedure through the life stages of a building. In the UK the BS EN 15978:2011[88] standard is typically used to define the different life cycle stages; these are illustrated in the diagram which is replicated from the LETI Embodied Carbon Primer.[89]

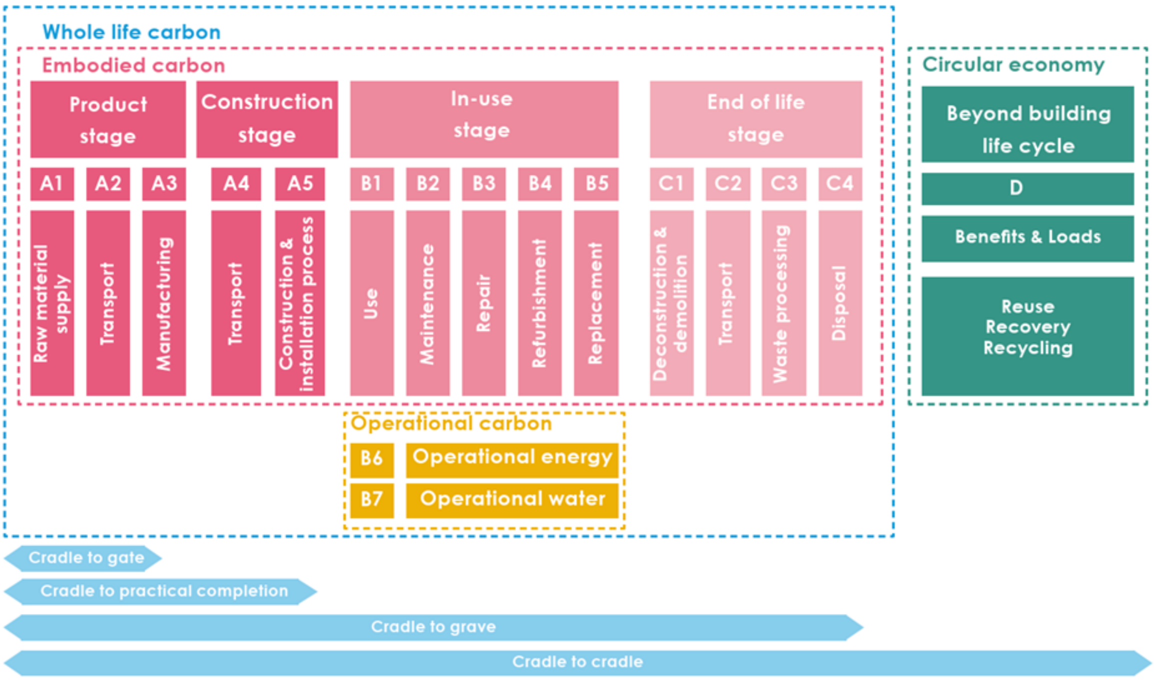


Figure 23. Different stages of the building lifecycle. Source: LETI (2020)

Carrying out a full WLC analysis will incur a significant design team fee which may be prohibitive in the context of minor developments, so this type of policy might be restricted to major developments. However, NWLDC could consider requesting that applicants for minor applications complete a simpler checklist to demonstrate that they have given due consideration to this topic.

[88] BS EN 15978: 2011: Sustainability of construction works - environmental performance of buildings - Calculation method.
[89] LETI, *'Embodied Carbon Primer'* (2020). Available at: https://www.leti.london/ecp

As an example, NWLDC could refer to the template recently produced by the GLA[90] for reporting on measures to reduce whole life carbon emissions. Key concepts discussed within the GLA guidance include:

- **Reuse and retrofit of existing built structures** – "a priority consideration";
- **Use recycled or repurposed materials** – many of the currently available standard products already include a degree of recycled content, but construction firms should ask questions of suppliers.
- **Material selection** – the overall life-time carbon footprint of a product can be as much down to its durability as to what it is made of, e.g. bricks may have a high carbon cost in terms of their manufacture, but have an exceptionally long and durable life expectancy;
- **Local sourcing** - sourcing local materials reduces transport distances and therefore supply chain lengths and has associated local social and economic benefits. Transport type is also highly relevant, e.g. a product transported by ship will have a significantly lower carbon cost per mile than one sent by HGV.
- **Designing for durability and flexibility** – a building designed for flexibility can respond with minimum environmental impact to future changing requirements and a changing climate. For example, new buildings for student accommodation should ideally be able to accommodate other types of residential, and potentially even non-residential, uses in case the need for student accommodation falls in the future.
- **Disassembly and reuse** – designing for future disassembly ensures that products do not become future waste and that they maintain their environmental and economic value.
- **Building life expectancy** – defining building life expectancy gives guidance to project teams as to the most efficient life expectancy choices for materials and products.
- **Minimise operational water use** – carbon emissions from water use are largely due to the materials and systems used for its storage and distribution, the energy required to transfer it around the building and the energy required to treat wastewater.
- **Building shape and form** – compact efficient shapes help minimise both operational and embodied carbon emissions from repair and replacement for a given floor area. This leads to a more efficient building overall, resulting in lower construction and in-use costs.
- **Regenerative design** – removing CO_2 from the atmosphere through materials and systems absorbing it makes a direct contribution to carbon reduction. Examples include unfinished concrete, some carpet products and vegetation.

This could be supported by guidance in an SPD on the common opportunities for reducing whole life carbon emissions, which include, but are not limited to: retention of existing buildings; use of cement substitutes where concrete is being used; use of timber elements in construction; use of materials with high recycled content; and designs that avoid glued and bonded composite materials which in turn facilitate disassembly and re-use of components at end of life.

Futureproofing to facilitate retrofitting LZC technologies

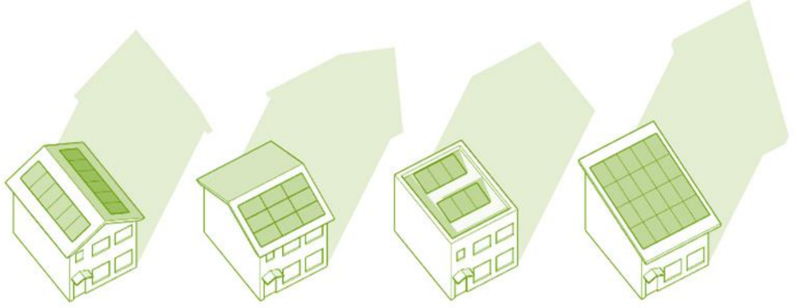
As discussed previously, in order to reach Net Zero emissions, there must be a major increase in the deployment of LZC technologies across the UK. Although this is an issue that is likely to be addressed in part through future changes in UK Building Regulations, in the interim period, it is important to ensure that new developments, along with extensions or refurbishment schemes, maximise opportunities to install such technologies – if not at the outset, then at a future date.

Although some technologies that are not yet widely available could become widespread in future (e.g. hydrogen gas and fuel cells), at the time of writing the key opportunities are likely to include:

- **Maximising opportunities for renewable energy generation** – The amount of electricity generated by PV depends on multiple factors, including annual solar irradiation, panel orientation, tilt and efficiency. Therefore, the design and geometry of a building, and the overall layout of the development, are important factors that determine how much PV can be installed.

[90] GLA, *'WLC Assessment Template'* (2020). Available at: https://www.london.gov.uk/sites/default/files/gla_wlc_assessment_template_may_2020_v.1.0.xlsx

To illustrate this point, the diagram below shows the difference in the amount of PV that could potentially be retrofitted onto buildings with the same footprint, but different roof geometries. The aim is not simply to compare the output of arrays with different orientations, but to highlight how multiple factors including array size, tilt and orientation have a combined impact on how much renewable electricity is generated, thus emphasising the need for sustainable design measures to be considered holistically.



	House 1	House 2	House 3	House 4
Description	Dual pitch	Dual pitch	Flat roof + parapet	Monopitch
Orientation	East/West	South	South	South
Electricity (kWh p.a.)	2,190	1,910	1,150	4,080

Figure 24. Comparison of the electricity generation from PV on houses with different roof shapes

In this example, House 4, which has a south-facing monopitch roof, would be expected to generate roughly three and a half times more electricity per year than House 3, where panels have been installed on a flat roof and arranged in order to avoid being overshadowed by the parapet or adjacent panels.[91]

- **Use of low temperature heating systems that can be more easily replaced with ASHPs** – As stated in the Baseline Report, in the future, the most carbon efficient form of heating is likely to involve heat pumps, which operate most efficiently when used with low-temperature heating systems.[92] Installing radiators and pipework that are compatible with low-temperature heating systems can both reduce the cost of retrofitting a heat pump (because the pipework and radiators can be retained), and in the meantime can potentially improve the performance of a gas boiler (resulting in an increase in boiler efficiency of around 3%). For example, this would likely involve underfloor heating or specifying larger radiators than would be typically used for a traditional gas boiler system.

- **Allowing space for LZC technologies and battery storage** – ASHPs must be placed in an accessible outdoor location adjacent to the property, ideally in the open air (i.e. not within a shed or similar structure). Similarly, the design of new buildings could include space to accommodate battery systems, inverters, and other associated hardware (although it is acknowledged that the spatial requirements are likely to change over time due to technological improvements). Note that the increasing use of electric heating systems, EVs, battery storage and onsite renewable electricity generation would place significant demands on existing power infrastructure which may require upstream reinforcements of the local grid (e.g. increasing the capacity of upstream substations and cabling).

- **Allowing access for maintenance and replacement of heating / cooling systems and other building services** – This issue is more likely to arise in non-domestic buildings with designated plant rooms and ventilation systems. It is important to ensure that the design allows for easy access to all building services (e.g. door dimensions and lift facilities allowing access to plant rooms in the basement or on the roof). Designing to facilitate maintenance can also help to reduce the amount of material needed to maintain a building over its lifespan and facilitate deconstruction.

These measures could be addressed within a future SPD.

Upgrading the existing building stock

Existing buildings account for the majority of CO_2 emissions in the District and therefore represent a key challenge when it comes to reaching the decarbonisation target. The Local Plan and associated guidance should

[91] Based on standard 250W / 1.6 m^2 panels with a maximum annual output of 850 kWh/kWp, shown with a minimum 300mm gap between the panel and roof edge.

[92] This refers to heating systems where the water circulating through the system is at 50°C or below, which is lower than conventional heating systems that normally circulate water at 60-80°C. Building Research Establishment, *'Design of low-temperature domestic heating systems'* (2013). Available at: https://www.brebookshop.com/details.jsp?id=327255

emphasise the importance of carrying out energy efficiency upgrades and incorporating LZC technologies wherever possible, and make it explicitly clear that NWLDC considers this to be a priority.

Opportunities for installing energy efficiency measures in existing buildings will be dependent on the construction build-up. Generally, it is not considered practical for existing buildings to improve insulation levels to match performance of new build standards due to spatial limitations (e.g. insufficient gap in a cavity wall), and practical considerations (e.g. cost or disruption to occupants). There is also a risk of retrofitting measures having unintended consequences, e.g. causing condensation and moisture issues, which may affect the types of measures that can be implemented. Nonetheless, it is always possible to improve the performance of the building *to some extent*, even if this simply means adopting low-cost, no-regret measures such as double or triple glazing, draughtproofing and loft insulation.

Evidence suggests that it is possible to achieve a 10-15% reduction in energy demand in non-domestic buildings via retrofitting, although this is highly case-specific.[93,94,95] For domestic buildings, common cost-effective measures can save around 10-15% on heating bills,[96] whereas 'deep energy retrofits' can save 75-90% or more.[97]

There are existing standards and approaches set out (e.g. BREEAM Domestic Refurbishment, Passivhaus / EnerPHit, or Energiesprong) that are applicable to existing buildings and could therefore be encouraged through planning policy or associated guidance. Although those generally represent best practice, they are often cost-prohibitive for individual property owners, and are unlikely to be widely adopted without significant Government incentives. However, NWLDC could consider requiring these for major refurbishment schemes where planning permission is required.

NWLDC will inherently have less influence over existing buildings than new buildings, but while it may be difficult for the Council to actively promote uptake through its role as a Local Planning Authority, it can passively promote uptake by loosening restrictions on certain energy and CO_2 reduction measures where appropriate. One option would be to adopt a presumption in favour of certain measures such as roof-mounted PV, air source heat pumps and external wall insulation, which could be done e.g. by issuing a Local Development Order (LDO) or otherwise extending permitted development rights, or implementing a 'fast track' that reduces the burden on applicants of submitting a full planning application.

For historic buildings (including but not limited to Listed buildings and those in Conservation areas), it is important to strike a balance between CO_2 reduction and preserving the heritage significance of these assets. Due to the unique nature of these buildings. it is impossible to set a universal energy or CO_2 performance standard that must be achieved, or to define specific measures that must be implemented. NWLDC should nonetheless seek to ensure that the Local Plan and associated guidance make it explicitly clear that sustainability measures are permitted in historic buildings and conservation areas, provided that they are carried out in line with best practice guidance, with consultation from appropriate stakeholders e.g. Historic England. NWLDC could encourage applicants to follow the process set out in the Historic England report, 'How to Improve Energy Efficiency in Historic Buildings' (2018) when identifying suitable intervention measures.

[93] Carbon Trust, *'Building the Future, Today'* (2009). Available at: https://www.ukgbc.org/sites/default/files/Carbon%20Trust%20-%20Building%20the%20Future%20Today.pdf
[94] BEIS, *'Consultation: The Non-Domestic Private Rented Sector Minimum Energy Efficiency Standards'* (2020). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/839362/future-trajectory-non-dom-prs-regulations-consultation.pdf
[95] BBP, *'Real Estate Environmental Benchmark: 2019 Energy Snapshot – Chart 6'* (2020). Available at: https://www.betterbuildingspartnership.co.uk/sites/default/files/media/attachment/BBP_REEB%202019%20Energy%20Snapshot.pdf
[96] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/895139/Domestic_NEED_Methodology.pdf
[97] For example, based on case study evidence from the Passivhaus Trust and Energiesprong programme.

Recommendations

Ensure that any policies relating to existing buildings emphasise the importance of carrying out energy efficiency upgrades.

NWLDC should consider issuing an LDO or extending permitted development rights for measures such as roof-mounted PV, air source heat pumps and external wall insulation to promote uptake.

Because there is a risk of such measures causing unintended consequences, should an SPD be undertaken, it should encourage applicants to undertake a whole-building approach to retrofitting, and in particular to carry out condensation risk analysis if any changes are proposed that would impact either insulation or ventilation levels in the building.

Guidance should emphasise the importance of following the energy hierarchy and, in particular, support a shift away from the use of gas boilers towards the use of low carbon heating systems.

5.2.2 Climate Change Adaptation

Measures to reduce overheating

At a masterplanning level, incorporating areas of green and blue infrastructure into the urban landscape can help to reduce the urban heat island (UHI) effect, in addition to providing attractive routes for pedestrians and cyclists, habitats for a variety of species, and helping to control surface water run-off. Reducing energy use in buildings overall will also reduce the amount of waste heat that is generated and rejected to the local microclimate, which is particularly relevant to urban areas.[98]

At an individual building level, the priority should be to minimise unwanted heat gains before considering alternative cooling strategies.[99] The geometry, orientation and form of buildings can have a significant impact on overheating risk. For example, single aspect units are at higher risk of overheating than other buildings, due to the lack of natural cross-ventilation. It is also important to ensure that, if natural ventilation is to be used to cool a building, this will not compromise its indoor air quality, noise levels, or security. The transition to EVs will be useful in this regard, because EVs are less noisy and have a significantly lower impact on air quality than traditional fuel vehicles, which means people may feel more comfortable opening windows.

In addition to building orientation, glazing area, and glazing specification, external shading devices are among the most effective means of reducing overheating risk.[100] This could also potentially be achieved through the use of balconies, external walkways or corridors and / or locating deciduous trees along the south, east or west facades of buildings. In the public realm, structures that provide shade (such as canopies and bus shelters) can be integrated with solar PV to generate renewable energy, thus serving a dual purpose. Materials that are lighter in colour have higher albedo (sun reflecting properties) and can therefore help to reduce heat absorption and build up.[101]

There are some sustainable design measures that can potentially conflict with measures aimed at reducing overheating and therefore must be given careful consideration. For example:

[98] Although it is difficult to determine the impact this would have on local temperatures in North West Leicestershire, research indicates that switching to Net Zero energy use buildings would reduce average summer UHI magnitude in London by around 15%. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7604/2185850.pdf

[99] For example, the GLA London Plan (Policy 5.9) includes the following 'Cooling Hierarchy':

1 minimise internal heat generation through energy efficient design
2 reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
3 manage the heat within the building through exposed internal thermal mass and high ceilings
4 passive ventilation
5 mechanical ventilation
6 active cooling systems (ensuring they are the lowest carbon options).

For more information, see https://www.london.gov.uk/sites/default/files/energy_assessment_guidance_2018.pdf

[100] Report produced by AECOM on behalf of the Department for Communities and Local Government, *'Investigation into Overheating in Homes: Literature Review'* (2012). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7604/2185850.pdf

[101] More information can be found in the following publications:

- CIBSE *'TM60: Good practice in the design of homes'* (2018)
- CIBSE *'TM52: Limits of thermal comfort – Avoiding overheating in European buildings'* (2013)
- CIBSE *'TM54: Evaluating operational energy performance of buildings at the design stage'* (2013)

- Over the course of a year, there is a trade-off that will occur between reducing solar gains in summer (to minimise overheating) while also maximising solar gains in winter (to minimise heating demand).
- Although materials with a high thermal mass such as concrete, brick or stone can help to reduce fluctuations in temperature, some of these products – concrete in particular – have a high embodied energy and carbon content. This can be minimised, for instance through the use of cement replacements such as ground granulated blast furnace slag (GGBS).

Recommendations

The 2017 Local Plan and Good Design SPD both include text that describes measures to reduce overheating risk. It is recommended that this text is retained. In addition, NWLDC should consider:

- Requiring developments to follow a 'Cooling Hierarchy' that prioritises passive cooling measures. This could be demonstrated e.g. through the Design and Access Statement.
- Encouraging all schemes to consider overheating risk at an early stage, and to undertake a full appraisal if this indicates a high risk of overheating. Major developments should be required to undertake a full overheating risk assessment as standard.

Guidance on minimising overheating risk could be included in a Supplementary Guidance Document.

The Good Homes Alliance (GHA) has produced a free tool that can be used to assess overheating risk at design stage. Applicants could be encouraged to use this. Alternatively, NWLDC could develop an 'Overheating Checklist' for applicants to submit to show that they have followed the Cooling Hierarchy.[102] This would not be expected to have a significant impact on viability as there would be little or no additional cost to the developer. However, in the longer term it would have potentially significant cost benefits to the building owners or occupants in the form of reduced heating bills. Reducing overheating risk would also provide wider social benefits in terms of occupant health and wellbeing. It would also reduce the future energy demand for cooling, minimising pressure on grid infrastructure.

In its response to the Future Homes Standard consultation the Government has set out proposals for requiring modelling of overheating risk in residential properties or for meeting pre-defined parameters for maximum glazing areas and window/shading design characteristics, as part of the proposed 2021 update to Part L of Building Regulations for New Homes.[103]

Improving water efficiency

North West Leicestershire – like much of the nation – is classified as an area with 'moderate' water stress. It is important to conserve water, partly due to the CO_2 emissions associated with its treatment and supply, but also because climate change is expected to affect water availability. This is acknowledged within the adopted 2017 Local Plan, which includes policies and guidance aimed at improving water efficiency. Going forward, those policies could potentially be strengthened to include more specific water use requirements.

Example policy wording could be, for example:

All development proposals should seek to reduce the use of mains water through adoption of water saving measures (e.g. smart meters), fittings and appliances. Refurbishment schemes will be expected to retrofit such measures.

- *Domestic developments should be designed to achieve a maximum of 105 litres per person per day, in line with the Optional Standard of Building Regulations Part G.*
- *Non-domestic developments should be designed to achieve the maximum available credits under BREEAM Wat 01 or an equivalent best practice standard.*

[102] For example, see the GLA Domestic Overheating Checklist in *'Energy Assessment Guidance'* (2020). Available at: https://www.london.gov.uk/sites/default/files/energy_assessment_guidance_2018.pdf
[103] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956094/Government_response_to_Future_Homes_Standard_consultation.pdf

All proposals are required to incorporate rainwater harvesting systems, and should consider utilising alternative sources of water, such as greywater recycling, and (where relevant) water efficient methods of irrigation methods and land use practices.

Where such measures are proposed, the Design and Access Statement should set out how they will be integrated with broader measures such as landscaping designs, SuDS, and the provision of green / blue infrastructure, to reduce demands on the public water supply.

BREEAM (Wat 01) guidance[104] sets out the following requirements that could also be adopted:

> *'Any greywater systems must be specified and installed in compliance with BS8525-1:2010 Greywater Systems - Part 1 Code of Practice. Any rainwater systems must be specified and installed in compliance with BS8515:2009 Rainwater Harvesting Systems - Code of practice.'*

Recommendations

Consider strengthening existing wording related to water efficiency by setting higher (numerical) targets and requiring rainwater collection as standard if a proposed development includes landscaped areas.

5.2.3 Cross-Cutting Issues

Promoting and facilitating sustainable modes of transport

The location and overall layout of the development should ensure that a mix of amenities are within easy walking or cycling distance of peoples' homes, to minimise the amount of travel required. In addition, wherever possible, developments should provide access to a range of public transport options (i.e. bus routes).[105]

The streetscape should provide safe and attractive pedestrian routes that link destinations both within, and between, neighbourhoods or developments. To this effect, it is also important to provide dedicated cycle lanes and bus routes, and consider limiting access for private vehicles in town or city centres. These measures improve safety for cyclists and pedestrians, in addition to offering air quality benefits.

As will be discussed further in Section 7, the shift to electric vehicles will rely on a significant increase in the availability of charging infrastructure, and will put additional pressure on electrical power networks. Therefore, integrating PV technologies into transport infrastructure (for instance, installing solar canopies above car parks) will help to maximise the use of renewable energy for such vehicles. The same principle applies to domestic buildings: new homes should offer the provision for EV charging, which could be linked with rooftop PV and (vehicle-to-grid) battery systems.

Changes in technology can contribute to reducing transport CO_2 emissions via measures that range from facilitating ridesharing and working from home, to smart logistics and traffic management. It is likely that intelligent traffic management systems will increasingly be used to optimise transport flow in ways that could reduce the need for parking spaces and multi-lane roads, although it is difficult to provide a quantitative estimate of the impacts these measures would have.[106]

Recommendations

The adopted Local Plan and SPD both include wording on promoting sustainable modes of transport that should be retained and could also be strengthened. It is recommended that future policy wording and / or supplementary guidance should:

- Emphasise that developments should not only design to accommodate pedestrians and cyclists, but prioritise these measures above private vehicle use, e.g. by restricting the number of parking spaces and / or providing spaces for car club parking.
- Require developments to include EV charging facilities in a portion of parking spaces. They should also provide infrastructure to accommodate additional charging points in the future.

[104] https://www.breeam.com/BREEAM2011SchemeDocument/Content/08_Water/wat01.htm
[105] Campaign for Better Transport, *'Getting there: How sustainable transport can support new development'* (2015)
[106] Department for Transport, *'The Road to Zero: Next steps towards cleaner road transport'* (2018). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

Sustainable material selection

Although there is no set definition of what constitutes 'sustainable sourcing' of materials, the term is commonly used to refer to a process that takes into account issues such as material traceability, health and safety, and environmental management through all stages of the supply chain. This could include consideration of energy, resource and water use, greenhouse gas emissions, and ecotoxicity. Local Authorities should support developments that seek to use materials that are sustainably sourced.

There are a variety of established standards and certification schemes that can be used to demonstrate responsible sourcing, some of which are recognised within the BREEAM or HQM environmental assessment standards (see Section 54). In the UK, the Building Research Establishment (BRE) has developed a *'Framework for Responsible Sourcing'* (BES 6001) which *'provides manufacturers with a means by which their products can be independently assessed and certified as being responsibly sourced'* through appropriate governance and supply chain management.[107] More broadly, organisations can implement environmental management systems (EMS) in line with ISO 14001 standards to demonstrate that they have taken steps to reduce their environmental impacts.

Other certification schemes exist for specific construction products or materials, including timber, aluminium, structural steel, and concrete.[108] For example, with regards to timber products, certification schemes are run by the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC).[109,110]

A range of potential benefits can be obtained by using materials and construction products that are produced near to the construction site. In particular, this can help to provide benefits to the local economy, providing jobs and skills training opportunities. It can also help to reduce the embodied carbon emissions of the development, for example if the material is transported a shorter distance – although distance is only one of many factors affecting the embodied carbon.

An obvious example of sustainable, local sourcing would be to utilise construction materials that have been reclaimed or recycled from existing buildings on or near the proposed development site, provided that these can be processed locally with minimal environmental impact. There are also examples of local reuse organisations that can provide furniture, appliances, and IT equipment. However, in many cases, the most sustainable method of meeting the demand for construction materials will be to avoid the need for them in the first place. This requires a design approach that maximises the retention and reuse of existing buildings and materials.

Recommendations

It is recommended that future policy wording and /or supplementary guidance should state the importance of selecting construction materials that have a low environmental impact, prioritising those that are available onsite or can be locally sourced where possible. (Note that this would inherently form part of any BREEAM or HQM assessment.)

Waste reduction and 'lean design' measures

By reducing the material demands of developments up front ('lean design') and implementing waste reduction measures during construction, it is possible to reduce the embodied carbon and broader environmental impacts of new development, and at the same time minimise the amount of waste that is generated. Although the County Council is responsible for waste planning at a strategic level, NWLDC can help to reduce waste by introducing relevant Local Plan policies and design guidance on these topics.

Designing for flexibility and adaptability, and following 'circular economy' principles, can contribute towards reducing the lifecycle energy demands and CO_2 emissions of buildings, while offering a range of co-benefits for sustainability and human health.

[107] https://www.greenbooklive.com/search/scheme.jsp?id=153
[108] For a list of schemes eligible for BREEAM and HQM credits, see BREEAM, *'Guidance note GN18: Recognised Responsible Sourcing Certification Schemes'* (2020). Available at: https://files.bregroup.com/breeam/GN18_BREEAM-NC_Guidance-Note.pdf
[109] https://www.fsc-uk.org/en-uk/about-fsc
[110] https://www.pefc.org/what-we-do/our-approach/what-is-certification

According to the Ellen MacArthur Foundation:[111]

> *'A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration […] and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.'*

A 'circular economy' therefore stands in contrast to the current 'linear' system of extracting materials, using them, and then throwing them away – which is inherently unsustainable when considering finite natural resources.

Designers should consider ways to minimise the additional material demands and waste produced over the course of a building's lifecycle, by ensuring that buildings are easy to adapt, repurpose, and deconstruct. In addition to the environmental benefits, this can result in social benefits (e.g. making it easier for families to reconfigure their living spaces over time, or making it easier for changes in use of commercial properties) and associated cost savings.[112]

Recommendations

It is recommended that future policy wording and /or supplementary guidance should:

- Encourage developers to undertake independent pre-demolition audits to identify opportunities for reusing or recycling any existing materials, either onsite or offsite.

[111] Ellen MacArthur Foundation, *'Towards the Circular Economy: Volume 1'* (2013). Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

[112] David Cheshire, *'Building Revolutions: Applying the Circular Economy in the Built Environment'* (RIBA Publishing, 2016)

6 Carbon Offset Fund

This section of the report describes the potential to establish a carbon offset fund for North West Leicestershire. It includes an overview of best practices in carbon offsetting, describes the types of projects that could be undertaken and their typical costs, and then presents a rough estimate of the scale of fund that might be generated from implementing a Net Zero target for all new development in the District. Then, it describes some of the practical implications and policy context that should be considered by NWLDC when setting up such a fund..

6.1 What is Carbon Offsetting?

6.1.1 Definition

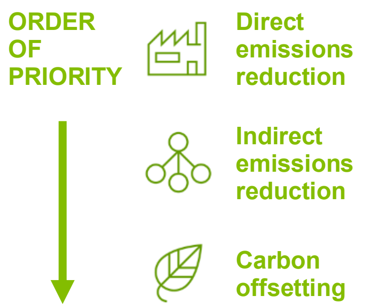
'Carbon offsetting' refers to compensating for carbon dioxide (CO_2) or other greenhouse gas (GHG) emissions in one area by taking actions that reduce emissions elsewhere. In the words of the Carbon Trust: [113]

> *"Carbon offsets are generated from projects that avoid or absorb/sequester carbon dioxide, or any of the other main greenhouse gases […] These projects can take various forms, including renewable power, energy efficiency, fuel switching [e.g. from natural gas to electricity], reforestation, or destruction of greenhouse gases."*

The key benefit of carbon offsetting is that it provides an opportunity to reduce the global warming impacts of human activities that would otherwise be difficult to abate, such as CO_2 emissions from aviation or methane (CH_4) emissions from livestock. For this reason, carbon offsetting is recognised as an important step towards delivering the UK's target of achieving Net Zero emissions by 2050.[114]

6.1.2 Best Practices in Carbon Offsetting

Although carbon offsetting can be beneficial where these funds are used for energy efficiency and carbon reduction projects that are actually delivered, and where the savings can be proven, the practice has also been criticised for diverting resources away from projects or measures that avoid carbon emissions in the first place, such as demand reduction.



When developing a strategy for carbon offsetting, the most important guiding principle is that **it should be a last resort where other opportunities for reducing direct and indirect CO_2 emissions have been prioritised**. This hierarchy, illustrated in the diagram to the right, is crucial for developing a cost effective, socially responsible and robust carbon management plan.[115]

With that in mind, any carbon offsetting strategy should adhere to the following best practice principles, which are based on guidance from the Carbon Trust and the International Carbon Reduction and Offset Alliance (IOCA).[113,116] Carbon offsetting projects should be:

- *Additional* – To qualify as an offset, the reductions achieved by a project need to be additional to what would have happened in the absence of the project.
- *Permanent* – The offset should have a lasting, permanent effect.
- *Real* – The offset must be possible to implement and the impact of the offset quantifiable.
- *Verifiable* – In order to provide assurance on the quality and credibility of the offsetting project, ideally the project should be verified through a viable standard or offsetting scheme.

---

[113] Carbon Trust, *'The Carbon Trust three stage approach to developing a robust offsetting strategy'* (2006). Available at: https://www.carbontrust.com/resources/developing-a-robust-carbon-offsetting-strategy
[114] Committee on Climate Change, *'Net Zero – The UK's contribution to stopping global warming'* (2019). Available at: https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/ Note a difference in terminology: the CCC report describes biological solutions in the section on 'reducing emissions in the land use sector' and technological solutions as 'greenhouse gas removal' or GGR, rather than 'carbon offsetting'.
[115] Adapted from *'Figure 1: The Carbon Trust three stage approach to developing a robust carbon management strategy'* (2006).
[116] International Caron Reduction & Offset Alliance, *'Code of Best Practices for the Carbon Market'* (2008). Available at: https://www.icroa.org/The-ICROA-Code-of-Best-Practice

- *Traceable* – The offset must be transparent and provide proof of the offset through monitoring and regular reporting, ensuring traceable progress and commitment to offsetting best practices.
- *Designed to minimise leakage* – The project must be designed to ensure that there are no increases in emissions beyond the project boundary attributable to the project activity, a phenomenon known as 'leakage'.

Although the primary focus is on reducing emissions, where possible, projects should maximise co-benefits that address broader sustainable development goals. Examples include but are not limited to: Improving air quality and biodiversity, reducing fuel poverty, and supporting the local economy through jobs and investment.

6.1.3 Rationale for Establishing a Carbon Offset Fund

Depending on the type of development in question, it may not be feasible to deliver the requisite level of CO_2 emissions reduction onsite. In this instance, some jurisdictions allow developers to make a financial contribution towards a carbon offset fund. The money can then be used to pay for interventions off site that would result in an equivalent amount of CO_2 being avoided (e.g. through energy efficiency measures or LZC projects) or removed from the atmosphere (e.g. through afforestation).

For example, the Greater London Authority (GLA) requires all new domestic developments to achieve a CO_2 saving of 100% compared with the CO_2 emission standards set out in Part L (2013) of the Building Regulations. A minimum 35% saving must be achieved through onsite measures, while the remainder can be offset via a financial settlement known as a Carbon Offset Payment. Payments to the GLA are currently based on a carbon price of £60 per tonne of CO_2[117] over thirty years. The soon to be adopted draft new London Plan will increase this to £95 per tonne of CO_2 over thirty years. All payments need to be completed prior to occupancy. The fund itself is ringfenced and can only be used for the purposes of funding carbon offset projects elsewhere in the respective borough.

6.2 Opportunities for NWLDC

6.2.1 Potential Carbon Offsetting Projects

There are a wide range of potential projects that a carbon offsetting fund could support. These could include:

- Energy efficiency measures in the local building stock;
- Projects that help to shift towards the use of sustainable transport;
- Local renewable energy projects; and
- Tree planting and other forms of land management to promote carbon sequestration.

NWLDC would need to ensure that any projects align with defined carbon reduction priorities for the District and develop suitable project evaluation criteria that account for e.g. carbon cost effectiveness (£/t CO_2), co-benefits, and so on.

[117] GLA, *'Carbon Offset Funds: Guidance for London's Local Planning Authorities'* (2018). Available at: https://www.london.gov.uk/sites/default/files/carbon_offsett_funds_guidance_2018.pdf

Figure 25. Tree saplings in protective sleeves planted as part of a new woodland.

Projects should be carried out locally where possible, and there may be an opportunity to deliver some of them on Council-owned land or buildings (such as roof-mounted PV or tree planting). Other public-sector buildings and land, such as schools and hospitals, could also be used.

For context, Table 11 below shows indicative costs for a range of domestic energy efficiency measures and projects that could be carried out using carbon offsetting funds.[118] It also shows typical carbon savings (based on estimates provided in the reference documents) per typical dwelling. Note that costs and carbon savings depend on the project in question, and carbon savings also vary over time depending on factors such as electricity grid decarbonisation, so these figures are compiled from a number of sources and are provided for information only.

Table 11. Indicative costs of domestic energy efficiency retrofitting measures and LZC installations

	Installation cost (£)	Annual carbon savings ($kgCO_2$)	Lifetime of installation (years)	Lifetime carbon savings (tCO_2)	Lifetime cost of carbon (£/tCO_2)	Ref.
Individual measures						
Cavity wall insulation	£595	577	42	24	£25	[a]
	£345-£610	335-1,150	-	-	-	[b]
Internal solid wall insulation	£5,300	1,187	36	43	£124	[a]
	£7,400	510-1,720	-	-	-	[b]
External solid wall insulation	£8,100	1,187	36	43	£190	[a]
	£13,000	510-1,720	-	-	-	[b]
Loft insulation	£300	108	42	5	£66	[a]
Loft insulation (add 270mm insulation to uninsulated loft)	£285-£395	550-1,030	-	-	-	[b]
Loft insulation (top up from 120mm to 270mm insulation)	£230-£290	50-95	-	-	-	[b]
Double glazing	£4,500	492	20	10	£457	[a]
Flat roof insulation	£1,050	594	20	12	£88	[a]
Floor insulation	£520-£1,300	120-310	-	-	-	[b]
Draughtproofing	£100	140	10	1	£71	[a]
	£200	-	-	-	-	[b]
Whole house refurbishment (see notes below)	£6,895-£14,400	1,215	30	36	£269	[a]
Whole house refurbishment (Energiesprong standard)	£35,000-£75,000	-	30	-	-	[c]
Whole house refurbishment (CCC, 2019)	£16,000-£25,000	-	30	-	-	[d]
Whole house refurbishment (EnerPHit case study)	Approx. £39,000	-	30	-	-	[e]
Renewable energy technologies						
1MW wind turbine	£1,000,000	317,355	25	7,934	£126	[f]
1MW ground-mounted PV	£600,000	117,283	25	2,932	£205	[f]
1MW roof-mounted PV	£1,000,000	117,283	25	2,932	£341	[g]
Domestic solar water heating (approx. 3kW)	£4,615	289	20	6	£798	[a]

References

[a] AECOM, *'London Carbon Offset Price'* (2017). Figures are based on the Green Deal impact assessment carried out by the Department of Energy and Climate Change in 2012. In this instance, 'Whole house refurbishment' includes wall, loft and floor insulation, new double glazing, doors and draughtproofing.

[b] Energy Saving Trust estimate 2020. Available at: https://energysavingtrust.org.uk/

[c] Green Alliance, *'Reinventing Retrofit: How to scale up home energy efficiency in the UK'* (2019)

[d] Committee on Climate Change, *'Costs and benefits of tighter standards for new buildings'* (2019)

[e] Based on a case study reported by Passivhaus Trust, *'UK's first pre-certified step-by-step EnerPHit'* (2018)

[118] AECOM, *'London Carbon Offset Price'* (2017). Available at: https://www.london.gov.uk/sites/default/files/london_carbon_offset_price_-_aecom_.pdf

[f] AECOM estimate 2020
[g] BEIS, *'MCS Installation Database - Small scale solar PV cost data'* (2019)

6.2.2 Potential Scale of the Carbon Offset Fund

Based on the new development figures provided by NWLDC, it is possible to make a rough estimate of the scale of carbon offset fund that could be generated annually via developer payments. In this illustrative example, key assumptions are as follows:

- It is assumed that North West Leicestershire will set a target of Net Zero regulated emissions for all new developments, recognising that the Council has voted to declare a Climate Emergency. The calculation assumes that 100% of new dwellings are required to meet the Net Zero target, i.e. there is no size threshold for the scale of development that the policy applies to.

- The annual, regulated CO_2 emissions for a new home built to Part L 2013 standards are assumed to be 1.78 tCO_2 per year per dwelling, based on analysis of Energy Performance Certificate (EPC) data for all new buildings completed in North West Leicestershire since 2013.[119] In addition, to reflect potential future changes in Building Regulations, figures are provided for the improved standards outlined in the FHS Consultation:

    - Option 1: 20% improvement on Part L 2013 → 1.43 t CO_2 per dwelling per year
    - Option 2: 31% improvement on Part L 2013 → 1.23 t CO_2 per dwelling per year

- The cost of carbon is set at £60/tCO_2, which is based on the carbon offsetting requirements of the Greater London Authority (GLA). (Whilst there are other examples where Local Authorities have set up a carbon offset fund, for example Milton Keynes Council, the one covering London is the most ambitious.) In practice, NWLDC could choose to set a higher carbon price; for example, as noted above the draft new London Plan suggests a price of £95/tCO_2.

- The cost is calculated over a 30-year period, so the total cost paid by the developer is £1,800/tCO_2, assuming £60/tCO_2.

- The number of new dwellings constructed per year is based on typical annual figures set out in the housing trajectory for North West Leicestershire (dated 9th October 2020), although **it is recognised that this figure is uncertain and subject to change**. The calculation shown below is therefore only an example.

The table below shows the amount of regulated CO_2 that each new dwelling would be expected to produce, *after* taking into account onsite energy efficiency and CO_2 saving measures. Then, it shows the amount of money that developers would need to pay in order to offset those residual CO_2 emissions – in other words, the size of the resulting illustrative carbon offset fund.

Table 12. Estimated annual carbon offset fund that could be generated from a Net Zero regulated CO_2 emissions target

Assumption	Units	Average Regulated CO_2 per dwelling (Part L 2013)	Average Regulated CO_2 per dwelling (FHS Option 1)	Average Regulated CO_2 per dwelling (FHS Option 2)
CO_2 emissions	tCO_2 / dwelling per year	1.78	1.43	1.23
Cost of carbon	£/ tCO_2	£60	£60	£60
Number of years	years	30	30	30
CO_2 offset generated	£ / dwelling	£3,204	£2,574	£2,214
Annual number of new dwellings	# of new dwellings	600	600	600
Total offset fund	**£ per year**	**£1,927,322**	**£1,541,858**	**£1,329,852**

Note that these payments into the carbon offset fund would be expected to occur in all years for which new development continues to be come forward as illustrated here.

[119] Ministry of Housing, Communities & Local Government, *'Live EPC statistics: Table NB3 - Floor Area, Size, Energy Use, Carbon Dioxide Emissions and Fuel Costs of New Dwellings'* (2020). Available at: https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates

Overall, this calculation suggests that the carbon offset fund could generate £1-2 million per year depending on development rates and how the policy is applied. This figure is purely illustrative; in this example, the scale of the carbon offset fund is directly proportional to the number of new dwellings that are delivered in a given year.

6.3 Practical Considerations

Some key practical considerations are set out below. For more details about how to set up a carbon offsetting fund, refer to *'Carbon Offset Funds: Guidance for London's Local Planning Authorities'* (2018) which was produced by the Greater London Authority but is also relevant to other locations.[120]

Setting targets

The requirement for developers to contribute towards a carbon offsetting fund would arise from a carbon reduction target set in a future Local Plan policy. Some key considerations would therefore include:

- What level of carbon reduction is required? – For example, the GLA requires domestic developments to achieve at least a 35% carbon reduction onsite and offset the remainder up to 100% (i.e. achieving Net Zero). More typically, Local Authorities tend to set 10-20% carbon reduction targets.
- Which developments does this apply to? – The target could apply to all developments or only certain types, e.g. major developments or those in certain strategic locations.
- What is the scope of the carbon offsetting calculation? – Will this refer to regulated emissions only, or total emissions? Will it be based on design stage predictions or operational energy use?

These issues would need to be tested through the Local Plan viability and consultation process.

Deciding how to administer the fund

Carbon offset funds can either be administered through Section 106 processes or set up as a separate fund. It is recommended that existing processes should be used if possible, to avoid a situation where some of the fund is needed for administration, enforcement and monitoring.

Setting a carbon price

Guidance produced by the GLA states that Local Planning Authorities (LPAs) *'should develop and publish a price for offsetting carbon based on either (a) a nationally recognised carbon pricing mechanism or (b) the cost of offsetting carbon emissions across the LPA.'* A range of examples and guidance are provided in the GLA document, but the most commonly cited figure is £60/tCO_2

Identifying suitable projects

Many Local Authorities begin by undertaking projects on their own housing stock or other Council-owned buildings. For energy efficiency retrofitting and associated projects, the Council may wish to begin by identifying properties that would benefit based on a variety of factors such as the type and age of buildings, along with neighbourhood and household characteristics. This could link with existing projects, for instance those aimed at reducing fuel poverty. For renewable energy or tree planting projects, NWLDC could begin by assessing its current landholdings and their uses to see whether there are any locations where these projects could be delivered, provided that this is done in line with the best practice principles outlined above.

Note: Impact of the 'Planning for the Future' White Paper (2020)

As stated in Section 2.2.7, the Government recently proposed that the current system of S106 contributions and the Community Infrastructure Levy be replaced with a nationally standardised, flat-rate infrastructure levy. Since carbon offset contributions are typically secured through S106 arrangements, this could impact Local Authorities' ability to use carbon offsetting funds. However, at the time of writing, the outcome of the consultation is unknown.

[120] Available at: https://www.london.gov.uk/sites/default/files/carbon_offsett_funds_guidance_2018.pdf

7 Electric Vehicle Infrastructure Provision

7.1 Future Trends in Transportation

7.1.1 Overview

To reach net zero emissions in transport, petrol and diesel vehicles will have to be phased out entirely by 2050 at the latest, being replaced mostly by ULEVs. Figure 26 shows an illustrative scenario to achieving zero emission transport, which is based on the National Grid Future Energy Scenarios (FES). If the trends in North West Leicestershire mirror the FES nation-wide trends estimates, then by 2029, electric and hydrogen fuelled vehicles would make up around a quarter of all vehicles, by 2033 they would make up over half of all vehicles and by 2036 they would make up over three quarters of all vehicles in the District.

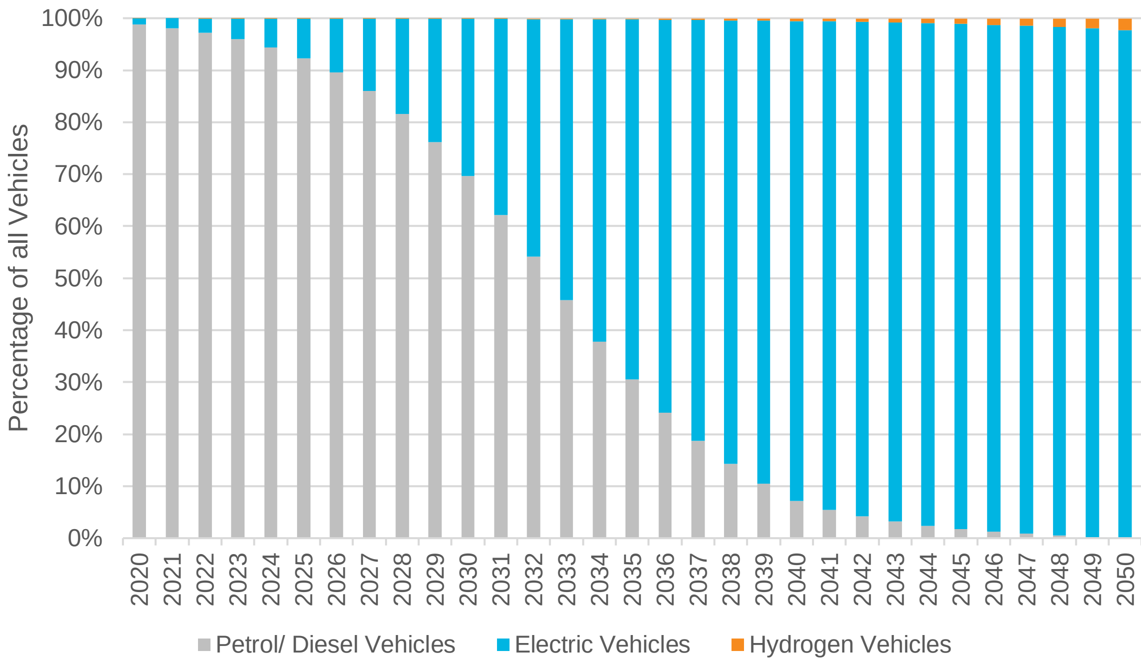


Figure 26. Vehicle Fuel Sources 2020-2050 (National Grid FES: 'Community Renewables')

7.1.2 Implications for North West Leicestershire

Table 13 shows the implications of this change for North West Leicestershire in terms of the number of vehicles that use traditional fuels (petrol or diesel) compared with electric or hydrogen fuelled vehicles. To be on track to match these figures, the number of ULEVs in North West Leicestershire would have to be over 15 times higher than current levels within 5 years.

Table 13. Illustrative trajectory showing changes in vehicle fuel sources from 2019 to 2050 based on the National Grid Future Energy Scenarios

Year	Petrol/ Diesel Vehicles	Electric Vehicles	Hydrogen Vehicles
2019	74,259	341	0
2020	73,686	910	4
2025	68,842	5,737	22
2030	51,792	22,738	69
2035	22,702	51,709	189
2040	5,808	68,405	387
2045	1,610	72,185	805
2050	0	72,837	1,763

By way of illustrating the challenge, Figure 27 compares the historical growth in ULEVs in North West Leicestershire from 2011 to Q3 2019 against two potential scenarios for growth through the year 2025:

a) Uptake increases linearly in line with the trends in the past three years (blue); and

b) Uptake increases in line with the Future Energy Scenarios as described in Figure 26 (green).

This highlights that, in order for North West Leicestershire to be on track to reaching net-zero transport emissions by 2050, the uptake rates will need to increase dramatically. (Note that these projections do not account for the increase in vehicle use due to any future development in the area.)

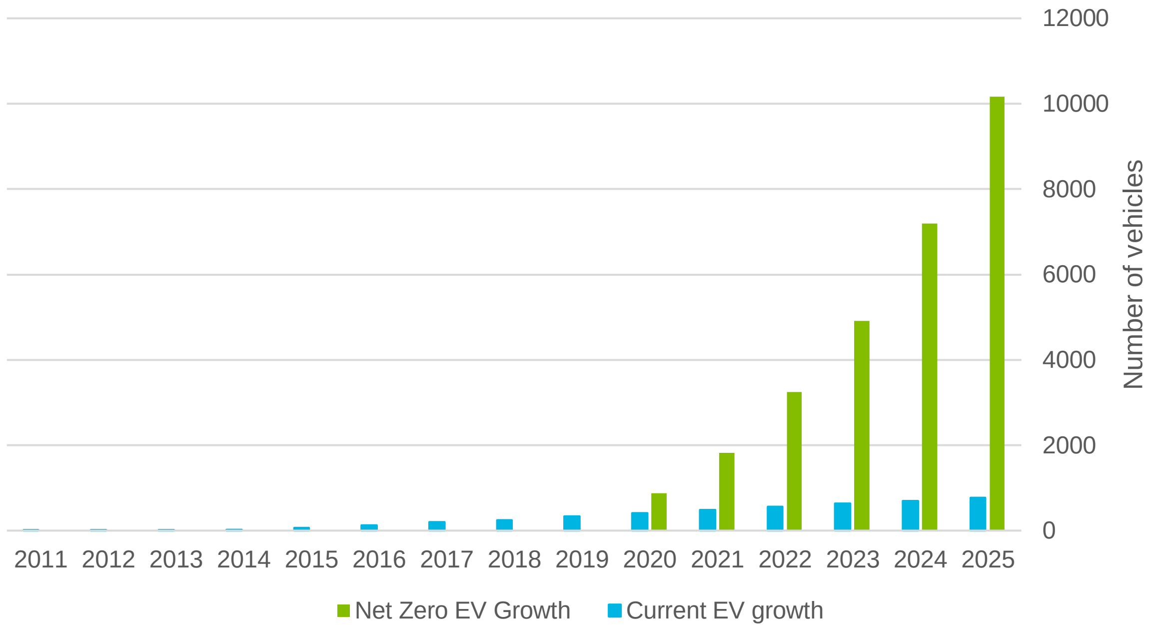


Figure 27. Current EV Growth vs. Net Zero EV Growth, 2011-2025 – North West Leicestershire

Although it is expected to be a significant challenge to reach these growth rates, the Government has confirmed that new cars running on conventional fuels (i.e. petrol and diesel) will be banned from 2035 at the latest (with the date potentially being brought forward to 2032 or earlier, as noted in Section 2.2.5). This is expected to support the ULEV market and accelerate the switch away from conventionally-fuelled vehicles.

Furthermore, and potentially as an indirect effect of the legislation described above, it is estimated that the price of electric, hybrid and traditional fuel cars could converge within the next decade.[121] This would be expected to further facilitate the shift, but this will need to be supported by robust policy and infrastructure reinforcements provided at a local level.

A large-scale shift to the use of electric vehicles must also be accompanied by a significant modal shift towards walking, cycling, ridesharing, and an increase in the use of public transport. This is necessary to reduce electricity demand – with added benefits in terms of air quality and, potentially, improving public health.

Figure 26 illustrates the potential change in transport fuel consumption from now to 2050, assuming that the trajectory for North West Leicestershire matches that of the nation as a whole, as set out in the National Grid FES. (In reality this would vary across different regions, but this is used to illustrate the wider trends that might be seen). 2017 fuel consumption figures are taken from actual statistics for North West Leicestershire (see Section 3.1) and projections are based on the National Grid 'Consumer Transformation' FES.

In this scenario, which assumes that the UK meets the net zero target by that time, the use of petrol and diesel is phased out by 2050, by which point the majority of transport fuel is electricity while the remainder is from low carbon hydrogen gas. In the interim period, a small amount of natural gas is also used to displace petrol and diesel in some circumstances (e.g. in HGVs).

[121] Cambridge Econometrics and Element Energy, *'Fuelling Europe's Future: How the transition from oil strengthens the economy'* (2018). Available at: https://europeanclimate.org/wp-content/uploads/2018/02/FEF_transition.pdf

Note: The significant decrease in overall road fuel consumption is predominantly attributed to the higher efficiency of ULEVs compared with traditional combustion engines.

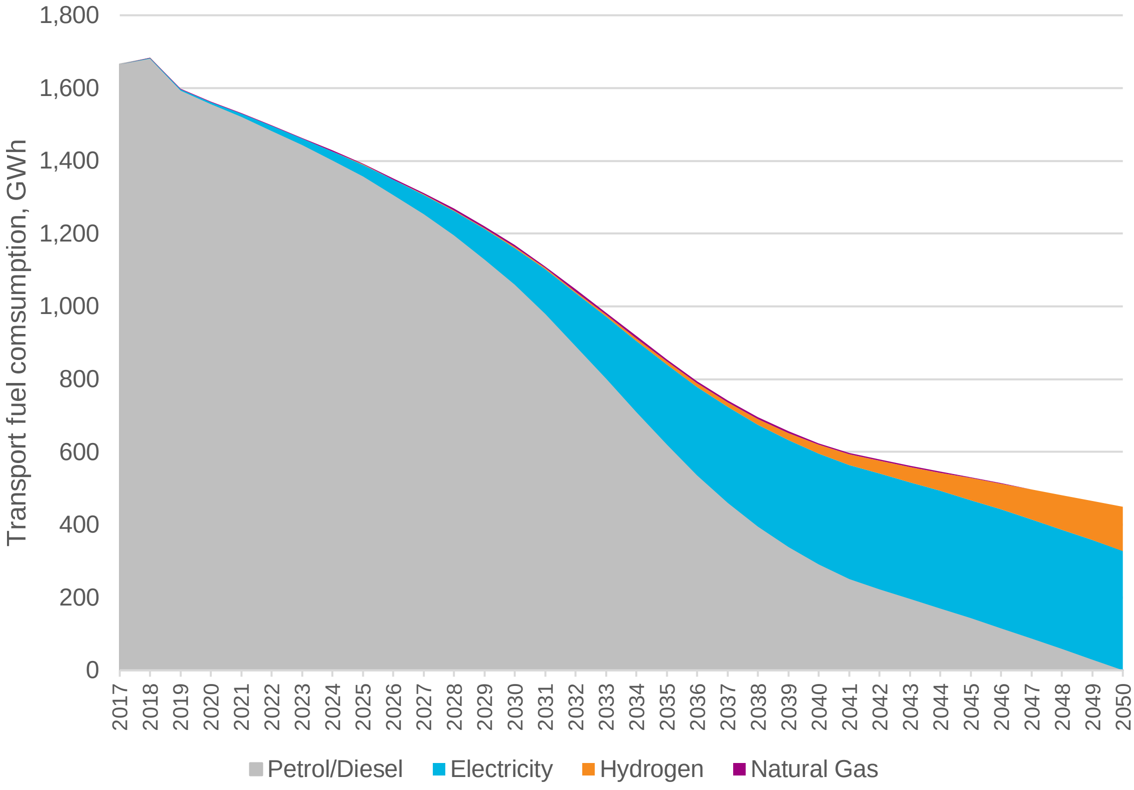


Figure 28. Potential changes in transport fuel consumption based on the National Grid FES

Below, Figure 29, extracted from the FES 2020 report, shows the impact this change, along with the broader shift to electrification, could have on peak electricity demands. In the shorter term (around 5 years) peak demands are expected to decrease slightly due to greater efficiencies. However, by 2050, peak electricity demands could increase by 30-60%. Again, this would vary depending on the geography in question, but it provides an indication of the scale of change that North West Leicestershire might face.

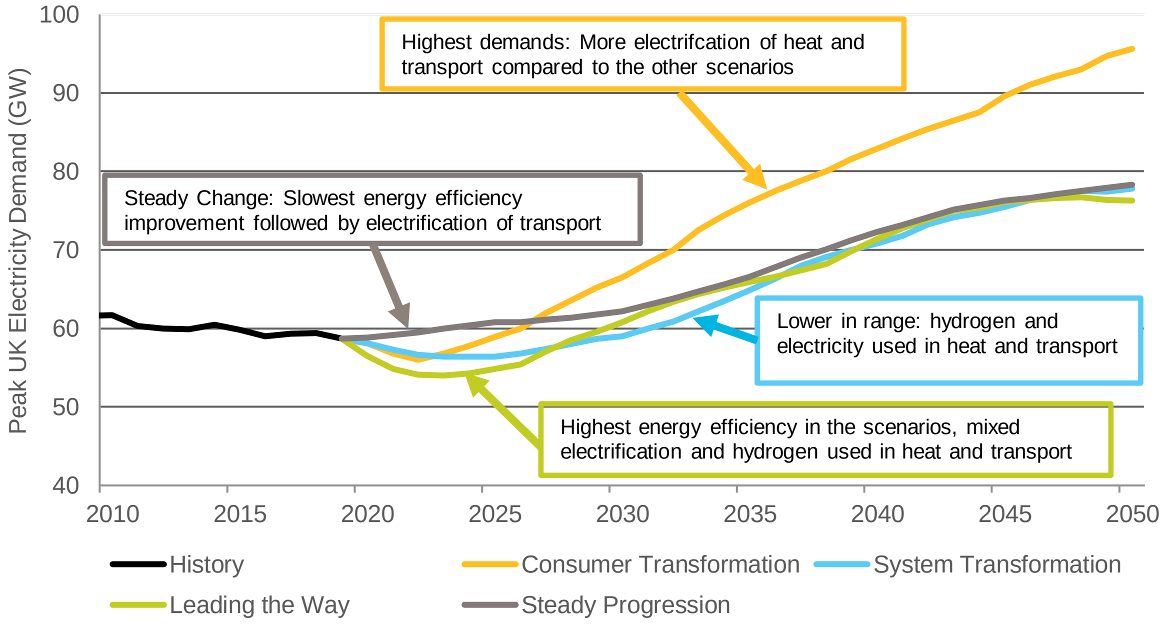


Figure 29. **FES peak** UK electricity **demand increase projection. Source: National Grid FES, Figure SV4**

7.2 Opportunities & Constraints Relevant to the Adoption of ULEVs

7.2.1 Electric Vehicles

Traditionally-fuelled vehicles have relied on a well-established network of filling stations, which in 2019 numbered 8,385 across the UK.[122] This number is down from 13,107 in 2000, and there continues to be a year on year decline, albeit the pace of decline has slowed in recent years. By contrast, as of October 2020 there are over 20,000 public charge points for EVs across the UK despite the number of conventionally-fuelled vehicles outnumbering electric vehicles by more than 100:1. These numbers illustrate how the two vehicle technologies require different strategies for 'refilling'. Below, Figure 30 shows the increase in the number of EV charge points.

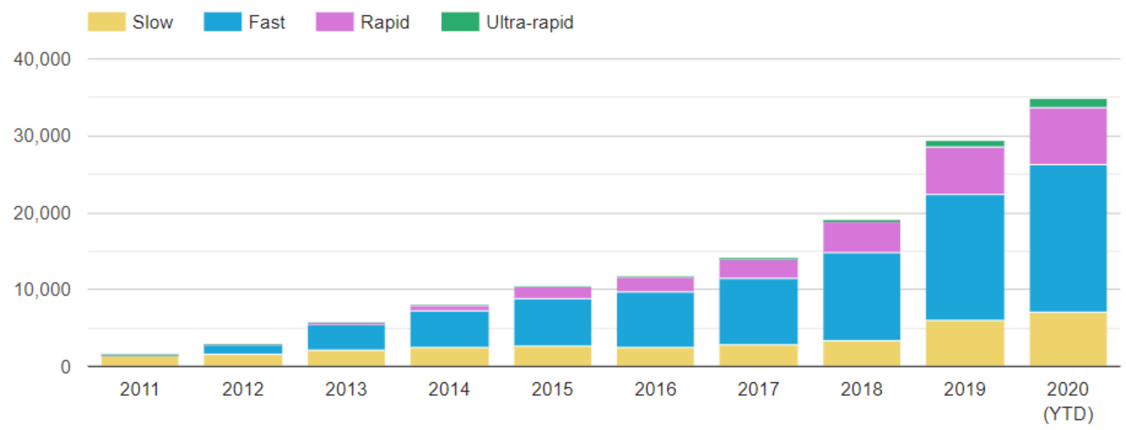


Figure 30. Number of public charging points in the UK by charge rate (2011-to date). Source: Zap-Map

While there are often several fuel pumps at conventional filling stations, the throughput of vehicles for each pump is high; the time required to fill up with fuel, complete payment, and vacate the fuel pump can typically be as fast as five minutes or even less. The fuel taken on board can then last several hundred miles, depending on the vehicle. This means that the range achieved for the amount of time required to 'acquire' that range (i.e. to fill up with fuel), is very high. This is because of the very high energy density of fossil fuels, and the liquid nature of petroleum products, which allows it to be pumped at high volumetric flowrates. These characteristics, in addition to the need to store petroleum in a safe, centralised place where fuel can be delivered frequently, have led to the development of a highly consolidated network of enabling infrastructure.

By contrast, electric charge points require more time to recharge the vehicle battery; depending on the charge point type and the size of the battery, these can take upwards of an hour for rapid charge points, and twelve hours or more for slow or trickle charge points. This means that owners' behaviours are changing the way that electric vehicles utilise charge points, compared to the way petrol/diesel cars are filled up traditionally.

The RAC Foundation has described[123] a future where EV charging infrastructure incorporates a range of charging facilities aimed at different charging needs and habits. It describes a public Charge Point Network (CPN) which facilitates two types of charging behaviour:

- **Journey charging** – this is where the driver's primary purpose for being at the charge point is to charge the vehicle. Charge points therefore need to be able to deliver rapid bursts of charge in a short space of time to ensure that the vehicle's 'dwell time' is minimised – this is important in order to ensure that both the delivered charge is of a meaningful quantity, and the throughput of vehicles is maximised (thereby reducing the risks of unwanted queueing at the facility).

- **Grazing charging** – this is where the driver's reason for being at the charge point is primarily for a purpose other than for charging (e.g. at work, a supermarket, or restaurant). The use of charge points for this purpose will be driven by the driver's existing routine and the length of time the vehicle is parked for their primary purpose. Charge points for this type of behaviour do not need to be able to deliver rapid bursts of

[122] https://www.statista.com/statistics/312331/number-of-petrol-stations-in-the-united-kingdom-uk/
[123] RAC Foundation, *Development of the UK Public Charge point Network*, December 2018. Available at: https://www.racfoundation.org/wp-content/uploads/Development_of_the_UK_CPN_Harold_Dermott_December_2018.pdf

charge, since the 'dwell time' for these vehicles is longer and charging does not necessarily need to result in a full charge.

Charging infrastructure is also expected to be required at the home and at workplaces in order to ensure a smooth transition to electric vehicles. Chargers that deliver a slow trickle of charge are expected to dominate the home charger market due to the increased available plug-in time at home and reduced electrical infrastructure upgrade requirements for these types of chargers.

The above concept illustrates a highly decentralised approach to charging infrastructure for EVs. The constraints associated with providing these charge facilities are therefore different to those which have governed where conventional filling stations were located in the past. For home and workplace charging facilities, these will mostly be determined by the availability of space for charging units and associated parking spaces, in addition to the incoming electrical supply capacity.

For public facilities, additional constraints will need to be considered. For those facilities which are aimed at journey charging, they are likely to be sited in dedicated charge hubs, where rapid or ultra-rapid chargers deliver significant amounts of charge in a short space of time. They are therefore likely to experience a relatively fast throughput of customers, meaning that the sites' access and egress provisions, their location in relation to and connectedness with the wider road network, and their impact on existing urban traffic patterns and capacity, will be key considerations in determining suitable locations. They may also place significant additional loads on the local electrical distribution networks; for example, a hub of six ultra-rapid chargers, where each charger is capable of delivering 150 kW of charge, will result in an additional electrical load of nearly 1 MW on the surrounding grid, should all chargers be in use simultaneously. This is a significant additional load, which may require upstream reinforcements of the local grid infrastructure (e.g. increasing the capacity of upstream substations and cabling). This may result in significant extra capital costs associated with grid reinforcements which should be carefully considered when determining the location for charge point hubs.

The Distribution Network Operator (DNO) in the region, Western Power Distribution (WPD) has developed an EV strategy which outlines how they aim to facilitate the uptake of EV charging infrastructure[124]. This document identifies the approximate connection cost and lead time associated with the connection of varying types of EV chargers.

Examples of where journey charging facilities are likely to be located include at nodes of transport interchange, such as at bus / coach stations or taxi ranks. The latter will likely see a consistent and high throughput of vehicles that require a short burst of charge in between picking up customers. They may also likely be installed at or near existing petrol/diesel filling stations.

In contrast, those facilities aimed at grazing charging behaviour are likely to be much more widely distributed. For example, supermarkets and other major retail outlets, to which a large proportion of customers typically drive, are expected to be prime locations for installing fast charging facilities. These destinations typically see customers' vehicles being parked for a significant length of time (an hour or more), and the substantial provision of such charge points would therefore encourage grazing charging behaviour. Leisure facilities, such as sports centres, cinemas, restaurants and museums, would also be suitable locations for the installation of fast charge points aimed at grazing charging.

For public-facing facilities which are aimed at journey or grazing charging, there are opportunities to integrate and pair charging facilities with renewable energy and/or battery systems. Solar canopy arrays at car parks for example (see Figure 31) represent a well-aligned opportunity to maximise the use of solar power for the purpose of charging EVs. The generation profile of the solar installation will likely match the demand profile (i.e. highest occupation during the day when solar generation is at its peak) which reduces the demand on the distribution system and increases the penetration of renewable energy in the system. Were large-scale battery systems to be deployed on the same site, they would enable the storage of any excess energy for which there is insufficient real-time demand for later use by EV charge points. They may also be used to manage the loading of the electrical supply system to maximise utilisation and reduce network infrastructure upgrade requirements. In their EV strategy document, WPD has a targeted commitment for 2020 to develop an infrastructure solution for public charging hub type installations.

[124] WPD EV Strategy, March 2019: https://www.westernpower.co.uk/downloads-view/29293

Figure 31. Solar car park. Source: BRE, *'Solar Car Parks: A Guide for Owners and Developers'* (2016)

Smart chargers can facilitate an optimised investment in electricity supply infrastructure. They enable the rate of charge to be controlled such that the electrical infrastructure's utilisation is maximised and not overloaded. The implementation of chargers offering variable rates need to be carefully managed to align with the customer's expectations of what charge rate they will receive when they plug in. This could be managed by varying price-points for different charge rates or offering a range of rates when the customer opts to use the unit.

As WPD is actively participating in the transition to EVs, engagement with them is recommended to gain their support and learn from the trials and existing installations they have implemented. Engagement with WPD is also recommended in order to gain understanding of where capacity exists on the network, and what plans WPD have for expanding capacity in the future.

It is also recommended that the Council note the activities and emerging best practice, data, insight papers and guidance that is being developed by the EV Energy Taskforce. The Taskforce[125] comprises key stakeholders and actors in the UK EV industry, who have come together in anticipation of growth in the use of electric and plug-in vehicles. The Taskforce aims to *'bring together the energy and automotive industries to plan for the changes that will take place as a result of rising EV use'*.

Whilst the current focus for the EV industry is the transition to vehicles which require recharging at dedicated facilities, it is possible that other solutions may come to the fore in the future. These could potentially include the development of a network of battery 'swap shops', at which drivers would exchange their empty batteries for fully-charged ones, which would then be easily slotted into vehicles. While this would address many of the infrastructure-related challenges associated with providing a highly decentralised charging infrastructure network, there would be different and significant barriers which the industry would need to address were this approach to be adopted.

It is unknown whether and to what extent this, or any other EV design solutions, will be adopted in the future. However, it is recommended that NWLDC maintain dialogue with key market participants (e.g. WPD, and the Government's Office for Low Emission Vehicles) in order to ensure that policy and efforts to support this transition are aligned with market developments.

[125] https://es.catapult.org.uk/impact/specialisms/ev-energy-taskforce/

7.2.2 Hydrogen-Fuelled Vehicles

A potential alternative to EVs is the development of a hydrogen-fuelled vehicle industry. Hydrogen potentially has an important role to play in decarbonising the transportation sector, while it also assists with progress against other key environmental priorities, such as improving local air quality.

Hydrogen vehicles store hydrogen gas in pressurised storage containers, which feed the gas into a fuel cell unit. The fuel cell combines the hydrogen with oxygen from the air in a non-combustion electro-chemical reaction that produces electricity. This electricity is then used to drive an electric motor.

Hydrogen usually exists in a compound state with other elements, for example in water (H_2O). In order to attain hydrogen for use in a fuel cell, the hydrogen needs to be separated from other elements in order to produce a pure elemental gas (H_2). One way of producing hydrogen is by splitting water, using a technique known as electrolysis (where an electric current is passed through water), into its component elements: hydrogen (H) and oxygen (O). Hydrogen is considered a low carbon and renewable fuel if this electrolysis is powered by renewable and low carbon electricity.

While the EV market is expanding quickly and is considered further along its development than the hydrogen vehicle market, there are important advantages which hydrogen vehicles possess when compared to EVs. These include, most significantly, the ability to cover long distances with a 'tank' of fuel and refill the vehicle rapidly. The refilling infrastructure would also be comparable to that used at existing centralised gasoline refilling stations. However, there remain only a small handful of hydrogen refilling stations in the UK[126], and a very significant expansion of this infrastructure would be needed to support a hydrogen vehicle market.

Currently in the UK, there are hydrogen-fuelled vehicles being used in the London bus fleet (ten in total) and in Aberdeen (six)[127]. However, there are many more planned across the country. While it remains to be seen whether a hydrogen vehicle market will compete fully with the EV market, there may be a selective requirement for hydrogen vehicles in niche uses (potentially for heavy goods vehicles, haulage as well as buses). It is therefore recommended that NWLDC continue to note the hydrogen vehicle markets as they continue to develop.

7.3 Policy Recommendations

The UK Government has placed strong emphasis on supporting electric vehicle uptake and is channelling £400m into a Charging Infrastructure Investment Fund.[128] It is recommended that local policies should be adopted to support the provision of infrastructure for ULEVs. Adequate infrastructure must be in place for this growth to be realised. In addition to helping to reduce CO_2 emissions, this will improve local air quality, decrease noise pollution, and otherwise benefit the environment and human health.

Developers should be required to demonstrate that EV charging points will either be provided or that it is prohibitively costly to do so. Our research shows that the cost of retrofitting EV charging points is higher than installing during initial construction, so there is an opportunity cost if charging points are not installed.[129] (Per DfT, as of 2019 a domestic charging point would cost around £976 to be installed upfront compared with around £2,040 if retrofitted; for non-domestic charging points these prices were around £3,822 and £4,925 respectively.)

Future Local Plans should include policy wording that address the need to:

- Reduce reliance on private vehicles; and
- Support the provision of ULEV infrastructure, particularly within new developments, car parks and public realm facilities.

Some of the ways that this could be achieved might include introducing policy positions that require major new developments and regeneration areas to undertake a detailed appraisal of the anticipated future EV infrastructure

126 https://www.drivingelectric.com/your-questions-answered/1363/where-can-i-buy-hydrogen-and-where-my-nearest-hydrogen-filling-station
127 https://fuelcellbuses.eu/
128 https://www.gov.uk/government/publications/charging-infrastructure-investment-fund
129 Department for Transport, *'Industrial Strategy: Electric Vehicle Charging in Residential and Non-Residential Buildings'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818810/electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf
Also see Energy Saving Trust, *'Guide to charge point infrastructure for business users'* (2017). Available at: https://www.energysavingtrust.org.uk/sites/default/files/reports/6390%20EST%20A4%20Chargepoints%20guide_v10b.pdf

needs as part of a planning application. These appraisals would need to consider both the number and type of appropriate charging infrastructure, in addition to considering its impact on the existing local electricity grid.

NWLDC should also consider undertaking assessments of where public EV charge points would best be located, and what type of charge points would best be most appropriate (e.g. slow vs rapid chargers). In general, the suitability of charge point types depend on where they are located, and what activities the surrounding area supports (e.g. shopping centres may be more suited to slower charge point infrastructure that those located in short-stay carparks, since the 'residence time' of the vehicle owners is likely to be longer). These assessments should consider not just EV charging facilities on Council-owned assets (e.g. Council-owned car parks), but also on other principal locations, especially those under public sector ownership (e.g. education facilities). Engagement with potential strategic partners should be encouraged, in order to realise the potential opportunities for EV charging infrastructure.

NWLDC should also consider how best to shift usage patterns away from private transportation to more sustainable and community-orientated modes of transport. For example, developments should consider the role that adequate density and the provision of mixed uses and amenities in walking distance can help to reduce the need for travel overall. In addition, developments should demonstrate that they are linked to adequate existing or future bus routes, and pedestrian and cycle networks. This would need to be addressed through an overarching spatial strategy and Local Transport Plan. Providing lower levels of parking provision, dedicated 'car club' parking spots and a range of EV charging infrastructure are also recommended, along with establishing transport and delivery hubs. Design guidance could also be provided, e.g. in a relevant SPD.

In addition, NWLDC should seek to:

- Implement plans and/or new policy that promotes walking and cycling e.g. by establishing new cycle lanes, pedestrian routes, and public transport links within North West Leicestershire and beyond. This should be reflected within the wider Local Plan spatial strategy.
- Work with highway authorities to ensure that, when undertaking repairs or upgrades to road layouts, these will seek to improve or provide new cycle lanes and pedestrian facilities (e.g. 'pedestrian priority' at junctions).
- Work with highway authorities to ensure that any transport planning, or road network expansion is required to quantify and take steps to significantly reduce emissions. Recognising the legal requirements of the Climate Change Act, it is inevitable that these types of projects will become more controversial in the coming decades due to their environmental impacts.
- Consider how NWLDC can use its licensing authority and other powers to promote sustainable transport modes, for instance by introducing low / zero emission zones (also known as clean air zones)[130] or congestion charges, workplace parking charges, differential charges for parking permits, or requiring all taxis and buses to be ultra low emission or EV.

[130] For more information, see DEFRA, *'Clean Air Zone Framework: Principles for setting up Clean Air Zones in England'* (2020). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863730/clean-air-zone-framework-feb2020.pdf

8 Key Points

The table below summarises the key areas of applicability for the LZC technologies that have been assessed as being most suitable for North West Leicestershire. **All of these technologies would require a site-specific feasibility study.**

Technology	Key considerations[131]	Potential applicability
Large scale wind	Visual impact Cumulative impacts Historic environment Local infrastructure constraints Noise, flicker and shadow	Constraints vary depending on location, height and number of turbines. Technically suitable for areas with adequate wind resource e.g. exposed hills, rural areas without nearby obstructions.
Small scale / urban wind	As for large wind, but effects likely to be smaller due to difference in size of turbines	
Small scale / building-mounted PV and SWH	Visual impact Cumulative impacts Historic environment Constraints associated with the local electricity network	Technically suitable for most building types subject to orientation and overshading, particularly for new developments which can be designed to maximise opportunities (e.g. orientation, roof geometry). May be particularly suitable for industrial buildings because of the large roof areas and character of industrial zones. Especially suitable as solar car ports. From a policy perspective, application is often limited for historic assets, listed buildings, Conservation Areas, etc. However, these should not be ruled out automatically.
Large scale / ground-mounted PV	Visual impact Cumulative impacts Constraints associated with the local electricity network	Most suitable for lower grade agricultural land, historic landfill sites or as temporary installations on brownfield because of competing land uses. However, this technology is relatively flexible and could be installed at scale across the District.
ASHPs	As for building-mounted PV Potential noise concerns	Can be installed new or retrofitted into most building types but may require energy efficiency upgrades and replacement of heating system for compatibility. Visual and noise impacts can be reduced depending on placement.
GSHPs	Depends on design but groundworks can affect soil, water quality, aquifers, archaeology, etc.	Requires site-specific feasibility study and EA consultation. Not generally suitable for existing buildings unless using boreholes or undertaking significant insulation upgrades.

The major strategic opportunities for increasing renewable electricity generation in North West Leicestershire are large-scale solar and wind energy projects. These are both well-established technologies that currently represent the most cost-effective solutions for generating renewable electricity in the UK.[53]

Roof-mounted and building-integrated PV will offer additional resource. Although this is more expensive than large-scale wind or solar farms, the benefit is that it does not compete with other land uses and has less visual impact on the natural environment.

Recognising that there are plans to increase EV charging provision across the District, NWLDC should also consider promoting PV and battery storage systems that are co-located with charge points.

At present, heat pumps offer the best opportunity to decarbonise the heat supply in North West Leicestershire; most new and existing buildings can, in principle, accommodate either an air or ground source heat pump. Due to the efficiency of these technologies, their use can also help to mitigate against electricity price increases when compared with direct electric heating.

Hydrogen gas offers the potential to help decarbonise the gas supply. Although this is currently not widely available, NWLDC should keep informed of technological advances in this area, including the HyDeploy project in Staffordshire.

[131] For more information, see https://www.gov.uk/guidance/renewable-and-low-carbon-energy#particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines

NWLDC should encourage developers to assess opportunities to deliver district heat networks in locations where there is sufficient energy demand and / or an accessible source of low carbon heat. This could include built-up new or existing urban areas, or sites in proximity to leisure centres and other high energy users.

Switching to the use of renewable electricity in buildings and vehicles will increase demand and therefore put pressure on existing grid infrastructure. NWLDC will need to work with the DNOs where relevant to plan for upgrade work. It also makes it all the more important to reduce demand through energy efficiency measures.

Appendix A – Methodology for assessing the additional LZC capacity

Air and Ground Source Heat Pumps (ASHPs and GSHPs)

The DECC Methodology (2010) states: *'The regional assessment of the potential for heat pumps is […] based on the premise that most buildings (existing stock and new build) are suitable for the deployment of at least one of the heat pump options.'* *– Paragraph 3.25*

The suggested parameters for estimating potential heat pump installations at regional scale are shown below:

Table 3-9: Detailed assessment of opportunities and constraints for heat pumps

No	Parameter	Description	Assessment requirement	Where to source data from
Opportunity assessment - natural and technically accessible resource				
1	Existing building stock	Number of buildings suitable for heat pumps	Domestic - 100% of all of-grid properties; for the remaining stock - 75% of detached and semi-detached properties, 50% of terraced properties and 25% of flats Commercial -	CLG Statistics English Housing Survey (EHS) ONS data
2	New developments	Number of new buildings suitable for heat pumps	50% of all new build domestic properties	RSS new housing provisions
3	System capacity	Average generation capacity of an individual system kW	Domestic - 5kW Commercial - 100kW	no data required
Constraints assessment - physically accessible and practically viable resource				
	n/a		No significant specific parameters have been defined as most constraints have already been taken into account in the assumptions applied for the parameters above.	no data required

Source: SQW Energy and Land Use Consultants

It should be noted that this methodology focuses on developing a universal approach to ASHPs assessments at a regional level. This means that these assumptions are broad and do not take into consideration local constraints for heat pump deployment. In addition, the level of ambition has increased since the methodology was developed, and it is now considered necessary for all buildings to be retrofitted with some form of low carbon heating system in order for the UK to meet its legally binding Net Zero target by 2050. As a result, the rules of thumb shown above would provide an underestimate of the scale of change that is required. This is why the additional ASHP capacity has not been quantified in Section 4.2.

Solar PV and hot water systems

Our estimate of the potential for roof-mounted PV and SWH on domestic and commercial buildings is based on rules of thumb set out in the DECC (2010) guidance document, which describes the percentage of different buildings assumed to be suitable for solar energy systems, along with average capacity of domestic systems (2kW) and non-domestic systems (5kW). For industrial buildings, DECC (2010) indicates that 80% of individual buildings could be suitable. However, recognising the wide variation in roof sizes, in this study satellite imagery was used to measure the roof area of 20+ existing industrial sites in the District, and rules of thumb were used to estimate the potential roof area available for PV.[132]

The DECC (2010) suggested parameters for estimating potential solar PV and hot water installations at regional scale are shown below:

Table 3-8: Detailed assessment of opportunities and constraints for solar energy

No	Parameter	Description	Assessment requirement	Where to source data from
Opportunity assessment - natural and technically accessible resource				
1	Existing roof space	Number of roofs suitable for solar systems	Apply the following assumptions for number of suitable roofs: • Domestic properties - 25% of all properties (including flats) • Commercial properties - 40% of all hereditaments • Industrial buildings - 80% of the stock	CLG Statistics English Housing Survey (EHS) ONS data
2	New developments	Number of new roofs suitable for solar systems	Assume that 50% of all new domestic roofs will be suitable for solar systems	RSS new housing provisions
3	System capacity	Average generation capacity of an individual system kW	Apply the following assumptions for average system capacity: • Domestic - 2kW (thermal or electric) • Commercial - 5kW (electric only) • Industrial - each region use their own assumption	no data required
Constraints assessment - physically accessible and practically viable resource				
	n/a		No specific parameters have been defined as most constraints have already been taken into account in the assumptions applied for the parameters above.	no data required

Source: SQW Energy and Land Use Consultants

132 Assuming that 3/8ths of roofs have an orientation of SE, S or SW, and that 50% of that roof space would be used for PV, we estimate that around 521,062 m^2 of industrial roof area is available for PV. Using a rule of thumb that 10 m^2 of roof area is required per kWp of PV, this means that 52,106 kWp of PV could be accommodated in total. This is a more conservative approach than that presented in the DECC (2010) guidance, which suggests that 80% of industrial buildings could accommodate PV, although as noted in Section 4.2.2 there are challenges associated with installing PV on existing buildings so this is only intended as a rough estimate.

The table below shows the calculation used to estimate the potential number and capacity of roof-mounted solar systems in North West Leicestershire.

New dwelling figures and quantities of consented employment space were provided in an email dated 09/10/20. This indicated 12,003 dwellings through 2031 and 2,082 thereafter, for a total of 14,085. The consented employment space totalled 261,007 m^2 in floor area.

To generate an estimate of the opportunities on the new employment sites, it was assumed that:

- Each building would be 3 storeys tall on average [261,007 m^2 / 3 = 87,000 m^2 total footprint]
- Roughly 3/8ths of the roof area would be oriented either south, southeast or southwest [87,000 m^2 x 3/8 = 32,625 m^2 roof area] and this was assumed to be suitable for PV.
- Roof-mounted PV spatial requirement of 10 m^2 / kWp [32,625 / 10 = 3,263 kWp of PV capacity]
- Typical annual PV output of 930 kWh/kWp based on RRS statistics for North West Leicestershire [3,23 kWp x 930 kWh/kWp = approximately 3,035 MWh per year]

Dwelling type	No. units	Percentage (%) of roofs suitable for solar systems	Number of suitable roofs	Total potential capacity (kW)*
Existing buildings				
Detached house	17,869	25%	4,467	8,934
Semi-detached house	16,158	25%	4,039	8,079
Terraced house	8,142	25%	2,036	4,071
Flat, maisonette or apartment	2,945	25%	736	1,473
Other domestic (e.g. caravans)	399	*Not in DECC methodology; excluded from analysis*	0	-
All Domestic	45,513	-	11,279	22,557
Commercial	3,273	40%	1,309	6,546
Industrial		*(Calculated separately)*		52,106
New buildings				
New dwellings		80%	14,085	13,101
New employment sites		*(Calculated separately)*		3,263
Totals				
Existing buildings	-	-	-	81,210
New buildings	-	-	-	17,348
New and existing	-	-	-	98,557

**Average domestic system capacity of 2kW and average commercial system capacity of 5kW. Roof space for industrial buildings has been calculated separately.*

Wind turbines

The table below summarises the key variables considered as part of the 2016 Wind Energy Study.

Category	Comments
Wind speed	Wind speed is one of the key variables impacting the wind energy resource assessment. The average annual wind speed in the District was assessed using the NOABL Wind Map which provides a 1km grid resolution. (Although this is the best resource available for undertaking area-wide assessments, it should be noted that the map is based on modelled estimates and may not reflect site-specific conditions.) The 2016 Wind Energy Study applied the following thresholds: • Large and medium scale turbines - 5 m/s at 45 m above ground level • Small turbines – 4.5 m/s at 25 m above ground level
Environmental and Landscape Designations	Relevant constraints set out within DECC (2010) include nationally and internationally recognised landscape and nature conservation designations e.g. Areas of Outstanding Natural Beauty, National Parks, Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA), Special Areas of Conservation (SAC), and Ramsar wetland sites. Per DECC guidance, these do not necessarily prevent wind energy development but as noted in the 2016 Wind Energy Study, *'their importance should be decided within the planning process and not used to determine areas classed as suitable / unsuitable for the purposes of this mapping exercise.'* The following designations were identified as being unsuitable for wind energy development: Ancient and Semi-Ancient Woodland, Scheduled Ancient Monuments and Registered Parks and Gardens.
Proximity to Residential Buildings	Proximity to buildings needs to be taken into account to avoid the risk of visual or amenity disturbance which can occur due to shadow flicker and noise. DECC (2010) recommends applying a buffer around residential buildings based on the height of the turbines under consideration. The 2016 study applied the following buffers to residential buildings: • Large and medium scale turbines - 130m + 10% • Small turbines – 50m + 10% These issues are highly dependent on site conditions (for instance, a building that falls within a 'rule of thumb' buffer zone could be shielded by nearby hedges or other landscape features.
Other Constraints	Examples include roads, railways, waterways, built-up areas, airports, MOD training sites, etc. For safety and amenity reasons, a buffer should be applied around these features, depending on the size of the turbine. DECC (2010) guidance suggests placing a 5km buffer around the East Midlands Airport. This is discussed within the 2016 Wind Energy Study, but it is noted that there are two 45m turbines in operation at the airport itself, so it does not pose an absolute constraint.

Appendix B – Bioenergy with Carbon Capture and Storage (BECCS)

Introduction

In order to restrict global warming to less than 2°C, in line with the Paris Agreement, it will be necessary to radically reduce greenhouse gas (GHG) emissions. However, achieving the level of decarbonisation required is a significant challenge. Therefore, it is likely that some form of GHG removal (GGR) will also be necessary, both to offset emissions from industries that are difficult to decarbonise, and to make up for any delays in adopting other mitigation measures. This assumption is reflected in the carbon emissions pathways published by the Intergovernmental Panel on Climate Change[133], the Committee on Climate Change (CCC)[134] and other organisations such as the National Grid[135], all of which rely on large-scale adoption of GGR in order to reach net zero GHG emissions.

In principle, options for removing CO_2 from the atmosphere include both 'natural' solutions, such as increased tree planting, restoration of peatland, and other changes in land use that increase the rate of CO_2 sequestration, and technological solutions that allow CO_2 to be captured and stored before it is released into the atmosphere. With regards to the latter, one of the most well-known options, although not one that is readily available at scale, is bioenergy with carbon capture and storage (BECCS).

This Appendix provides a brief summary on how BECCS works, including its key advantages and barriers to deployment. Then, this information is used to develop an initial, high-level assessment of potential opportunities to deploy BECCS within North West Leicestershire (NWL). There is no standardised method for assessing BECCS opportunities on an area-wide basis – there is only one BECCS pilot project in the UK as of autumn 2020 – so this is intended only as a starting point for further study. No attempt has been made to quantify the potential energy or CO_2 benefits that BECCS could provide in NWL in future.

What is BECCS?

BECCS refers to a combination of technologies that result in the net removal of CO_2 by the following process:

1. Plants absorb CO_2 from the atmosphere via photosynthesis.
2. The plant biomass is harvested and then either converted into biogas (e.g. via anaerobic digestion, pyrolysis or gasification) or burned directly, to produce electricity and / or heat.
3. The energy conversion in Step 2 takes place in a facility fitted with carbon capture and storage (CCS) technology, which allows CO_2 to be extracted from flue gases, and therefore prevents it from being emitted.
4. The CO_2 is permanently stored in geological structures such as depleted oil and gas fields, saline aquifers or un-mineable coal seams.

In principle, BECCS offers the benefits of reducing atmospheric CO_2 while also providing low carbon bioenergy that can be used to displace fossil fuels. As such, it can be used to offset CO_2 emissions from sectors that are difficult to decarbonise by other means, such as aviation. The CCC estimates that, '*By 2050 between 20 and 65 $MtCO_2e$/yr could be sequestered through BECCS in the UK (equivalent to up to around 15% of current UK CO_2e emissions)*.' The component technologies are also mature and widely established – bioenergy is widely in use in the energy system, both in the UK and internationally, and CCS has been used in the gas and oil industry for decades – but they have not yet been combined at scale.

Although BECCS can be deployed using existing, mature technologies, there are a variety of reasons why it has not yet been widely adopted. Firstly, as with all forms of bioenergy, the key constraint is the amount of sustainably sourced biomass that can be used as fuel (see Section 4.2.5 of this report for more details). Other barriers include high costs and uncertainty as to the overall level of CO_2 reduction that is achieved:

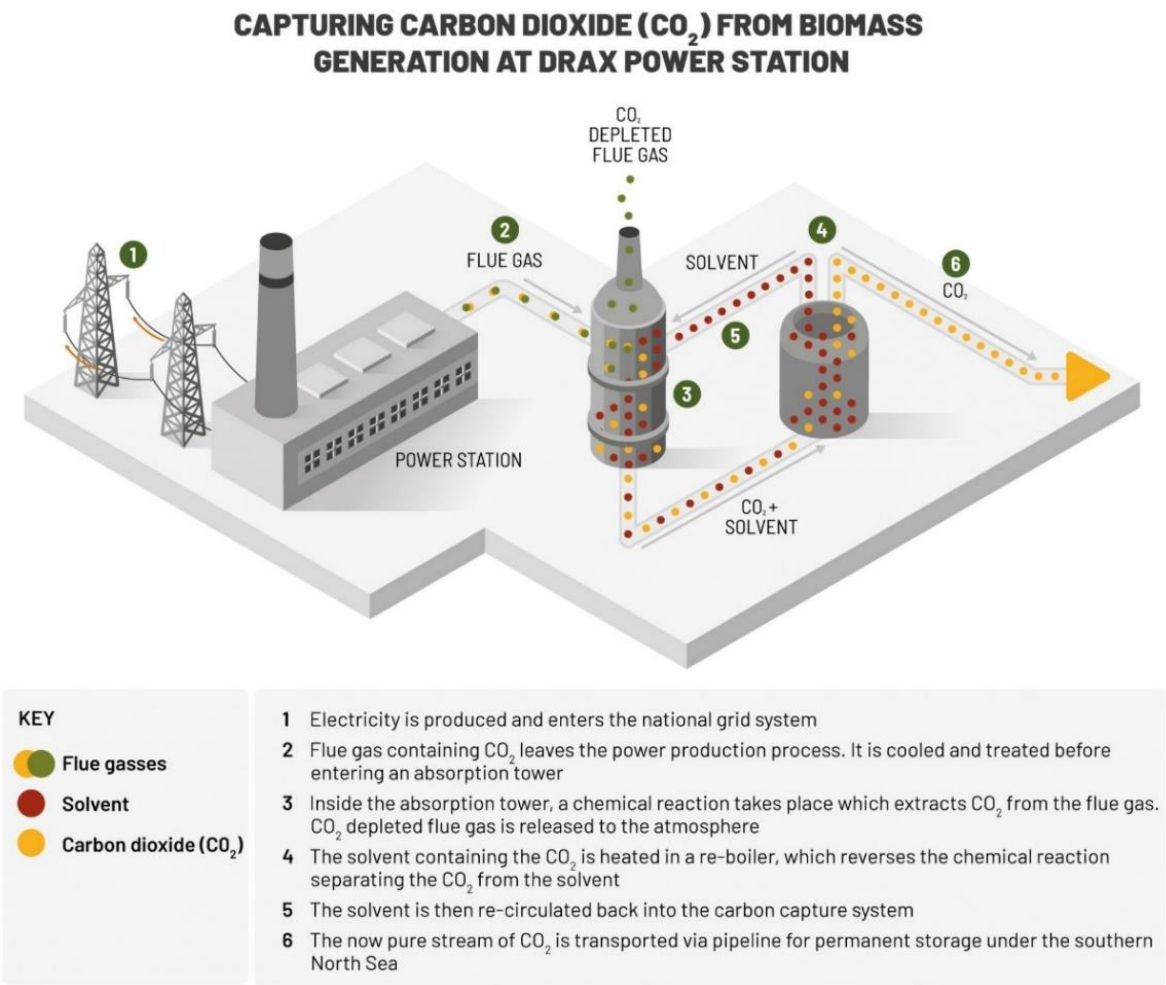
133 https://www.ipcc.ch/report/ar5/syr/
134 https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
135 https://www.nationalgrideso.com/future-energy/future-energy-scenarios

- **High cost of CCS technology** – The Government's Clean Growth Strategy outlines an ambition for CCS to be deployed at scale from the 2030s onwards, but acknowledges that this would require costs to decrease significantly.[136] In addition to the cost of the CCS technology itself, BECCS facilities have lower conversion efficiencies than traditional fossil fuel power plants, both due to the CCS process and the lower energy density of the biomass fuel, which further impacts the financial viability.
- **Wide variability in energy and CO_2 reduction efficiency** – It is also important to note that the efficiency of BECCS, both in terms of energy per unit of feedstock and CO_2 reduction per unit of feedstock, can vary dramatically depending on factors such as how the biomass is sourced and what technologies are used to convert it to energy, as illustrated in Figure X below.[137] Research suggests that the cost per tonne of CO_2 saved can be anywhere from USD \$20/tCO_2 to USD \$288/ tCO_2.[138]

In short, there are cheaper ways to provide renewable energy, and cheaper methods of CO_2 mitigation / offsetting. It is likely that large-scale BECCS adoption would therefore require a significant change in Government incentives and policies, along with technological improvements to reduce costs.

At the time of writing (autumn 2020) there is only one large-scale BECCS facility in operation globally, which is located at a corn ethanol processing plant in Illinois.[138] There are smaller-scale facilities and pilot projects at various stages of planning and construction, including at the Drax Power Station in Yorkshire, where it is anticipated that BECCS would be deployed on two of the existing biomass generating units by 2030.[139]

Figure 32. Diagram showing the BECCS chain proposed at Drax Power Station. (Source: Drax)



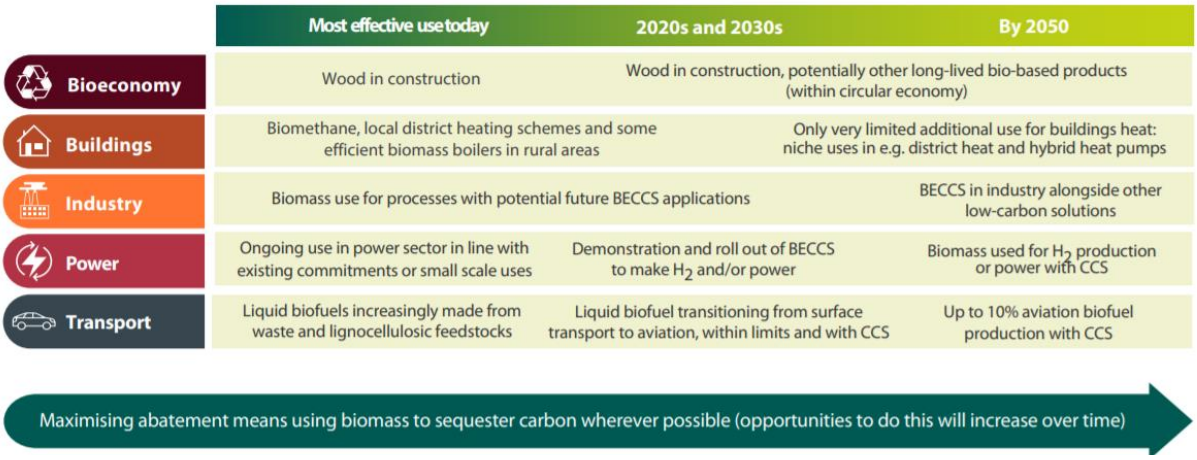
[136] https://www.gov.uk/government/publications/clean-growth-strategy
[137] https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/BECCS-deployment---a-reality-check.pdf
[138] https://www.globalccsinstitute.com/wp-content/uploads/2019/03/BECCS-Perspective_FINAL_PDF.pdf
[139] https://www.drax.com/about-us/our-projects/bioenergy-carbon-capture-use-and-storage-beccs/

Overall, our research suggests a consensus view among experts that, although BECCS (along with other GCR techniques) will be crucial for achieving net zero emissions, its adoption will need to be supported by a sustainable biomass supply chain and robust governance structure that have not yet been developed.[140, 141, 142, 143] Furthermore, it should be understood as one of a range of options for mitigating climate change.

The Global CCS Institute[138] states: *'The potential, future deployment of BECCS should not be considered as an alternative to achieving critical, cross-sector emissions reductions today.'*

In the interim period, there are other uses for sustainable bioenergy that are considered more appropriate. The diagram below, extracted from the CCC report 'Biomass in a Low Carbon Economy' (2017), shows a 'Hierarchy of best use for sustainable biomass resources' and describes how this might change over the coming decades as technologies develop. It suggests that CCS and BECCS will start to be rolled out in the 2020s and 2030s, and by 2050 will be available but restricted to use in aviation and other industries that are difficult to decarbonise.

Figure 33. Diagram showing the most effective use of biomass over time. (Source: CCC)



Potential Opportunities for BECCS in NWL

The process of adopting BECCS involves several steps, including: (a) sourcing sustainable biomass, (b) converting it to energy (c) capturing the CO_2; (d) transporting the CO_2 and (e) storing the CO_2. Although BECCS is not considered a viable option for NWL at present, in future there could be opportunities for organisations within North West Leicestershire to participate in, or facilitate, any of these steps. The table below indicates the types of issues that would need to be considered and provides an initial, high-level assessment of potential avenues to explore.

Step in the process of BECCS	**Key questions to consider**	**Opportunity in NWL?**	**Comments**
Sourcing sustainable biomass	Is there a local source of waste biomass in the District that cannot be dealt with via waste reduction measures?	✓ **Likely yes, but difficult to quantify**	*The following should be read in conjunction with Section 4.2 of this report.* **Plant biomass:** A significant portion of the UK's bioenergy comes from imported plant biomass; in 2018, it is estimated that the UK imported 7.8 million tonnes of wood pellets.[144] To the extent that there is sustainable plant biomass available in NWL, it may be preferable for this to be used to offset feedstock that is currently imported from abroad, if this would reduce the lifecycle carbon emissions that arise from the existing supply chain. **Food waste (primary production):** There is minimal research available to suggest how much may be available on an area-wide basis. Pilot

[140] https://www.nationalgrideso.com/document/173821/download
[141] https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
[142] https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
[143] https://royalsociety.org/-/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf
[144] https://www.ons.gov.uk/economy/environmentalaccounts/articles/aburningissuebiomassisthebiggestsourceofrenewableenergyconsumedintheuk/2019-08-30

			research[145] carried out into lettuce and strawberry farming has found that, 'crop waste levels are relatively significant, variable between growers and influenced by a complex set of factors.' As stated in Section 3.4.2, there is at least one agricultural business in the District that is currently using this waste stream as a feedstock for an anaerobic digestion (AD) plant with CHP. In our view, crop waste could provide a significant resource but there is not enough data to support a quantitative estimate. **Food waste (post-farm gate):** The UK produces around 9.5 million tonnes of food waste per year, of which the majority (70%) was intended for consumption while only 30% comprises inedible parts.[146] Assuming that waste reduction measures are used to minimise the edible waste, this means there is approximately 2.85 million tonnes of inedible food waste remaining. Scaled for population, this would mean that roughly 4,390 tonnes of inedible food waste are produced in the District annually.[147] Applying a rule of thumb of 150 kWh per 1 tonne food waste[148] processed at an AD biogas plant, this could be used to generate around 0.66 GWh of electricity per year. For context, in 2018 NWL's total electricity demand was 568.5 GWh. **Energy crops:** It is assumed that this would not be viable without Government incentives and there are concerns about competing land uses. **Animal biomass (litter and wet organic waste):** This will be most suitable for use where agricultural or industrial facilities that can utilise the heat or power are co-located with a ready source of animal biomass.
Converting biomass to energy	Are there biomass conversion facilities within the District or nearby surrounding area such as AD, incineration or gasification plants?	**X** **Not at present**	Adopting BECCS within NWL or nearby would require new energy conversion facilities to be built, or existing ones to be modified. As stated in Section 3.4.2, the Regional Renewable Statistics (RRS) indicate that there are currently two Anaerobic Digestion (AD) facilities located in the District with a combined capacity of 1.3 MWe that can generate approximately 7 GWh of electricity per year. There are several other AD facilities in the surrounding area.[149] None of these currently utilise CCS technologies. (Note that the RRS only lists installations that produce electricity, so it is possible that this omits facilities that produce only heat or biogas.) Going forward there could be an opportunity to convert existing power stations to utilise BECCS. The nearest major power station is located at Ratcliffe-on-Soar, which is due to close in 2025. Potentially, sustainable biomass produced in NWL could be exported to other sites within the UK; however, the CCC recommends that **large-scale biomass burning should only be supported if CCS technologies are also being installed** so this is unlikely to occur in the short to medium term.[150] *Note: CCS technologies could also be installed in facilities that do not produce bioenergy but nonetheless have high CO_2 emissions. Examples would be waste incineration plants, cement and steel manufacturers and brickworks. A review of the National Atmospheric Inventory Map suggests that there are two brickworks in NWL that could be candidates for CCS in future.*[151]

145 https://wrap.org.uk/sites/files/wrap/Food_waste_in_primary_production_report.pdf
146 https://wrap.org.uk/sites/files/wrap/Food_%20surplus_and_waste_in_the_UK_key_facts_Jan_2020.pdf
147 9.5 million tonnes of food waste per year x 30% inedible portion = 2.85 million tonnes of inedible food waste per year for a UK population of 66.65 million. Assuming NWL had a population of 102,126 as of 2018, this gives an average of 0.043 tonnes of inedible food waste per capita per year in NWL, for a total of 4,367 million tonnes per year. 4,367 million tonnes x 150 kWh/tonne = 655,047 kWh or roughly 0.66 GWh per year.
148 https://www.ieabioenergy.com/wp-content/uploads/2018/12/Food-waste_WEB_END.pdf
149 https://www.biogas-info.co.uk/resources/biogas-map/
150 https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
151 https://naei.beis.gov.uk/emissionsapp/

Capturing the CO_2	Is there a commercially viable technology to capture CO_2 from biomass energy facilities?	**X** **Not at present**	Our review found that there are very few BECCS sites in operation globally even though CCS technologies have been in use for decades in different sectors. Pilot projects are underway at the Drax power station in Yorkshire but the timescales for adoption in the main generating units are 2030-2035. NWLDC should keep abreast of developments in this area and should support BECCS or CCS projects if suitable initiatives are brought forward.
Transporting the CO_2	Is there suitable CO_2 transport infrastructure available?	**X** **Not at present**	In the UK it is likely that CO_2 would be transported primarily by pipeline or ship.[152] Only pipelines are relevant for NWL. These would either need to be newly constructed, or would involve re-purposing the existing gas network. The CCC indicates that CO_2 infrastructure would require significant investment and cooperation across different geographic areas, so Local Authorities would need to help facilitate this process.
Storing the CO_2	Are there any locations in NWL where CO_2 could be stored?	**?** **Requires further study**	In general, storage sites could include geological structures, such as depleted oil and gas fields, saline aquifers or un-mineable coal seams. Although research[153] indicates that, *'offshore geological storage in rocks deep beneath UK territorial waters will be the lowest cost option for the UK consumer over the long-term,'* there may be opportunities to utilise un-mineable coal streams in NWL at some point in the future, subject to further research being carried out.[154]

Conclusion

The main option for NWL to contribute to a BECCS chain would be to produce sustainable biomass, particularly from agricultural waste, food waste and wood products, if these cannot be addressed through alternative waste reduction measures. Another potential option would be to investigate the use of un-mineable coal streams for CO_2 storage in future, although there is limited research on this subject. CCS technologies (without bioenergy) can also be used for industries that emit large amounts of CO_2, and so could be adopted for industries within NWL such as brickworks. There is also the option of using timber and plant biomass in construction, as this offers a CO_2 storage solution for the lifetime of the building or product. It is recommended that NWLDC should keep abreast of developments in this area.

In the meantime, the focus should remain on reducing CO_2 emissions at source through energy efficiency and behaviour change measures, reducing waste, minimising the demand for natural resources, increasing tree planting and adopting other land management techniques that maximise natural CO_2 sequestration

[152] https://www.parliament.uk/globalassets/documents/post/postpn335.pdf
[153] http://www.co2stored.co.uk/home/about_faq
[154] https://core.ac.uk/download/pdf/81108824.pdf