DERBYSHIRE County Council

SCENE

Derbyshire Spatial Energy Study

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Glossary

AMES - Areas of Multiple Environmental Sensitivity
ANM - Active Network Management
ASHP – Air-Source Heat Pump
BEIS - UK Government Department for Business, Energy, and Industrial Strategy
CCC - Committee on Climate Change
CCUS - Carbon Capture, Utilisation, and Storage
CFD - Contracts for Difference
CFR - Central Feed-in Tariff Register
CHP – Combined Heat and Power
CMP – The Peak District National Park Carbon Management Plan
C&I – Commercial and Industrial
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide equivalent
CoP – Coefficient of Performance
COVID-19 - Coronavirus pandemic (2019 - present)
DCC - Derbyshire County Council
DEC - Display Energy Certificate
DECC - Department for Energy and Climate Change
DFES - Distribution Future Energy Scenarios
DHN – District Heating Network
DJMWMS - Derbyshire and Derby City Joint Municipal Waste Management Strategy
DMP - Development Management Policies
DNO – Distribution Network Operators
DPS - Dynamic Purchasing Systems
DSO - Distribution Service Operators
DWP - Derbyshire Waste Partnership
EfW – Energy from Waste
EMR - Electricity Market Reform
ENA - Energy Networks Association
EPC – Energy Performance Certificate
ETS - Emissions Trading System
EV – Electric Vehicle
HABS - Heat and Buildings Strategy
HV – High Voltage
GSHP – Ground-Source Heat Pump
GVA - Gross Value Added
GW - Gigawatts

GWh – Gigawatt hours
ICE - Internal Combustion Engine Vehicles
IEA - International Energy Agency
IPCC - Intergovernmental Panel on Climate Change
ITPL - Integrated Local Transport Plan
kW – Kilowatts
kWh – Kilowatt hours
kWp – Kilowatt peak
ktCO_2 – Kilo tonnes of Carbon Dioxide
LAEP - Local Area Energy Planning
LCOE - Levelised Cost of Energy
LDF - Local Development Framework
LED – Light Emitting Diode
LEP - Local Enterprise Partnership
LEVI - Low Emission Vehicle Infrastructure
LILEE - Low Income Low Energy Efficiency
LPG – Liquid Propane Gas
LTP3 - Local Transport Plan
LULUCF - Land Use, Land-Use Change and Forestry
LV – Low Voltage
MEES - Minimum Energy Efficiency Standards
MOD - Ministry of Defence
MW – Megawatts
MWh – Megawatt hours
MWp – Megawatt peak
NDC - Nationally Determined Contributions
NHS – National Health Service
NPMP - Peak District National Park Management Plan
NPPF - National Planning Policy Framework
NTS – National Transmission System
OLEV - Office for Low Emission Vehicles
OSN - Office for National Statistics
PDNP - Peak District National Park
PDNPA - Peak District National Park Authority
PHEV - Plug-in Hybrid Electric Vehicles
PV - Photovoltaic
RHI – Renewable Heat Incentive
REPD - Renewable Energy Planning Database
SAC - Special Areas of Conservation

SME – Small-to-Medium Enterprise
SPA - Special Protection Areas
PG - Planning Guidance
SRC - Short Rotation Coppicing
SWH - Solar Water Heating
TDP - Transport Decarbonisation Plan
TWh – Terawatt hours
ULEV - Ultra Low Emissions Vehicles
UNFCCC - United Nations Framework Convention on Climate Change
NG - National Grid (Previously Western Power Distribution)
WSHP – Water-Source Heat Pump

1. Executive Summary

In 2022, Derbyshire's local authorities undertook a spatial energy assessment covering all of Derbyshire. The purpose of this study is to provide an evidence base which will ensure better integration of energy system planning with the growing need to address and mitigate climate change at local and regional levels in the county. In particular, the study will form a building block for a Climate Change Planning Guidance (PG) document for Derby and Derbyshire, as well as assisting in decision making and the development of planning policy and local development plans.

This study has been supported by the Midlands Net Zero Hub and D2N2, and conducted by energy consultancy, Scene Connect. *Derbyshire* within this report refers to the geographical county of Derbyshire, which covers the administrative areas of Derby City and Derbyshire County Council, as well as the area of the Peak District which falls within Derbyshire.

1.1 Energy in Derbyshire

To provide an understanding of the current situation and future of Derbyshire's energy system, assessment was undertaken across electricity and heat demand, generation and supply within the County.

As of 2022, Derbyshire consumes 4,547 GWh of electricity and 10,046 GWh of heat energy annually. Electricity is primarily met by the national electricity grid, which is supplied by generation assets from across the country. Heat demand is primarily met by the national gas grid, although 6% of properties within the County are off-gas-grid.

Energy consumed in Derbyshire is now largely sourced from outside of the region, with energy generated within Derbyshire now largely from renewable or low carbon sources. Electricity generation in Derbyshire totalled approximately 270.5 MW in 2021, comprised of solar PV (76.2%), onshore wind (10.3%), and energy from waste (10%). There are a number of planned energy projects in Derbyshire, including large scale ground-mounted solar PV, battery storage systems, and energy from waste sites.

Future energy scenarios developed for Derbyshire suggest that energy demand will increase as a result of a 9% increase in population and 11% increase in housing between 2022 - 2040. Further increases in energy demand would be expected as associated non-domestic (i.e., commercial and industrial) development occurs.

Derbyshire has a total carbon budget of 38.1 million tonnes of CO_2 equivalent (tCO_2e) up to 2100. To remain within this budget, understanding of current and projected carbon emissions is required. Total net carbon emissions across Derbyshire totalled 7,224 kilo tCO_2e in 2019 across large industrial installations (36%), transport (26%) and domestic energy emissions (18%), meaning Derbyshire's local authority areas must meet an average carbon emissions reduction of 13.5% a year to meet local and regional targets.

To meet the carbon targets set out above, a number of energy trajectories were considered within this study (figure 1.1). Key areas of focus in the short-term are expected to be demand reduction - including energy efficiency improvements - and the decarbonisation of heat demand. Regional projections suggest between 14,000 - 174,000 heat pumps and similar low carbon heating technologies may be deployed by 2040, alongside wide reaching energy efficiency improvements. In terms of electricity supply, between 50 - 300 MW of low carbon energy generation may be developed in Derbyshire up to 2040, across domestic and commercial solar PV, onshore wind, and supporting technologies (e.g., battery storage). Electric Vehicle (EV) deployment is expected to rise from 7,300 vehicles (2022) to between 350,000 - 510,000 by 2040.

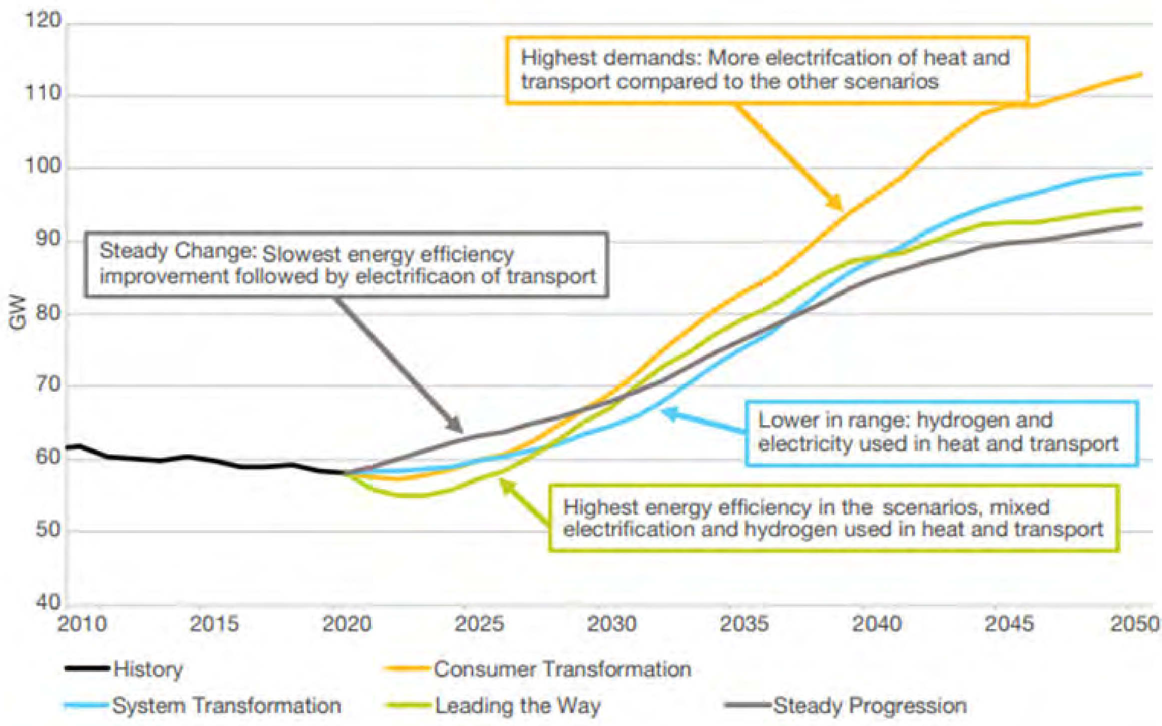


Figure 1.1 – UK Electricity peak demand projections

1.2 Spatial & Technical Analysis

A spatial understanding of energy is critical to defining the location, technology and scale of energy development which may occur in a given area. Derbyshire is a particularly sensitive area, as it includes a number of naturally and culturally important areas - including the Peak District National Park and Derwent Valley Mills World Heritage Site.

Spatial and technical analysis of energy opportunities suggest that:

- Larger scales of energy development, including **ground-mounted solar PV** and **onshore wind** are particularly constrained in the north of the County due to the National Park as well as around the urban centres of Derby and Chesterfield and surrounding Green Belt land. Lesser constraints to development were found running south west to north east across the County for solar PV, with onshore wind subject to greater constraints throughout this area. Ground mounted solar PV could meet up to 7% of Derbyshire's electrical demand, whilst wind could meet upwards of 6% depending on actual deployment levels.

- Landscape sensitivity analysis highlighted the high levels of sensitivity in and surrounding the National Park, particularly in relation to ground-mounted solar PV and onshore wind.

- **Hydropower** opportunities are limited in scale, though there are opportunities throughout Derbyshire to develop small-scale hydropower installations.

- **Rooftop solar PV** could meet up to 19% of Derbyshire's electricity demand if deployed on domestic, commercial and industrial rooftops across the County.

- **Rooftop solar thermal** could meet 18% of Derbyshire's heat demand, although historic levels of deployment suggest this is unlikely and that solar PV is the dominant rooftop technology.

- Derbyshire would require 3,635 MW of **heat pump** capacity to meet regional heat demand across homes and businesses. This would lead to an increase of ~3,500 GWh in electricity demand as a result of the electrification of heat supply.

- **Biomass** could provide a thermal capacity of 1,202 MW in Derbyshire, although the high fuel demand would require sourcing of fuel from outside the region which may negatively affect carbon emission reduction potential.

- **Anaerobic digestion** is expected to be a limited opportunity but it is considered viable across much of Derbyshire, including within the National Park subject to nearby sourcing of feed stock.

- There are a number of active **Energy from Waste** (EfW) plants in Derbyshire totalling 26.6 MW. There are opportunities for further development but these projects should seek to meet regional waste processing requirements rather than sourcing fuel from outside of Derbyshire.

- **District heating** may be able to meet up to 18% of heating demand in Derbyshire, in line with national projections. Priority areas in Clay Cross, Matlock and Chesterfield have already been identified.

- **Energy efficiency** will play a critical role in demand reduction and heat decarbonisation in Derbyshire. Committing to bringing all properties up to a rating of 69 or above (C) would lead to an annual heat energy demand reduction of around 743 GWh and aggregate energy bill reduction of over £58m per annum across 292,574 properties.

- **Energy storage** may play an important role at utility scales, through supporting energy network operation and within commercial and domestic properties. As of 2022, 10 MWh of large-scale battery storage is operational in Derbyshire, with a further 199 MWh planned.

- As of 2022, there are around 7,300 **Electric Vehicles** (EV) used within Derbyshire, primarily by private owners. This is expected to rise to between 200,000 – 350,000 by 2040, requiring an increase in public **EV charging points** from current levels (310) to meet future low carbon transport demand.

1.3 Investment & Impact

Renewable and low carbon energy development has the ability to generate significant socio-economic benefits at national, regional, and local scales. The investment requirements for each technology option are set out in Table 1.1, providing a high-level guide of the potential investment need for the deployment extents identified within this report.

Cost of Energy Development in Derbyshire		
Electricity Generation	**Deployment Potential (MW)**	**Total Cost (£)**
Wind	218	£17,569,056
Hydropower	< 2	£1,233,408
Solar PV (Ground-Mount)	1,176	£49,860,518
Solar PV (Rooftop)	913	£100,293,415
Solar Thermal	69,160	£29,648,373
Biomass	7,413	£93,813,416
Heat Pump	42,134	£117,741,494
Anaerobic Digestion	< 50	£38,934,696
Energy from Waste	< 20	£6,334,882
Energy Efficiency	292,574	£2,372,775,140
Electric Vehicles	509,579	£12,739,475,000
EV Chargers	333,103	£1,998,618,000
Electrical Storage	167	£44,589,000

Table 1.1 – Cost of Energy Development in Derbyshire

Further analysis of non-economic benefits of energy development highlighted impacts such as skills development, behaviour change, consumer bill reductions and benefits to health and wellbeing. Smaller scales of development - in particular, domestic and non-domestic energy efficiency, rooftop solar PV and low carbon heating - were found to have the greatest impact potential, due to direct engagement and benefits realised by home and business owners.

Low carbon mobility was seen as one of the major non-economic impact areas, with the potential to greatly reduce pollution, consumer bills, and support wider low carbon behaviour change.

1.4 Policy Implications

The study identifies and describes a number of policy and planning tools which may be applicable to Derbyshire and may be implemented by the local authorities in Derbyshire. These are recommendations only and no prescriptive measures or wording are set out in this report.

The study identified several key routes and mechanisms which may enable Derbyshire to meet its climate targets within the given time frame.

Decarbonisation

- Embed climate change, energy, sustainability, and carbon into the whole authority, across staff and systems.
- Build the above into all local planning, Masterplanning and other emerging plans.
- Local Area Energy Planning (LAEP) should be considered to ensure maximisation of energy demand met and resources used.

Demand Reduction

- Focus on reducing energy demand for all new premises and land uses.
- Adhere to energy efficiency standards and building regulations within all emerging policies.
- Support the development and implementation of local zero carbon design guides.
- Focus on the retrofit of public buildings and housing stock and on meeting minimum national target EPC levels of c.

Electricity Generation

- Focus on technologies which offer the greatest generation potential and which have the greatest unconstrained area for development.
- Focus on aggregating positive impact from buildings through local energy development.
- Engage with energy network operators in their area, to discuss ongoing activity and innovation projects in the energy sector.

Heat Generation

- Develop and deliver heat network connections in public and private scenarios.
- Implement and enforce national regulations and policy (e.g., Minimum Energy Efficiency Standards (MEES)).
- Support low-carbon heating and energy efficiency measures throughout the County.
- Engage with businesses and constituents around heat generation and supply.

Low Carbon Transport

- Invest in low carbon vehicles within council owned vehicle fleets, decarbonise public transport, and promote low carbon alternatives for staff travel.
- Define future local plans and infrastructure which support the provision of ULEVs and reduces reliance on private vehicles.
- Define local plans and transport plans which encourage zero carbon transport.
- Implement policies which limit the potential for car use or limit specific high emissions vehicles from certain areas.

2. Introduction

This study provides a spatial assessment of energy opportunities to support emerging local development planning and planning guidance across Derbyshire. It is supported by the 2019 Derbyshire Environment and Climate Change Framework, developed by Derbyshire County Council to initiate a collaborative approach to reducing greenhouse gas emissions and achieving net zero by 2050.

The purpose of this study is to provide an evidence base which will ensure better integration of energy system planning with the growing need to address and mitigate climate change at local and regional levels in Derbyshire. It will be one of the building blocks for the development of a Climate Change Planning Guidance (PG) document for Derby and Derbyshire, as well as assisting in decision making and the development of planning policy and local development plans. This evidence base provides Derbyshire County Council, local authorities in Derbyshire, and wider stakeholders with a clear overview of the existing energy system, future energy system projections, and a spatial assessment of energy opportunities in Derbyshire.

This report uses an adapted spatial assessment framework (DECC, 2010) supported by data relating to energy resource, energy demand, development constraints and opportunities. Using this data, spatial opportunities for future energy development in Derbyshire have been identified and described. These areas of opportunity will enable Derbyshire County Council and local authorities to better design low carbon planning policy, ensuring that future energy development in Derbyshire is located in a sensitive and appropriate manner, whilst supporting the transition to net zero emissions.

2.1 Study Area

Derbyshire is a county located in the East Midlands of England, covers an area of 2,625 km^2, and is home to 1,063,997 people (ONS, 2020). The county is primarily rural with several urban centres and numerous small towns and villages. The landscape consists primarily of rolling hills and upland areas, with the Peak District National Park covering 35% of the county. The south and east of the county are generally low lying including several large river valleys. The character of the northeast of Derbyshire is influenced by former coalfields and their settlements, with more rural areas in the west and north-west of the county. The Rivers Derwent, Dove and Trent are interconnected across the county forming historically and environmentally significant features in Derbyshire.

Derbyshire has a three-tier local government system, with a county council based in Matlock, eight district and borough councils and, since 1997, the City of Derby unitary authority area. Across these areas, there are 347,200 homes and 1 City, Derby (243,752 dwellings), and 13 towns, including Chesterfield (103,788 dwellings) which is the most populated. Derby City and Derbyshire's towns have their roots in traditional industries such as quarrying in the northwest, former coal mining in the north east, and remnants of engineering and textile industries scattered elsewhere across the county. Parts of both

Parts of both Derbyshire Dales District, High Peak Borough and North East Derbyshire lie within the jurisdiction of the Peak District National Park.

The county contains a large number of environmentally and culturally sensitive locations, including 6 Special Areas of Conservation (SAC) / Special Protection Areas (SPA), 88 Sites of Special Scientific Interest (SSSI), 371 Conservation Areas, over 6,500 listed buildings, and more than 20,000 sites and features of archaeological and historic interest. Most notably, the Peak District National Park (890km²) and the Derwent Valley Mills World Heritage Site, which protects 24km of the Derwent Valley, where modern factory systems were originally invented.

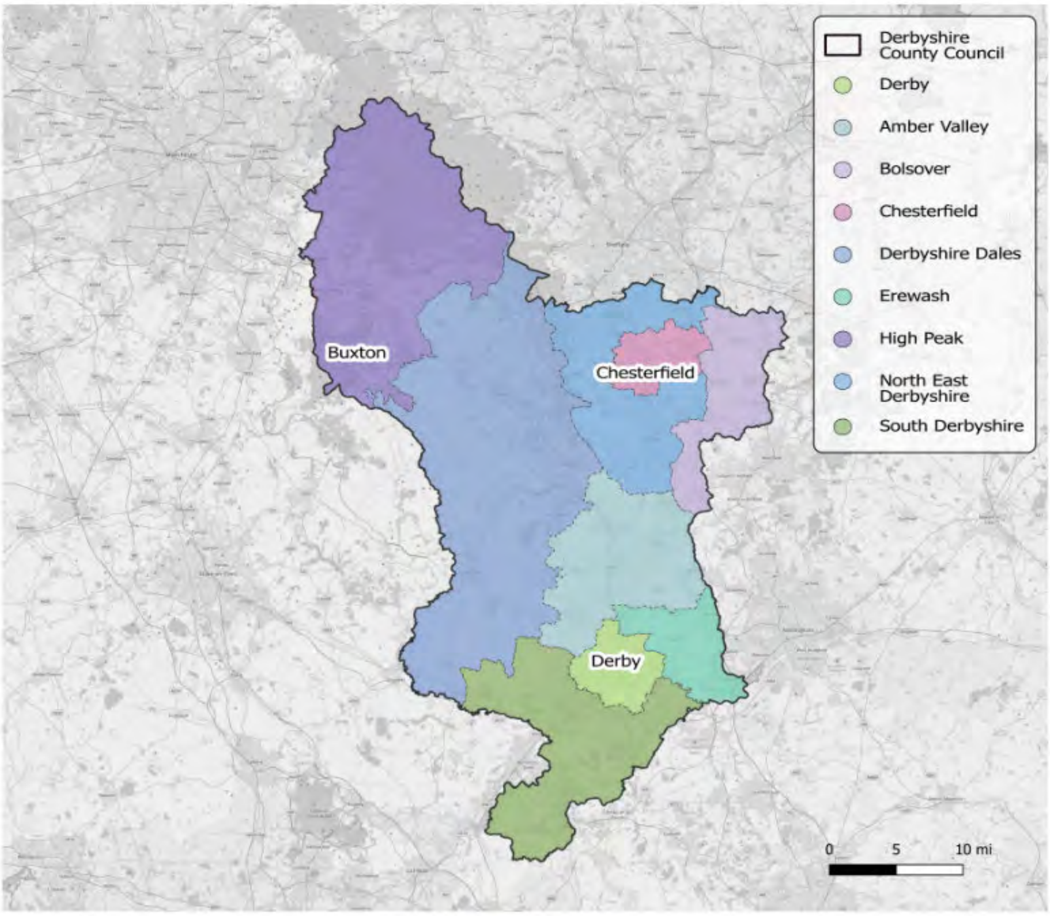


Figure 2.1 - Overview of the Derbyshire County Council area

2.2 Objectives

The objective of this study is to provide a spatial energy context and projection for Derbyshire which will support local and regional energy planning and better enable the transition to net zero across the county.

In particular, this study will:

- Detail the international, national, regional, and local energy and planning context which underpins this report.

- Understand existing electrical and heat energy demand, networks, and supply in Derbyshire.
- Project energy system development scenarios in Derbyshire.
- Identify the energy resource availability and development opportunities and constraints.
- Provide a spatial assessment of energy development opportunity areas and strategic development sites.
- Provide policy recommendations which will support local development planning and planning policy in Derbyshire.

2.3 Report Structure

The report is structured as follows:

Section 1: Foreword.

Section 2: Executive Summary.

Section 3: Introduction, purpose, and structure of the report.

Section 4: Policy context, setting out the relevant climate, carbon, and energy policies applicable to energy development in Derbyshire.

Section 5: Current energy system, describing energy generation, networks, use and mobility across Derbyshire.

Section 6: Future energy system, setting out projections for energy system development in the next 10 years and demonstrating the spatial aspect of future energy development.

Section 7: Spatial Energy Assessment, detailing the constraints and opportunities to energy development in Derbyshire.

Section 8: Financial and impact assessment, estimating the potential investment requirement and resulting economic, environmental, and social impacts of future energy development.

Section 9: Conclusion, summarising the key findings and policy recommendations.

Relevant supporting information is provided in the Appendices.

3. Policy Context

This section sets out the relevant national, regional, and local policies affecting energy planning in Derbyshire. It focuses on policies and instruments which are relevant to energy planning, development, and net zero strategy in the UK, Derbyshire, and its local authorities.

The energy context relates to existing and emerging national planning policy, guidance, support mechanisms and underlying research regarding energy generation, transmission, use and low carbon mobility. Wider climate change and net zero policy and strategy is also referred to due to its relevance in guiding, and providing a rationale for, low carbon energy development in Derbyshire.

The energy system is undergoing a period of unprecedented change at rapid pace. At the time of writing, the goal is for the UK energy system to have completely decarbonised by 2035 (BEIS, 2021). This decarbonisation requires decentralisation, digitalisation, and democratisation – referred to as the 4Ds of energy transition. While significant progress has already been made to decarbonise electricity through the development of renewables and demand reduction, with the decarbonisation of heat and transport electricity, demand is going to increase. The extent of that increase depends on the way in which future energy scenarios unfold, with the policy framework currently supporting all options, due to the scale and pace of change necessary.

3.1 International Policy

Encouraging sustainable development and tackling climate change are interrelated aspects of energy planning, analysis and policy making. The energy sector must play a central role in mitigating climate change as it accounts for three-quarters of global greenhouse gas emissions. Despite reductions in energy use during 2020 as a result of the global pandemic, CO_2 emissions have rebounded by 4.8% in 2021 as the global economy recovers, driven by increases in coal, oil, and gas production and demand (IEA, 2021).

Whilst there are no overarching international energy policies which are directly relevant to the UK, the International Energy Agency (IEA) has highlighted several overarching points for policy makers:

- The energy sector is the source of around three-quarters of greenhouse gas emissions today and holds the key to averting the worst effects of climate change, perhaps the greatest challenge humankind has faced.
- The global pathway to net-zero emissions by 2050 requires all governments to significantly strengthen and then successfully implement their energy and climate policies.
- The path to net-zero emissions is narrow: staying on it requires immediate and massive deployment of all available clean and efficient energy technologies.

- Ever-cheaper renewable energy technologies give electricity the edge in the race to zero.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 °C underlined the importance of reaching net-zero CO_2 emissions by 2050 or sooner to avoid the worst impacts of climate change (IPCC, 2018). A united global response is required to combat the causes of climate change and mitigate its ongoing effects, with a rise of average global temperatures of 1.1° recorded in 2021. Nations working under the Paris Agreement, a global framework to avoid dangerous climate change by limiting global warming to well below 2°C, are required to submit Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) and to implement policies with the aim of achieving their stated objectives.

2021 has seen a dramatic increase in the number of governments undertaking to reduce greenhouse gas emissions and achieve net zero. Nations representing around 90% of global GDP and CO_2 emissions have made commitments or agreed targets to achieve net zero (either by 2050, 2060 or 2070). As of February 2022, 105 countries and the European Union have pledged to meet a net-zero emissions target, with a further 31 under discussion. Of these countries, 17 have enshrined a target of carbon neutrality by 2050, including the UK (ECIU, 2021).

3.2 National Policy

The following sections summarise national policy, legislation, and emerging Government plans of significance for this study, including UK energy, climate, and sustainability policy.

3.2.1 Climate Change Policy

The UK is a leading country in terms of climate change policy and action. It has made considerable progress, reducing emissions by 48% on 1990 levels, including a reduction of 3% between 2018 – 2019 (CCC, 2019). This has largely been driven by renewable power deployment and a large reduction in coal use. The UK also benefits from a strong policy framework for climate commitments in the form of the Climate Change Act (2008).

This Act (as amended in 2019) legally commits the UK Government to reducing carbon emissions by 100% by 2050, against the 1990 emissions baseline. The UK Committee on Climate Change (CCC) states that '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 period which act as stepping stones towards the 2050 target), and the development of a climate change adaptation plan' (CCC, 2019).

In 2019, the UK became the first country to declare a Climate Emergency and a legal commitment to net zero greenhouse gas emissions by 2050. Through this, the UK has demonstrated international leadership with regards to its obligations under the Paris Agreement.

In 2021, the UK Government adopted the Sixth Carbon Budget (2033 – 2037) to cut emissions by 78% by 2035 from the 1990 emissions baseline. Originally proposed by the UK Committee on Climate Change in December 2020, achieving this target will require:

- **Take up of low-carbon solutions**: By the early 2030s all new cars and vans and all boiler replacements in homes and other buildings are low-carbon – largely electric. By 2040 all new trucks are low-carbon.

- **Expansion of low-carbon energy supplies**: UK electricity production is zero carbon by 2035. Offshore wind becomes the backbone of the whole UK energy system. Clean electricity in transport, heating, and industry, trebling electricity demand by 2050 in comparison to 2020. Low-carbon hydrogen energy scales-up to be almost as large, in 2050, as electricity production is today.
- **Reducing demand for carbon-intensive activities**: The UK wastes fewer resources and reduces its reliance on high-carbon goods. Diets change, reducing our consumption of high-carbon meat and dairy products by 20% by 2030, with further reductions in later years.
- **Land and greenhouse gas removals**: By 2035, 460,000 hectares of new mixed woodland are planted to remove CO_2 and deliver wider environmental benefits. 260,000 hectares of farmland shifts to producing energy crops. Woodland cover increases from 13% of land area to 18% by 2050.

The **UK Governments Net Zero Strategy** was published in 2021 and sets out proposals to guarantee the UK's homes and businesses are supplied with affordable, clean, and secure electricity by 2035. Most notably, the plan sets ambitious targets to completely decarbonise the UK energy system by 2035, as well as supporting low carbon fuel supply, industrial carbon capture, a pathway for decarbonising homes and workplaces, removing all road fuel emissions, and investing in afforestation.

3.2.2 Energy Policy

Energy policy in the UK is underpinned by the 2013 Energy Act and aligns with the UK government's Climate Change Act 2008. This is further supported by several policy documents and strategies regarding the decarbonisation of electricity, heat, and transport.

UK Energy Act (2013)

The Energy Act 2013 is a legislative framework for providing secure, affordable, and low carbon energy. It includes decarbonisation targets up to 2030 and the Electricity Market Reform (EMR). The EMR comprises the existing Contracts for Difference (CFD) low carbon generation auction, capacity markets supporting security and affordability of electricity supply, investment contracts, access to markets, renewables transition (under the renewables obligation scheme) and emissions performance standards to fossil fuel power stations. Whilst several elements referred to in the Energy Act (e.g., Renewables Obligation, Feed-in Tariff) are no longer applicable, the Act is still an underpinning piece of legislation for UK energy networks and market.

British Energy Security Strategy (2022)

The Energy Security Strategy was published in April 2022 in the context of increasing climate change concern, the UK cost of living crisis and Russian invasion of Ukraine. The policy reviews the UK Government's energy strategy, providing an approach to meeting low carbon targets whilst reducing reliance on international fossil fuel imports, including oil and gas.

The strategy sets out an ambition for 95% of the UK's electricity to come from low carbon sources by 2030, ahead of a complete decarbonisation target in 2035. To achieve its stated aims, the strategy focuses on:

- Nuclear: implementing up to 24GW of nuclear power by 2050, meeting 25% of projected electricity demand.
- Offshore Wind: implementing up to 50GW of offshore wind power by 2030, providing enough electricity to meet 60% of total demand in 2030.
- Onshore Wind: consulting on developing partnerships with a limited number of supportive communities who wish to host new onshore wind infrastructure in return for guaranteed lower energy bills
- Solar PV: aiming to increase solar capacity up to 70GW by 2035, incorporating both rooftop and ground-mounted solar PV projects
- Hydrogen: doubling the UK's hydrogen production capabilities to up to 10GW by 2030.
- Oil and Gas: launching a new round of licensing for North Sea oil and gas exploration projects in Autumn 2022, seeking to deliver greater domestic fossil fuel production.
- Hydraulic Fracturing: the UK government intends to remain open-minded about our onshore reserves and review technical evidence before acting on the current hydraulic fracturing moratorium.

Little mention of energy efficiency and demand reduction is included in the Energy Security Strategy, although external research suggests that the UK could reduce its consumption of Russian gas by 80% this year through measures to improve energy efficiency and cut energy demand (E3G, 2022).

Energy White Paper (2020)

The Energy White Paper sets out targets and road map to net zero by 2050 in the UK. The white paper sets out several ambitions for the UK energy system, including:

- Investing heavily in renewable energy sources with a goal set of 40GW (about 60% of the UK's energy consumption) of offshore wind by 2030.
- Support the deployment of carbon capture, utilisation, and storage (CCUS) at four industrial locations.
- Establishing a new UK emissions trading system (ETS).
- Bringing at least one large-scale nuclear project to the investment stage.
- Grow the rate at which electric heat pumps are installed to 600,000 a year by 2028.
- Consulting on whether to end connections to the national gas grid for new homes from 2025.
- Building world leading digital infrastructure for the UK energy system.

These ambitions generally align with the trajectory of the UK energy system: decentralisation and decarbonisation across scales. Of particular relevance to this study, the White Paper establishes a precedent and commitment to dramatic short-term change in relation to energy network functionality and management as well as decarbonisation of domestic heat energy. The White Paper also addresses green recovery, setting ambitions to deliver industrial low carbon development in a post-pandemic economy and to provide a fair deal to energy users in the UK.

Heat and Buildings Strategy (HABS) (2021)
The Heat and Buildings Strategy sets out a ten-point plan to address UK building stock energy efficiency and heating systems, including:

1. Phasing out domestic natural gas boilers by 2035.
2. Reducing the cost of heat pump installation by 25 – 50% by 2025 and ensuring cost parity with gas boilers by 2030.
3. Investing in heat pump research and innovation.
4. Providing financial support through the Clean Heat Grant for domestic homeowners of £5,000 per installation.
5. Re-balancing energy prices to ensure heat pumps are no more expensive to run than gas boilers.
6. Targeting 600,000 heat pump installations per year by 2028 by supporting the domestic supply chain.
7. Implementing a Future Homes Standard, including heat pumps in a third of new homes.
8. Phasing out of fossil fuel heating in off-gas-grid locations from 2026.
9. Targeting a 30-fold increase in UK manufactured heat pumps by 2030.
10. Working with Ofgem to ensure that electricity systems can accommodate increased electricity demand.

The strategy has created cautious optimism about the potential to overcome the limited progress on UK energy efficiency and heat decarbonisation relative to similar countries. In the short term, subsidy and policy support focusing on domestic and commercial heat energy is expected to greatly increase heat pump deployment and, in time, completely phase out gas-based heating demand.

Transport Decarbonisation Plan (2021)
The Transport Decarbonisation Plan (TDP) addresses vehicle and fuel transitions, passenger and freight demand, and associated infrastructure development. The TDP at its core focuses on electric vehicle uptake, supporting the target to phase out petrol, diesel, and plug-in hybrid (PHEV) cars by 2030. On the demand side, the TDP sets out aims to achieve a shift to walking, cycling and public transport in towns, increasing car occupancy, improving rail and coach services, and reiterating the importance of decarbonisation in spatial planning.

The TDP is supported by the Automated and Electric Vehicles Act (2018), which supports the UK Government's ambition for installation of EV charge points that are 'smart' and practical for consumers in motorway, commercial and domestic contexts. The UK Government has a target for all new vehicles to be Ultra Low Emissions Vehicles (ULEV) by 2040. This means that new internal combustion engine (ICE) vehicles, of which the majority are petrol or diesel based, will be completely phased out from new sales by 2040.

An Office for Low Emission Vehicles (OLEV) has further been set up to support local authorities, companies, and consumers to increase ULEV uptake. The OLEV provides grants for new vehicles, workplace charging equipment, and low emission buses.

3.2.3 Planning Policy

UK planning policy at the national level is underpinned by the National Planning Policy Framework (NPPF) first published in 2012 and updated in 2018, 2019 and 2021. The NPPF provides the framework for producing Local Plans for housing and other development, and accordingly the basis against which applications for planning permission are decided

National Planning Policy Framework (NPPF) (2021)

The National Planning Policy Framework 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 when determining applications where there is no up to date local plan or where there are no relevant or up to date development plan policies in place.

In respect to energy development, there are a number of important sections within the NPPF which are laid out below. Whilst these sections provide the justification, guidance and policy base for energy planning, all sections of the NPPF must be considered in respect to any planned development.

It addresses topics that are relevant to the economic, environmental, and social sustainability of development proposals, including but not limited to:

2. Sustainable Development states that, 'at the heart of the Framework is a presumption in favour of sustainable development,' meaning development plans should seek to promote development which meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change; and adapt to its effects.

9. Promoting Sustainable Transport states that 'the environmental impacts of traffic and transport infrastructure should be identified, assessed and taken into account,' in local planning. It highlights that new development should be designed to enable charging of plug-in and other ultra-low emission vehicles in safe, accessible, and convenient locations.

11. Making Effective Use of Land states that 'Local planning authorities, and other plan-making bodies, should take a proactive role in identifying and helping to bring forward land that may be suitable for meeting development needs,' which includes identifying opportunities for development, as considered within this study.

12. Achieving well-designed places, highlights the need to remain sympathetic to local character and history (including built environment and landscape setting), whilst optimising the scale and extents of development. Where available, development must follow local design guides or the national design guide and code in their absence.

13. Protecting Green Belt Land, states that green belt designations must promote sustainable development and consider the consequences of channelling development away from green belt land. It further states that developers must demonstrate very special circumstances for the development of renewable energy projects within green belt land, such as environmental or wider societal benefits.

14. Meeting the challenge of climate change, flooding, and coastal change, focuses on the mitigation (i.e., carbon emissions reduction) and adaptation (i.e., vulnerability reduction) potential of new developments. The NPPF states that renewable and low carbon energy and heat plans should provide a strategy which maximises potential suitable development whilst minimising adverse impacts (including cumulative landscape and visual impacts). Plans should identify suitable areas for renewable and low carbon energy sources and the potential for new developments to be supplied by such energy. Once identified and included in local plans, renewable and low carbon projects should be approved within these areas if the impacts of the development are (or can be made) acceptable. For developments outside of identified areas, the developer must demonstrate that the proposed location meets the criteria used to identify suitable areas.

15. Conserving and enhancing the natural environment sets out many of the constraining factors to energy development. It states that plans should 'distinguish between the hierarchy of international, national and locally designated sites; allocate land with the least environmental or amenity value, where consistent with other policies in [the NPPF].' Furthermore, it states that major development within national parks should be refused other than exceptional circumstances, where development can be demonstrated to be in the public interest. In terms of biodiversity and habitats, the presumption in favour of sustainable development does not apply where significant adverse impacts on habitat sites are expected to occur. Finally, developments must consider the presence of air quality management areas and clean air zones, impacting on combustion-based energy sources.

Build Back Better: Our Plan for Growth (2021)

Build Back Better was published during the COVID-19 pandemic and sets out a plan for growth and economic recovery in light of the challenges posed by the pandemic. The paper sets out three core pillars for growth:

- **Infrastructure**: stimulating short-term economic growth through investments in communications, transport, and city mobility; connecting people with opportunities through the Levelling Up Fund; investing £12bn in projects through the Ten Point Plan for a Green Industrial Revolution; and securing private investment through the UK Infrastructure Bank.
- **Skills**: Supporting productivity through further education investments; supporting learning through the Lifetime Skills Guarantee programme; and supporting apprenticeships and training programmes.
- **Innovation**: Incentivising creative ideas and technologies; reforms to reduce disincentives for investment in high growth companies, including the £75m Future Fund; attracting new people to Britain through competitive high-growth innovation; and supporting SMEs to boost productivity through the Help to Grow programme.

These pillars are intended to form the basis for levelling up, including regeneration of struggling towns, supporting regional prosperity, and strengthening the union through free ports and improved international transport links. Net Zero will be supported through investment in offshore wind, carbon capture and hydrogen, as well as supporting net zero industrial development and ending petrol and diesel car and vans sales in 2030. Lastly, the pillars will underpin a 'Global Britain,' through international action, new multilateral trade relationships, and export strategy.

Building Regulation (2014) and Future Homes Standard (2022)

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

Homes Standard intends to ensure that all new homes built from 2025 will produce 75 - 80% less carbon emissions than homes delivered under current regulations.

The UK Government completed a consultation on Part L (fuel and power) of the Building Regulations, as part of the Future Homes Standard consultation, in April 2021. The revised Building Regulations will be published in June 2022 and will include changes to the energy efficiency standards for non-domestic buildings, as well as changes covering the wider impacts of Part L.

In June 2022, Part S of the Building Regulations took effect setting out new requirements for electric vehicle charging provisions for new residential buildings and new non residential and mixed use buildings, and in both cases where major renovations are taking place.

3.3 Regional Policy

Regional policies and strategies cover those of the local enterprise partnership (D2N2), the upper-tier local authority (DCC), and the Peak District National Park.

Local Enterprise Partnership (LEP)

Established in 2010, The Derby, Derbyshire, Nottingham, and Nottinghamshire Local Enterprise Partnership (D2N2) is one of the largest Local Enterprise Partnerships (LEPs) in England, with a population of more than two million people.

D2N2 Energy Strategy (2019 – 2030)

The D2N2 Energy Strategy sets out a suite of linked targets and actions that align with the national Clean Growth objectives. It recommends short- and long-term actions for D2N2 and its constituent local authorities to address energy security, decarbonisation, and affordability across electricity, heat, and transport. The strategy sets out its two-degree milestones for D2N2, supported by a list of aspirations, specific targets, and an action list to achieve net zero in the region in line with the National Climate Change Act 2008.

A summary of 2030 targets includes:

T1: 100% avoidance of recoverable materials going to landfill

T2: At least a 60% reduction against 1990 carbon emissions per capita and a 15% reduction in per capita energy demand

T3: 15% of buildings using low carbon heating and all current building stock to be Energy Performance Certificate (EPC) Level C or above where possible

T4: To comply with, and exceed where possible, applicable air quality standards in all locations

T5: 100% low carbon energy supply with 60% renewable generation output and increase of 180MW in electricity storage in the D2N2 region.

T6: Increase the provision of smart transport infrastructure to support a target of 70% of vehicle miles to be Ultra Low Emissions

T7: 100 new businesses in the Low Carbon and Renewable Energy sector and 1000 new jobs

T8: Decouple carbon from growth through the reduction of carbon intensity ratio of growth by 50%

T9: Secure at least £100m of investment in local low carbon energy projects with adequate funding for infrastructure development and resilience

T10: 15MW of low carbon community energy installed and two industrial sites brought into low-carbon energy generation and innovation

Derbyshire County Council

Derbyshire County Council is the upper-tier local authority for the non-metropolitan county of Derbyshire, England. Detailed below, it provides policy and strategic guidance to its planning authorities via energy, climate, and low carbon strategies.

Derbyshire Climate Change Strategy (2021 – 2025)

The "Achieving Net Zero Strategy and Action Plan" sets out DCC's climate change mitigation approach, and how DCC can reduce emissions across its operations and estate to reach net zero by 2032 or sooner. The strategy sets out the current CO_2e emissions across the county, projections for future emissions and a strategy for reducing emissions in the short to medium term. The strategy contains 28 priority targets, supported by over 120 individual climate actions, and commits DCC to delivering net zero buildings, expanding local renewable energy generation, changing transport choices, generating green jobs, and preventing waste being sent to landfill, and also to benefit the local economy.

The Strategy details key actions before 2025, including addressing:

- Council estate and operations, including asset decarbonisation, sustainable procurement, and low carbon transport.
- Low carbon economy, including renewable energy strategy, net zero local planning, green entrepreneur funding, and energy network engagement.
- Domestic decarbonisation, including heat and electricity feasibility, local area energy planning, regional low carbon skills development
- Transport and travel, including integrated low carbon transport planning, enhanced bus partnership, charging infrastructure partnerships, and cycling and walking planning.

Derbyshire Environment and Climate Change Framework (2019)

In November 2019, DCC approved the Derbyshire Environment and Climate Change Framework, setting out how local authorities in Derbyshire can work together to reduce greenhouse gas emissions within allotted carbon budgets and to achieve net zero by 2050. The framework also focuses on the benefits which can be delivered in conjunction with climate change action, including health and well being, the low carbon economy, equity and social cohesion and community resilience.

Derbyshire has a total carbon budget of 38.1 million tonnes of CO_2 equivalent (CO_2e) up to 2100. This has been broken down and attributed to each local authority in Derbyshire, with the cumulative emissions reductions requirements shown in Table 3.1.

Year	Reduction in Annual Emissions
2020	20.5%
2025	63.6%
2030	83.4%
2035	92.4%
2040	96.5%
2045	98.4%
2050	99.3%

Table 3.1 - Derbyshire Carbon Emissions Targets

The framework recognises that, whilst local authorities have no statutory responsibility for reducing emissions in line with the Climate Change Act, they must produce plans which influence emissions reduction and lead on the pathway to net zero.

Natural Capital Strategy (2022, pending)
The DCC Natural Capital Strategy will be released in summer 2022. The Strategy will set out plans to ensure Derbyshire's Natural Capital assets remain in good order to positively impact on Derbyshire's economy and the lives of its residents. The Strategy will examine the type of ecosystem services, such as carbon capture and storage, which are required, alongside the natural capital elements that are appropriate to Derbyshire's diverse, yet distinct, landscape character types. The strategy will reinforce the value of Derbyshire's natural environment and define priority areas for protection, restoration, and enhancement of natural assets. The strategy builds on legal requirements in the Environment Act 2021 including that new developments produce a 'net gain' to biodiversity (i.e that the biodiversity value attributable to a development to exceed pre-development biodiversity value by at least 10%). The Strategy will be influenced by national and regional targets for Natural Capital, such as the Forestry Commission's desire to see tree coverage across the UK to increase from 13% to 17%.

Good Growth Strategy (2022, pending)
The Good Growth Strategy will provide a framework to examine how economic growth, protection of the natural environment, continued reduction in emissions and generation of renewable energy are delivered in Derbyshire. The Strategy is closely aligned to the D2N2 Local Strategy and the UK's Industrial Strategy. Key themes include increasing productivity, creating good jobs and boosting earning power, and helping protect the climate and environment upon which we and future generations depend.

Low Emission Vehicle Infrastructure Strategy (2019-2029)
The LEVI Strategy has been designed to promote the uptake and deployment of LEVs, including electric, hybrid, hydrogen, and e-bikes in Derbyshire. It builds on national policy regarding climate action, clean growth, and industrial strategy, providing a strategic action plan for low carbon transport development. With ever increasing numbers of LEVI being used in the UK, and a continued shift in transport mode away from internal combustion engines, a strategy is required to prepare and implement infrastructure to support this transition.

The LEVI strategy details ten strategic points to guide LEVI development up to 2030, with a working group set up to implement and monitor the plan. These actions include:

> **LEVI1**: Collaborating with partners on the provision and delivery of low emission vehicle infrastructure (e.g., electric vehicle charging) across the county.
>
> **LEVI2**: Developing partnership to trial new LEV technologies and explore opportunities to innovate.
>
> **LEVI3**: Working through the planning system and with private developers and landowners to provide LEVI.
>
> **LEVI4**: Reviewing current parking management policies to support EV use.
>
> **LEVI5**: Raise awareness of low emission travel via a LEVI communications action plan.
>
> **LEVI6**: Provide LEVs to DCC employees and facilitate uptake via LEV infrastructure at DCC facilities.

LEVI7: Deploy LEVs within the DCC pool fleet.

LEVI8: Support private industry and public sector organisations to deploy LEVs within fleets.

LEVI9: Support public transport and taxi operators to embrace alternative fuel technologies and infrastructure.

LEVI10: Embed the LEVI Strategy and Action Plan within the context of an umbrella Derbyshire Clean Growth Strategy.

Local Transport Plan (LTP3)

The Local Transport Plan (LTP3) sets out a transport vision, goals, challenges to be tackled and a strategy covering the period to 2026. It is expected to be replaced by the fourth iteration (LTP4) in 2022. The transport plan sets out a strategy which ensures the transport system in Derbyshire is fair and efficient, promoting healthier lifestyles, safer communities, safeguarding and enhancing the natural environment, and providing better access to jobs and services.

The plan has five core goals:

- Supporting a resilient local economy.
- Tackling climate change.
- Contributing to better safety, security, and health.
- Promoting equality of opportunity.
- Improving quality of life and promoting a healthy natural environment.

In respect to low carbon development, including low carbon mobility, it states the DCC will "strive towards a low carbon economy where we undertake low carbon transport interventions to enhance the economy." Actions include implementing low carbon buses and supporting ULEV deployment in the county.

A new Integrated Local Transport Plan (ITPL) is currently in production for Derbyshire. The ILTP will be based on a 2050 vision and net zero, it will support local plans/local needs but also link to and support the delivery of regional transport and decarbonisation agendas.

Dealing with Derbyshire's Waste (2013-2026)

The Derbyshire and Derby City Joint Municipal Waste Management Strategy (DJMWMS) was created by the Derbyshire Waste Partnership (DWP) to address the way that waste is managed in Derbyshire, including targets for recycling, reduction of certain waste streams going to landfill, and activity around waste prevention. The strategy focuses on activities that fall within the upper sections of the waste hierarchy and considers how the local authorities in Derbyshire can work to reduce or reuse waste and improve recycling and composting performance.

The strategy intends:

- Reduced waste.
- Increased reuse and recycling/composting of waste.
- Reduced waste to landfill and recovering value from waste.
- Increased public understanding and engagement in waste and recycling leading to

high levels of customer satisfaction.

- An accessible, efficient, effective and value for money service.
- Improved resource efficiency.
- Reduced carbon / climate change impacts.
- Protection of natural resources.
- The management of non-household waste.
- Local self-sufficiency in the management of waste.

The strategy has applicability to energy development in respect to generation opportunities (e.g., energy from waste, anaerobic digestion), energy demand sources in Derbyshire, and site use (e.g., landfill sites).

New joint mineral and waste local plans are being developed by Derby and Derbyshire. The plans' area will cover the geographical county of Derbyshire, excluding that part which falls within the Peak District National Park

Peak District National Park

The Peak District National Park (PDNP) forms a large part of Derbyshire's area. Due to its national importance as an environmentally and cultural significant area, the Peak District National Park Authority (PDNPA) has developed specific policy and strategy plans for the park.

PDNP National Park Management Plan (NPMP) (2018 – 2023)

The National Park Management Plan provides the framework that encourages everyone to work together to achieve national park purposes. PDNPA identified six areas of impact where actions have the potential to add the greatest value to existing work or to drive forward bold new agendas:

- Preparing for a future climate.
- Ensuring a future for farming and land management.
- Managing landscape conservation on a big scale.
- A National Park for everyone.
- Encouraging enjoyment with understanding.
- Supporting thriving and sustainable communities and economy.

Of particular relevance to spatial energy planning, the management plan states that the national park "Need[s] energy production that does not produce greenhouse gases. However, this must not result in harm to the National Park's special qualities." Appropriate scale and design of energy generation technologies will address this concern. Furthermore, the PDNPA aims to reduce visitors' carbon footprint through low carbon transport, including promoting walking, cycling and low carbon vehicles. These actions, alongside protection and enhancement of carbon stores within the park environment will enable PDNPA to achieve net zero carbon emissions by 2050.

The PDNPA is in the process of revising the Management Plan, providing an opportunity to ensure that National Park plays an active part in development of renewable energy development in Derbyshire.

PDNP Local Development Framework Core Strategy (2011)

The PDNP Core Strategy sets out policy to achieve the statutory purposes as defined in the Environment Act 1995: primary legislation underpinning national park designation. It is the principal document of the Local Development Framework (LDF) and provides the spatial planning expression of the NPMP 2018 – 2023 and the landscape strategy. Part 2 of the Local Plan for the PDNP, entitled the Development Management Policies (DMP) document, guides and manages development across the National Park alongside the adopted Core Strategy.

The Core Strategy sets out the spatial strategy and high-level planning policies to guide development in the National Park. Policies GSP1, 2 & 3 ensure that all decisions are determined in line with National Park purposes and duty. Policies DS1 (Development Strategy) sets out what types of development are acceptable in principle in settlements and in the countryside. Policy L1 (Landscape Character and Valued Characteristics) requires all development to conserve and enhance the valued characteristics and landscape character of the National Park.

Relevant policies in regard to the spatial development of energy include, but are not limited to:

- **CC1 – Climate change mitigation and adaptation**. This policy sets a requirement for PDNPA to support efficient and sustainable use of land, buildings, and resources in line with the energy hierarchy (reduction, demand efficiency, supply efficiency, low carbon supply). It requires development to demonstrate the highest carbon reduction and water efficiency standards, as well as to avoid areas of, and impacts on, flood risk.
- **CC2 – Low carbon and renewable energy development**. This policy encourages low carbon and renewable energy development that can be accommodated in the PDNP landscape (i.e., without adverse impacts to landscape character, environmental and cultural assets via singular or cumulative impact). Where impacts occur, social economic and environmental value must be demonstrated.
- **CC3 – Waste management.** Authorities should promote sustainable waste management. Large scale waste facilities are not permitted, with small scale facilities implemented in a way which meets the needs of the local community. After-use must prioritise contributions to recreational and biodiversity value in the park.
- **CC4 – On-farm anaerobic digestion of agricultural manure and slurry.** Development is considered potentially acceptable only if locally produced agricultural waste (i.e., manure or slurry) or energy crops are used as a fuel source. Centralised systems may only be permitted where fuel sources (e.g., farms) are located in close proximity and centralisation is demonstrated to be economically advantageous.
- **T1 – Reducing the general need to travel and encouraging sustainable transport.** Transport management must prioritise conserving and enhancing the National Park's value, with cross-park traffic deterred. Demand management and low carbon initiatives will be sought by the PDNPA where appropriate.

Further policy guidance can be found in the Climate Change and Sustainable Building SPD (2013).

Carbon Management Plan (2020 – 2050)

CMP2 covers emissions from activities over which the PDNPA has operational control:

including energy and fuel used by the PDNPA and within its property portfolio, as well as the operational emissions from transport, waste, and water. PDNPA's total carbon footprint for the 2017/18 year was 723 tCO_2e. The authority aims to be net zero carbon by 2050, with an aspiration to achieve net zero before that point if possible.

The CMP highlights several key areas and locations where PDNPA can address carbon emissions via energy demand reduction and generation. The study considers 80 properties owned or operated by PDNPA, accounting for differing usage and the emissions of building users. These include operational sites, residences, agricultural business, public facilities, and visitor attractions. The CMP identifies 5 strategic themes relevant to PDNPA carbon management:

- **Monitoring and data management:** Standard approaches to data management and collection
- **A vision for the PDNPA property portfolio:** demonstrating best-practice with respect to energy efficiency, waste, and water use.
- **Travel and transport:** Assessing the accessibility of PDNPA buildings to lower-carbon forms of travel such as walking, cycling, public transport, and electric vehicles.
- **Awareness raising, communication and workplace culture:** Communicate CMP actions and outcomes to local communities, users of the park and more widely.
- **Resources for implementation:** Resourcing carbon management through a combination of the PDNPA capital strategy as well as on-going operational budgets.

Peak District Landscape Strategy and Action Plan (2009 – 2019)
The Landscape Strategy and Action Plan provides information regarding landscape change, a vision for the future and landscape guidelines for the distinctive landscapes of the Peak District. The Strategy is split into character areas and character types through which landscape features are described and their valued characteristics identified. The Strategy provides the context and direction for actions to conserve and enhance natural beauty, wildlife, and cultural heritage within the Peak District National Park. The Landscape Action Plan includes specific actions related to landscape education and to communicating the special qualities of the landscape.

- **Recognising landscape in law**, ensuring the PDNP is considered in future legislation and policy.
- **Integrating landscape into policy**: ensuring local and national development considers the PDNP, including Natural England, planning policy and bespoke PDNP policy development.
- **Identifying and assessing landscapes:** Assessment and protection of landscape character.
- **Setting landscape objectives:** Reviewing management planning, climate objectives, landscape action planning and character assessments to ensure cohesive and appropriate objectives.
- **Protecting landscapes**: Identifying and protecting priority cultural and environmental features.
- **Managing landscapes:** Working with planning authorities to ensure protection of

the PDNP landscape and appropriate types and scales of development.

- **Planning landscapes:** Addressing landscape impacts, ensuring best practice local development, and developing specific action planning (e.g., biodiversity, geodiversity action plans).
- **Monitoring change** across policy, perception, and action.
- **Promoting education and training** in environment and landscapes.
- **Raising awareness** through communications strategy and planning.
- **Cooperating across Europe**: including sharing experience and best practice with European public authorities.

3.4 Local Policy

Within Derbyshire there are eight district and borough councils. The City of Derby is a separate unitary authority in its own right and therefore distinct from Derbyshire County Council. Similarly, the PDNPA is a distinct planning authority covering the National Park area.

This spatial energy assessment will provide supporting evidence for the preparation of local development plans for District and Borough councils, Derby City Council and the PDNPA, as the majority of councils are in the process of developing new development plans (see Table 3.2). Further information on relevant climate, carbon and energy strategies within Derbyshire are provided below.

Overview of Local Plans and Climate Change in Derbyshire						
Local Authority	Local Plan Start	Local Plan End	Emerging Plan	Climate Emergency	Net Zero Target	Local Plan Low Carbon Policies
Amber Valley Borough Council	2006	2009	Yes	Yes	2030	-
Bolsover District Council	2018	2033	No	Yes	-	SS1 Sustainable Development SC2 Sustainable Design and Construction SC6 Renewable and Low Carbon Energy ITCR10 Supporting Sustainable Transport Patterns
Chesterfield Borough Council	2020	2035	No	Yes	2030	CLP12 Renewable Energy (Strategic Policy)
Derby City Council	2017	2028	Yes	Yes	2050	CP2 Responding to Climate Change CP9 Delivering a Sustainable Economy CP23 Delivering a Sustainable Transport Network
Derbyshire Dales District Council	2013	2033	Yes	Yes	2030	S1 Sustainable Development Principles PD7 Climate Change
Erewash Borough Council	2014	2028	Yes	No	-	P1 Climate Change
High Peak Borough Council	2016	2031	Yes	Yes	2030	S1 Sustainable Development Principles EQ1 Climate Change

Overview of Local Plans and Climate Change in Derbyshire						
Local Authority	Local Plan Start	Local Plan End	Emerging Plan	Climate Emergency	Net Zero Target	Local Plan Low Carbon Policies
North East Derbyshire District Council	2014	2034	No	Yes	2030	SS1 Sustainable Development SDC10: Decentralised, Renewable and Low Carbon Energy Generation ID3: Sustainable Travel
Peak District National Park Authority	2011	2026	Yes	No	2030	CC1: Climate change mitigation and adaption CC2: Low carbon and renewable energy development CC4: On-farm anaerobic digestion of agricultural manure and slurry T1: Reducing the general need to travel and encouraging sustainable transport
South Derbyshire District Council	2011	2028	Yes	Yes	2030	S1 Sustainable Growth Strategy SD6 Sustainable Energy and Power Generation INF2 Sustainable Transport

Table 3.2 - Overview of Local Authority Low Carbon Policy and Planning

4. Derbyshire's Energy System

Understanding the existing energy system in Derbyshire – including energy demand, energy generation, sustainable transport, and carbon emissions – is necessary to provide context for future low carbon development in the county. This section describes the existing energy system in Derbyshire as a whole as well as within each council area within the geographical county.

4.1. Energy Demand

The objective of this study is to provide a spatial energy context and projection for Derbyshire which will support local and regional energy planning and better enable the transition to net zero across the county.

4.1.1 Energy Efficiency

Information on the energy efficiency of the housing stock in Derbyshire was gathered from the Energy Efficiency of housing in England and Wales: 2021 database provided by the Office for National Statistics (ONS).

Energy Performance

EPC certificate describes the theoretical efficiency of energy consumption that a particular building could feasibly achieve, with Band A being the most efficient (92 – 100 points) and band G the lowest (1 – 20 points). Figure 4.1. Demonstrates that domestic properties in Derbyshire have a median energy efficiency rating of 65 (Band D) across all nine districts, marginally above the UK average of 60. Annual carbon emissions from domestic properties in Derbyshire averages 3.6 tCO_2e per property per year.

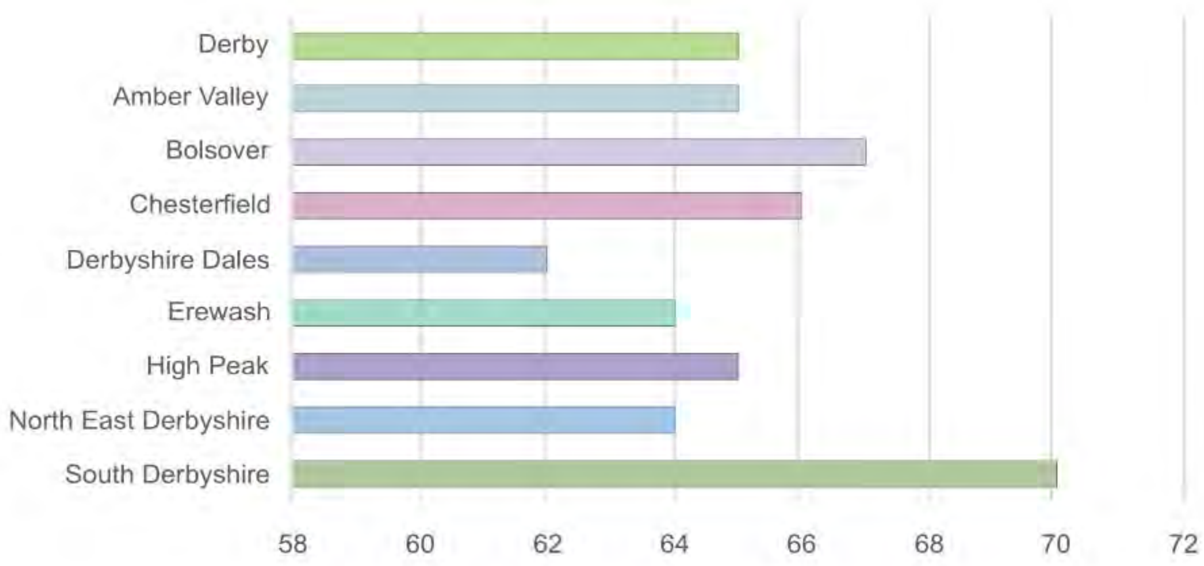


Figure 4.1 - Median domestic EPC score by local authority

Figure 4.2 provides an overview of EPC ratings for non-domestic buildings in Derbyshire. The average non-domestic EPC rating is C, with few highly rated EPCs recorded in Chesterfield (10), Derby (3) and Derbyshire Dales (2).

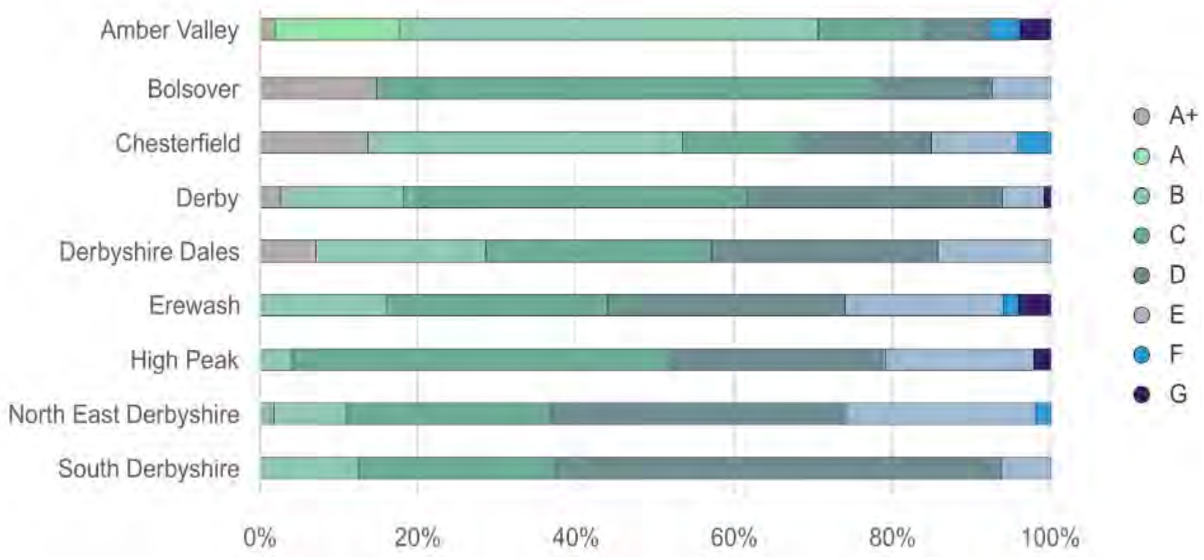


Figure 4.2 - Non-domestic EPC ratings per local authority

Display Energy Certificates

Display Energy Certificates (DEC) were introduced by the UK Government in response to the EU Energy Performance of Buildings Directive and are designed to promote improvements in the energy performance of non-dwelling buildings. Data for the DECs of eligible non-domestic buildings throughout the nine local authorities across Derbyshire was collected from UK Government data sets.

DEC certificates describe the actual energy performance of a building over the previous 12-month period. Figure 4.3 provides a proportional breakdown of DEC ratings across each local authority in Derbyshire in 2021. The average DEC rating across the area is D, with 36% of non-domestic properties. Currently 59% of non-domestic properties within Derbyshire have a rating of D or worse.

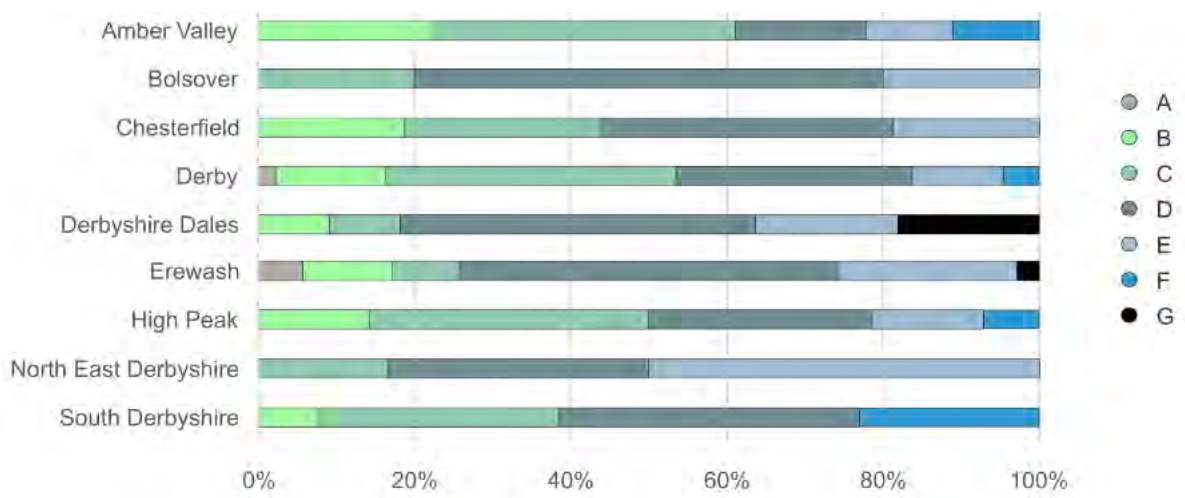


Figure 4.3 - Non-domestic DEC ratings in Derbyshire

Fuel Poverty

In 2021, the government published an updated fuel poverty strategy "Sustainable Warmth – Protecting Vulnerable Households in England". The strategy includes a new fuel poverty indicator, Low Income Low Energy Efficiency (LILEE). LILEE aims to ensure that energy efficiency improvements are prioritised in homes that have an EPC rating below C. The strategy sets out a target for all UK homes to achieve an EPC rating of C by 2030.

In total, there are 356,926 households facing fuel poverty in Derbyshire as of 2021. This figure is likely to increase as UK electricity and gas prices continue to rise through 2022. The majority of local authorities were found to have fuel poverty levels similar to the UK average (13.4%). However, Derby City (15.6%) and Bolsover District (16.2%) have notably higher levels of fuel poverty, whilst South Derbyshire has lower levels than average (11.8%).

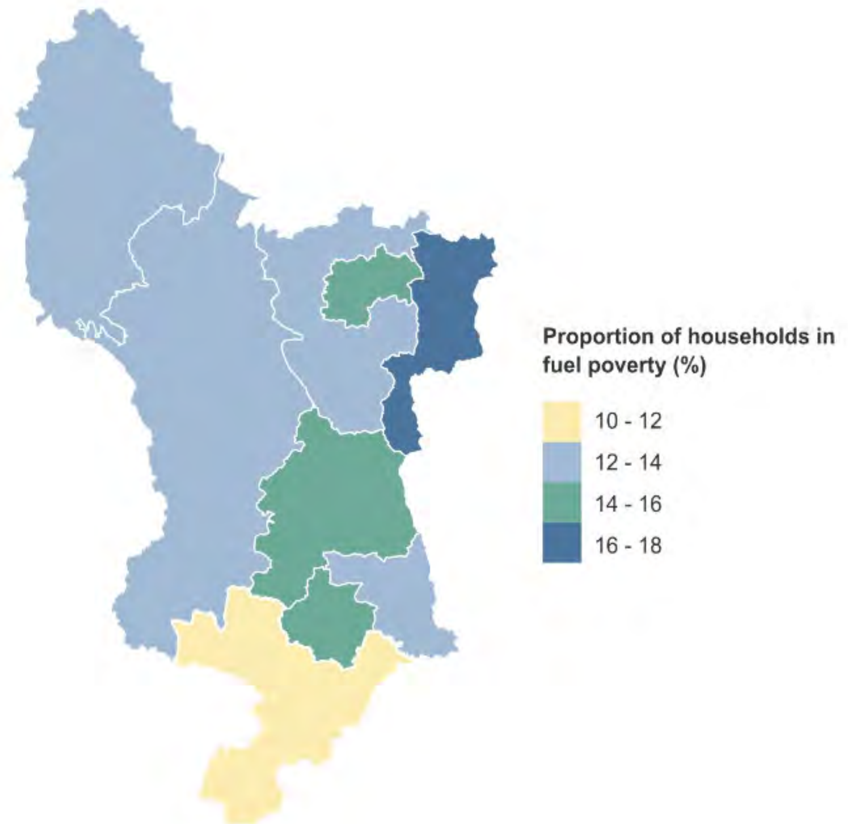


Figure 4.4 - Proportion of fuel poor households in Derbyshire

4.1.2 Electricity Demand

Long term trends show that domestic electricity consumption in the UK has been falling, dropping 9.2% between 2005 and 2020. This is a result of a number of factors including product energy efficiency regulations, energy-efficient lighting, environmentally conscious consumers, and economic restructuring, including offshoring of energy-intensive industries. However, as a result of the coronavirus pandemic, domestic consumption rose in 2020 by 5.6%.

Domestic Demand

Derbyshire has an annual total domestic electricity consumption of 1,735 GWh, representing 1.6% of England's total domestic consumption. Mean domestic electricity consumption is 3,668 kWh, lower than the UK average of 3,748 kWh.

Figure 4.5 shows total domestic consumption for each local authority within Derbyshire, and highlights which areas have the highest (Derbyshire Dales) and lowest (Chesterfield) domestic consumption per meter, compared to the regional and national averages.

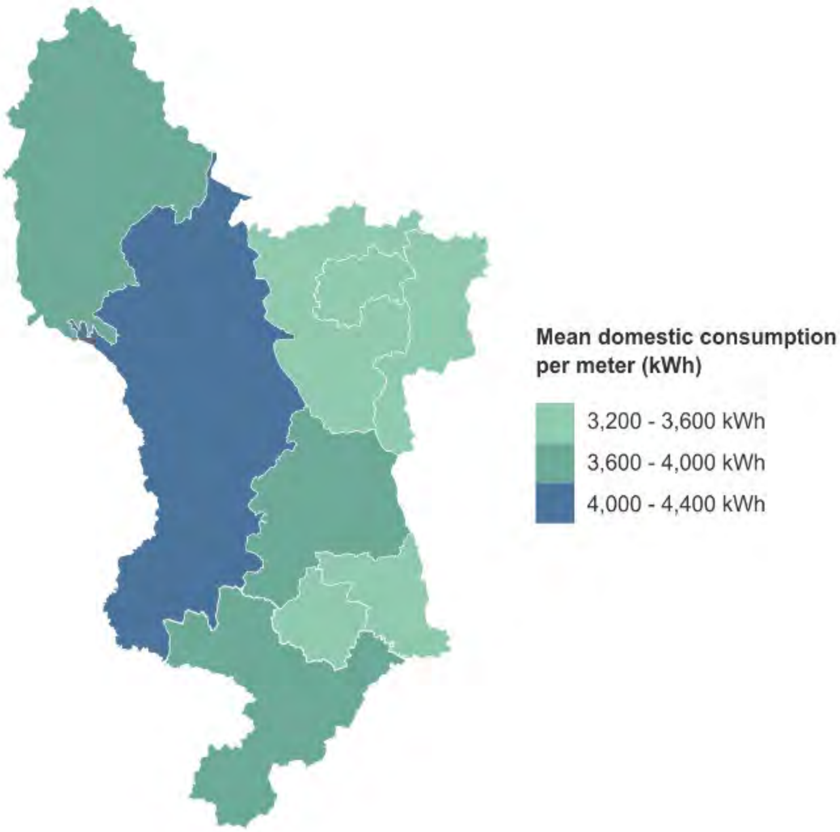


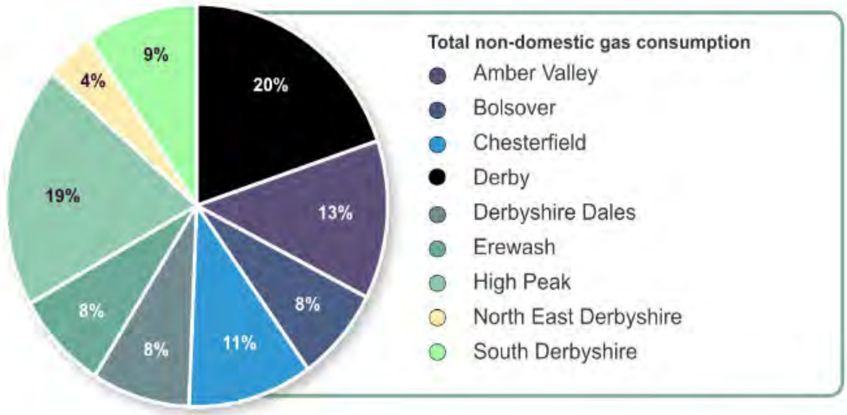
Figure 4.5 - Mean Domestic Electricity Consumption in Derbyshire

Non-Domestic Demand

Non-domestic electricity consumption accounts for more than half of all electricity consumed in the UK. In the UK, total non-domestic electricity consumption fell by 11.1% during 2020 due to the coronavirus pandemic and associated lock downs.

Mean non-domestic electricity consumption is around 10.1 MWh per m2 of non-domestic floor area. Derby City has the highest average consumption, at 40.7 MWh/m2, compared with Bolsover District which recorded just 2.7 MWh/m2.

Derbyshire has an annual total non-domestic consumption of 2,812 GWh, representing 1.86% of UK total non-domestic demand. Mean annual non-domestic consumption in Derbyshire is 71,716 kWh, significantly greater than the UK average of 59,015 kWh. This is likely to be due to the relatively high level of industrial demand in comparison to the rest of the UK.



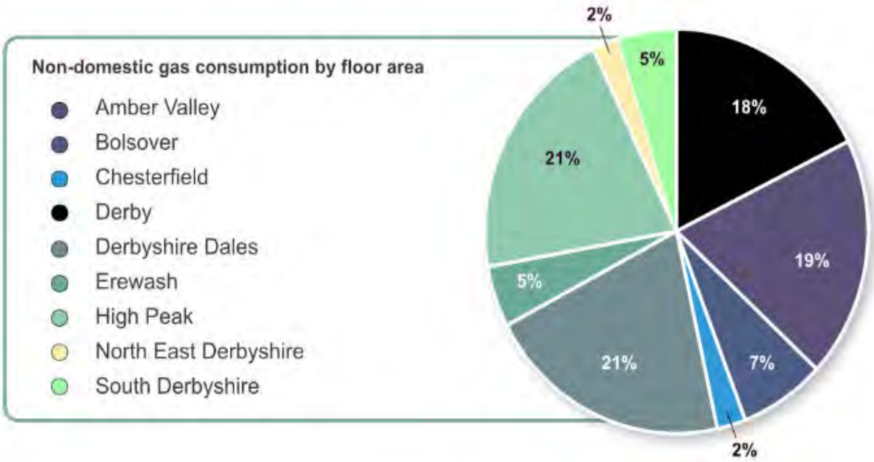


Figure 4.6 - Non-Domestic Electricity Consumption in Derbyshire

4.1.3 Heat Demand

Approximately half (760 TWh) of all UK energy consumption is heat energy, which is more than the energy required for electricity production and transport combined. Of this, 57% (434 TWh) is used to heat and provide hot water for our homes. In Derbyshire there are approximately 995,621 domestic and non-domestic gas meters, with a total consumption of 10,046 GWh, representing 1.3% of total UK heat demand.

Domestic Demand

Total domestic heat demand was 6,171 GWh in 2021 across Derbyshire, with a mean consumption of gas per household of 14,073 kWh. This is slightly higher than the UK average of 13,698kWh and East Midlands average of 13,925kWh. Derby City accounted for 22.5% of all domestic heat demand in Derbyshire. Figure 4.7 demonstrates the distribution of domestic consumption across each local authority within the study area.

Non-Domestic Demand

Total non-domestic gas consumption across Derbyshire was 3,875 GWh in 2021, with an average consumption of 13.9 MWh per m2 of floor area. Similar to domestic heat demand, Derby City accounts for 22% of all non-domestic heat demand, with High Peak (19%) and Amber Valley (13%) also forming a comparatively high proportion of the county's heat demand.

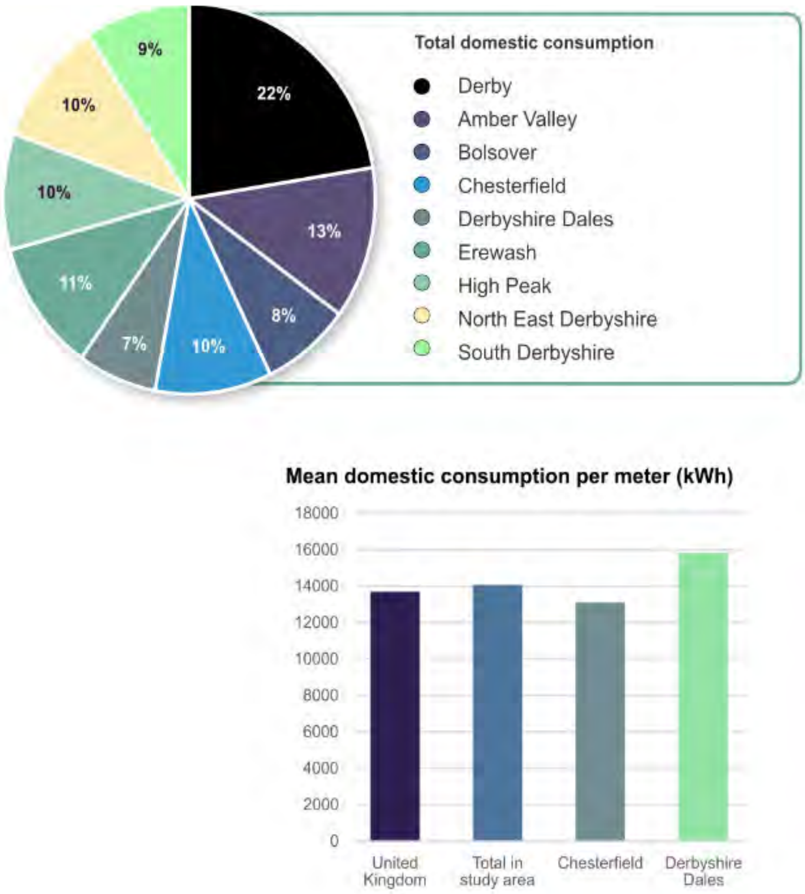


Figure 4.7 - Domestic gas consumption in Derbyshire

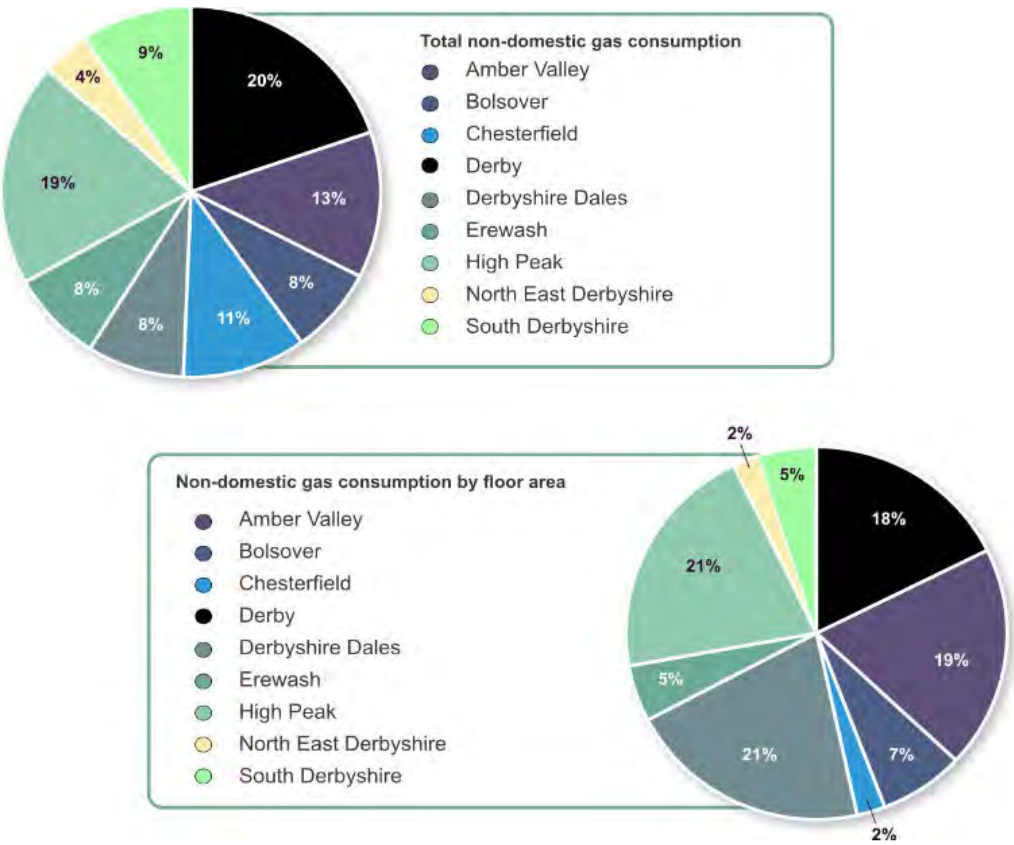


Figure 4.8 – Non-domestic gas consumption in Derbyshire

Heat Demand Density

Data for variable heat demand within Derbyshire was taken from the UK CHP Development Map produced by the UK Government's Department for Business, Energy, and Industrial Strategy (BEIS). This map provides indicative estimates of heat load (i.e., heat demand) per km^2 for a particular local authority or region within the UK (Table 4.1). This heat demand data was then further disaggregated by sector, across various domestic, industrial, government, and commercial uses.

A 2018 study, 'Derbyshire County Council – Heat Mapping and Energy Masterplanning' conducted by AECOM for Derbyshire County Council, has highlighted that cooling benchmarks are only used for offices and retail buildings. Therefore, it assumed for all other building types there is no demand for cooling.

Distribution of Heat Load in Derbyshire		
Sector	Share	Total MWh
Domestic	78.2%	23,374,576
Large Industrial	7.0%	2,079,423
Small Industrial	4.9%	1,453,772
Commercial Offices	2.8%	833,824
Education	2.1%	635,201
Communications and Transport	1.2%	357,534
Health	1.0%	296,324
Retail	0.9%	271,704
Hotels	0.5%	136,114
District Heating	0.5%	141,142
Sport and Leisure	0.3%	76,390
Warehouses	0.3%	102,243
Government Buildings	0.3%	89,372
Other	0.2%	43,576
Total heat load	**100.0%**	**29,891,195**

Table 4.1 – Distribution of heat load across sectors

4.2. Energy Supply

Energy supply incorporates fossil and non-fossil fuel energy generation, storage, transmission, and distribution. Once at the heart of the industrial revolution, Derby and Derbyshire is witnessing and promoting cleaner, reliable, and cheaper means of generating and supplying energy.

4.2.1 Energy Generation

In 2020, UK energy generation totalled 312 TWh, of which 136 TWh was generated by renewable sources and 117.8 TWh from fossil-fuel sources. Of this total generated electricity, gas was the dominant electricity source (111.4 TWh). Total generation capacity decreased in 2020 to 75.8 GW from 77.9 GW in 2019.

Figure 4.9 displays the breakdown of the UK's electricity generation by fuel type as of December 2021. Fossil fuels currently provide fuel to generate 40.3% of the UK's electricity[1], with a further 16.1% from nuclear generation. Renewable technologies account for 43.6%, with 24.2% of generation from wind.

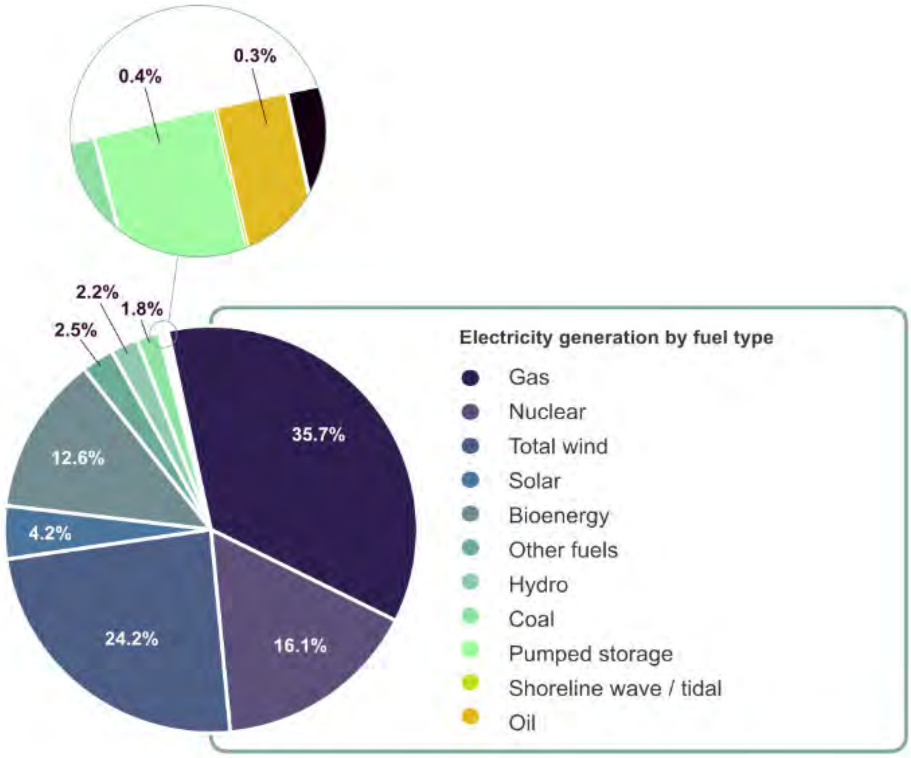


Figure 4.9 – UK electricity generation by fuel type

Fossil Fuels

Currently, approximately one third of the UK's energy demand is met by natural gas. There are also significant oil and gas reserves from coal bed methane and shale gas. There is currently no fossil fuel exploration being conducted in Derbyshire.

Demand for coal as an energy source has reduced significantly in recent years as a result of Government policies to address climate change and reduce greenhouse gas emissions. Whilst there are substantial reserves of coal in the North East and South Derbyshire

[1] Includes coal, oil, gas, and other fuels (e.g., non-biodegradable waste fuels).

coalfields it is unlikely that coal will be extensively worked again as a source of energy generation. Derbyshire has seen the closure of two major coal power station sites in the last two decades at Willington and Drakelow. The Derby and Derbyshire emerging Minerals Local Plan, and the 'Gas from Coal' Background Paper identifies that there are two coalfields within Derbyshire. Both the North Derbyshire Coalfield and the South Derbyshire Coalfield have up to 30 seams of varying thickness that are substantial enough to be worked commercially. The Oil and Gas Authority has recently granted 3 private companies extraction licenses in 11 areas of Derbyshire.

Minimal production of methane gas in Derbyshire has been conducted using abandoned mines and the potential for further gas extraction is considered to be low. The shale deposit which covers northern and eastern Derbyshire has been identified as a source of gas. However 'hydraulic fracturing' is required to access the gas and there is currently, as of 2022, a Government moratorium in view of environmental concerns. Willington has been proposed as a future site for a new gas power station. The Drakelow site in South Derbyshire closed in 2003 and in 2019 permissions to develop an energy-from-waste facility on the site was granted, with construction of the facility scheduled to be completed by 2023. Derwent Power Station, a 214MW gas-fired power station closed in 2012 and the station is due to be demolished in 2021 as it is no longer commercially viable.

Renewable & Low Carbon Energy

Renewable electricity by local authority data produced by BEIS demonstrates the number of sites with renewable assets and the total installed capacity of each. Table 4.2 and Figure 4.10 show the breakdown of asset type and capacity (MW) across the study area.

The total installed capacity of renewable and low carbon electricity generation in Derbyshire was approximately 270.5 MW in 2021, comprised primarily of Solar PV (76.2%), onshore wind (10.3%), and energy from waste (10%). The Derbyshire Dales was found to have the highest generation capacity, with 49MW of solar PV and 15MW of wind energy generation installed. The Central Feed-in Tariff Register (CFR) shows Feed-in Tariff supported installations per local authority, including solar PV, wind, hydro, anaerobic digestion, and micro-CHP. The average installs per 10,000 properties in Derbyshire is 383, which is significantly higher than the national average (298).

Low Carbon Energy in Derbyshire									
	Solar PV	Wind	Hydro	Anaerobic Digestion	Sewage Gas	Landfill Gas	Municipal Solid Waste	Biomass	Total
Number of Sites	18,202	72	24	3	4	6	1	3	**18,315**
Installed Capacity (MW)	206.1	27.8	1.7	0.4	3.5	9.2	13.8	7.9	**270.4**
Generation (GWh/year)	202.2	64.4	5.9	2.2	15.0	31.5	43.3	39.8	**404.3**

Table 4.2 – Overview of Low Carbon Energy in Derbyshire

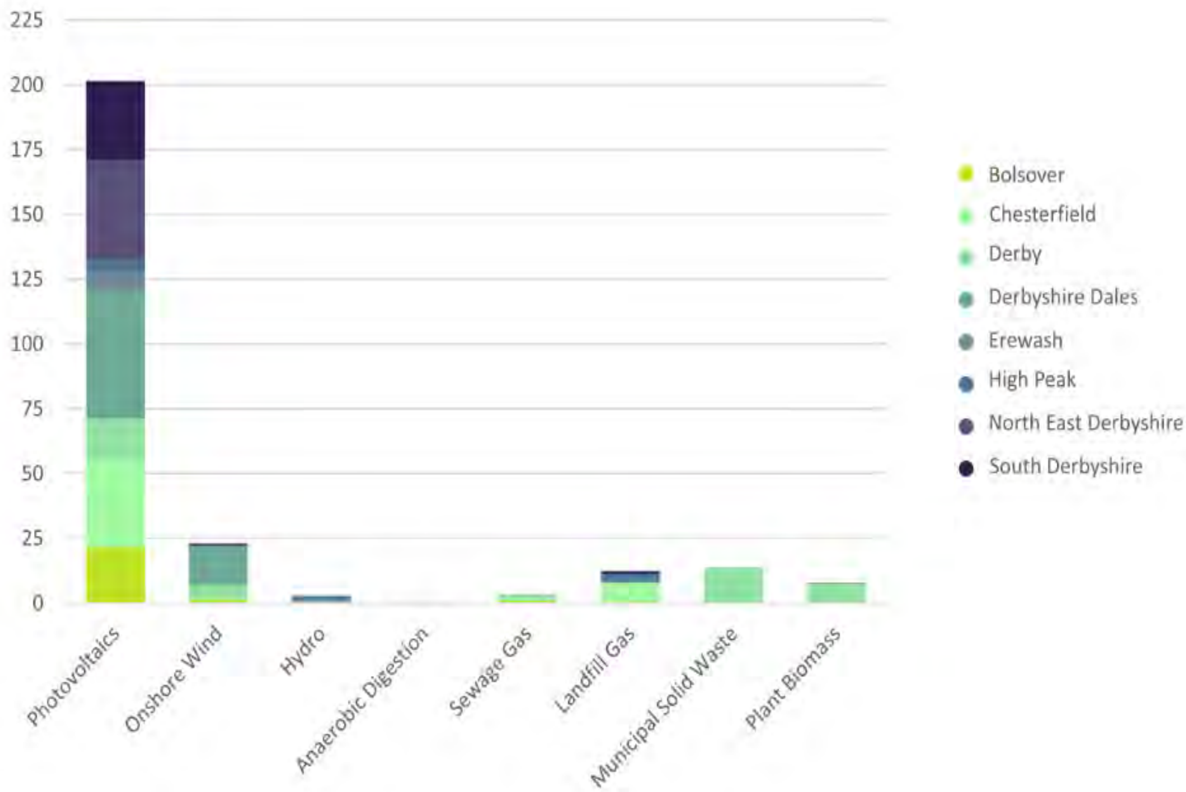


Figure 4.10 - Installed Low Carbon Generation Capacity by Technology

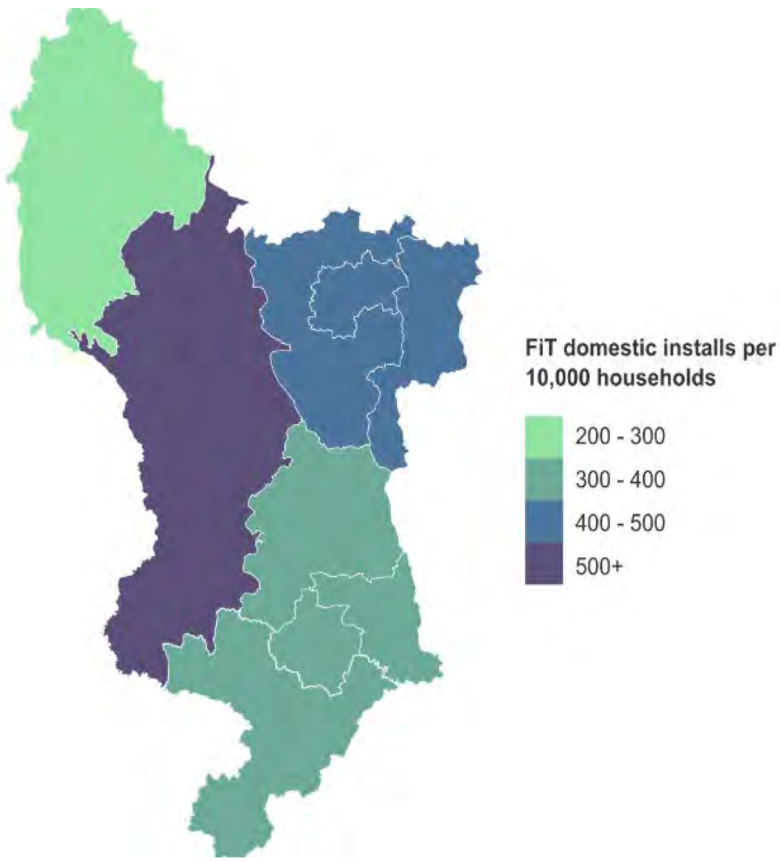


Figure 4.11 – Domestic FiT installs per 10,000 households in 2020

Based on data from the Renewable Energy Planning Database (REPD, Table 4.3), as of 2021 there are 16 renewable or low carbon projects with active planning permission (i.e., granted in the last 3 years). This includes the conversion of the decommissioned Drakelow Power Station to become a biomass CHP renewable energy centre (15 MW) due to become operational in 2023; as well as over 86 MW of Solar PV. There is a further 219 MW of standalone, grid-connected battery storage, intended to provide operational support to electricity grid and improve renewable generation output.

Planned Low Carbon Projects in Derbyshire		
Technology	Capacity in Planning (MW)	Capacity Permission Granted (MW)
Wind	2	-
Solar PV	65.4	71.29
Battery	160.35	129.1
Energy from Waste (Advanced Conversion Technologies)	-	15

Table 4.3 – Planned low carbon generation in Derbyshire (REPD, 2021)

Energy from waste

Derbyshire and Derby's joint Municipal Waste Management Strategy - 'Dealing with Derbyshire's Waste' - sets out a vision to help manage waste sustainably for their communities up to 2026.

In 2021, a £150m energy from waste (EfW) power plant was proposed in in Swadlincote, Derbyshire. The Swadlincote Resource Recovery Park would convert around 230,000 tonnes of post-recycled sewage into heat and electricity, producing around 23MW of low carbon power for use by local businesses at a nearby industrial estate.

An integrated waste management scheme (Derby and Derbyshire Waste Treatment Centre) processing 190,000 tonnes of waste with capacity to receive up to 200,000 tonnes of municipal waste annually, includes an advanced conversion technology that would export 8 MW per hour of electricity to the national grid generating enough to power 14,000 homes annually. Future plans to implement the scheme at the site remain under consideration.

4.2.2 Energy Storage

The UK currently has approximately 1.3GW of installed battery storage capacity, with a forecasted total of 4.5GW by the end of 2022. Currently the majority of the battery storage installations are in the south of England, including 80% of new energy storage planning applications.

There are a number of active and planned large scale battery projects in Derbyshire (Table 4.4), including installations which provide grid flexibility and balancing services, as well as those co-located with existing renewable energy generation. Additional to these projects, battery storage at the domestic level is becoming increasingly viable in the UK and the number of domestic installations is expected to be increasing across the country.

Planned Energy Storage Projects in Derbyshire				
Developer	Site	Capacity (MWh)	Status	Date
Anesco / Green Hedge Energy UK	Breach Farm	10	Commissioned	2018
Anesco / Green Hedge Energy UK	Breach Farm - Energy Barn	40	Planning Granted	2020
Volta Energy Storage	Callywhite Lane	18	Planning Granted	2020
Anesco	Newton Wood Farm	49.9	Planning Granted	2021
Together Housing	Smithybrook View	1.2	Planning Granted	2021
Aura Power BESS Ltd	Caldwell Road	90	Planning Granted	2021

Table 4.4 – Overview of grid-connected battery storage sites

4.2.3 Low Carbon Heat

The East Midlands has 9% of all RHI-accredited low carbon heat installations, totalling 1,976 separate installations with a heat generation capacity of 660.6 MW^{th}. The study area currently has 312 RHI-accredited installations, with a total capacity of 69 MW^{th} and annual generation of 680 GWh^{th}.

Within Derbyshire 66.4% of installations are Air-Source Heat Pumps (ASHP), providing heat to both domestic and commercial properties. Ground-source Heat Pumps (GSHP) account for 15% of RHI installations, with biomass (12%) and solar thermal (5%) making up the rest.

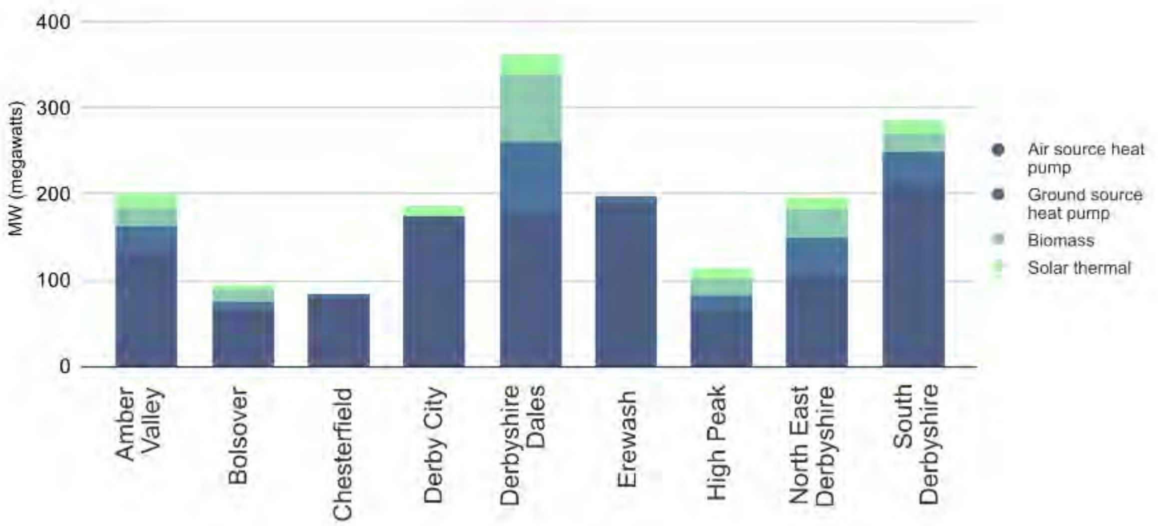


Figure 4.12 – Installed capacity of accredited RHI technologies across DCC

Heat Networks

The heating requirements of existing and planned industrial, commercial, and residential buildings in Derbyshire were assessed and illustrated by Derbyshire County Council's Heat Mapping and Energy Masterplanning report (2011).

The Master plan identified 3 areas where heat networks are highly likely to be viable:

- Clay Cross: with heat imported from the planned 10MWth Clay Cross Energy Recovery Facility.
- Matlock: with around 4MWth of heat imported from the battery recycling facility in Darley Dale.
- Chesterfield: supplying Derbyshire's largest heating load, the Chesterfield and North Derbyshire Royal Hospital, as well as a number of other buildings in the town centre, with heat generated specifically for use in the district heating network (DHN).

The BEIS heat networks data set 2021 details 4 planned heat networks in Derbyshire:

- Pronto Paints: A 20kWth biomass installation supplying storage warehouses in Chesterfield.
- 41 Market Place & 2 Union Street: A private 6 connection ASHP network supplying a mixture of residential and retail properties in Ashbourne.
- Becketwell Performance Venue: A single connection ASHP network supplying a planned 3,500 capacity performance arena in Derby with the potential to integrate solar PV electricity supply.

4.3. Energy Networks

Energy networks provide the delivery infrastructure for both electricity and heat, including electrical transmission and distribution networks and the national gas grid. Energy networks will play a vital role in delivering the UK's 2050 and 2045 net-zero emissions targets. With increasing levels of distributed renewable energy and innovation in how demand and networks are managed, energy networks are central to the spatial opportunities and limitations for new generation.

4.3.1 Electricity Network

There are two types of electricity cables used to transport electricity across the UK:

- The transmission network transports high voltage (HV) electricity over long-distances between generators and areas of demand.
- The distribution network transport low voltage (LV) electricity at a more local level, connecting energy users with the transmission system.

The distribution networks are regional grids that branch from the National Grid to deliver power to industrial, commercial, and domestic users. The Derbyshire area is supplied by 3 different Distribution Network Operators (DNO) (Figure 4.13), with the majority of the area supplied by National Grid, Electricity North West supplying the north west, and Northern PowerGrid (Yorkshire) supplying the north-east of Derbyshire.

4.3.2 Gas Network

The United Kingdom's National Transmission System (NTS) is the network of gas pipelines that supply gas to approximately 40 power stations, large industrial users and to gas distribution companies that supply commercial and domestic properties. The East Midlands region has 13 gas distribution off takes from the NTS, these supply industrial users, local distribution networks, storage sites and export pipelines.

Off-gas-grid properties are mostly found in rural areas, with fewer households not connected to the gas network in built up areas (e.g., only electric heating). Recent Government policy includes measures such as the 'rural first approach', with a proposed replacement boiler ban from 2026 in off-gas-grid properties, compared with 2035 for on grid properties. In Derbyshire, 6% of properties are off-gas-grid, with the greatest number in more rural areas, such as Derbyshire Dales (21%), and fewer in built up areas, such as Chesterfield (3%).

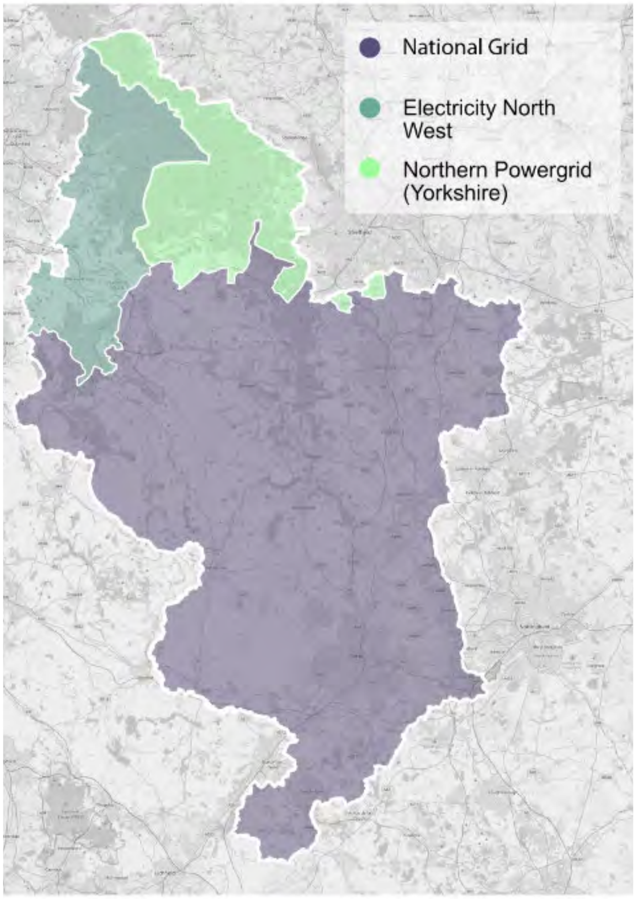


Figure 4.13 – Distribution Network Operators (DNO) within Derbyshire

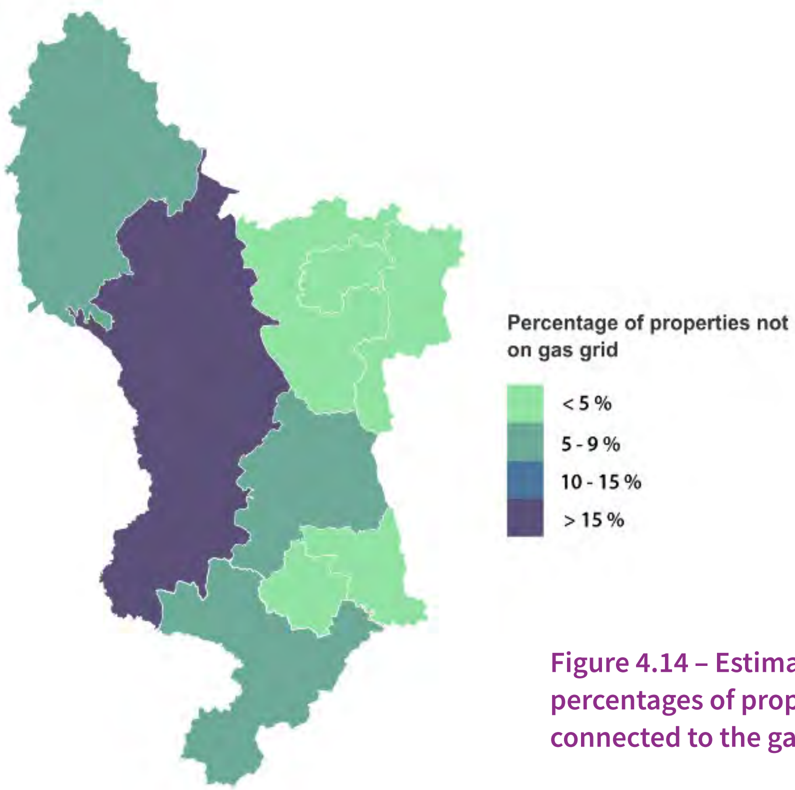


Figure 4.14 – Estimated percentages of properties not connected to the gas grid

4.4. Sustainable Transport

Sustainable transport refers to all vehicles which have a degree of energy demand or carbon emissions, with a focus on low and zero emissions vehicles.

4.4.1 Ultra-Low Emission Vehicles (ULEV)

ULEVs incorporate all vehicles with less than 75 g/km of CO_2e emissions. Uptake of Ultra Low Emission Vehicles (ULEVs) has increased dramatically since the UK Government's records began in 2011. Table 4.5 and Figure 4.15 detail the number and proportion of ULEVs across the local authorities within Derbyshire.

ULEV Uptake in Derbyshire		
Local Authority	Number of ULEVs (2021)	Percentage of total ULEVs in Derbyshire
England	**576,273**	-
Derbyshire	**8,308**	-
Amber Valley	711	8.6%
Bolsover	314	3.8%
Chesterfield	2,003	24.1%
Derby City	2,462	29.6%
Derbyshire Dales	594	7.1%
Erewash	548	6.6%
High Peak	497	6.0%
North East Derbyshire	565	6.8%
South Derbyshire	614	7.4%

Table 4.5 – Ultra Low Emission Vehicles per Local Authority in Derbyshire.

4.4.2 Low Emission Vehicle Infrastructure (LEVI)

The scale-up of electric vehicles in the UK is dependent on simultaneous implementation of low emission vehicle infrastructure (LEVI), particularly electric vehicle charging systems. There is growing demand for vehicle charging facilities, helping to reduce fossil fuel- based vehicles by replacing them with electric powered alternatives such as cars, public transport vehicles such as taxis and buses, and increasing the availability of electric public transport, taxis, rented Evs (e.g., car clubs), bikes and scooters. In some cases bus operators or franchises may have their own programs for the replacement of fossil fuel buses with electric alternatives.

The UK Department for Transport provides regularly updated national and regional electric vehicle charging device data. This data has been compared with 2020 population estimates to provide comparable statistics for different areas across the UK (Table 4.6). The data does not include private domestic and commercial charging infrastructure (i.e., unregistered chargers installed at homes or business properties).

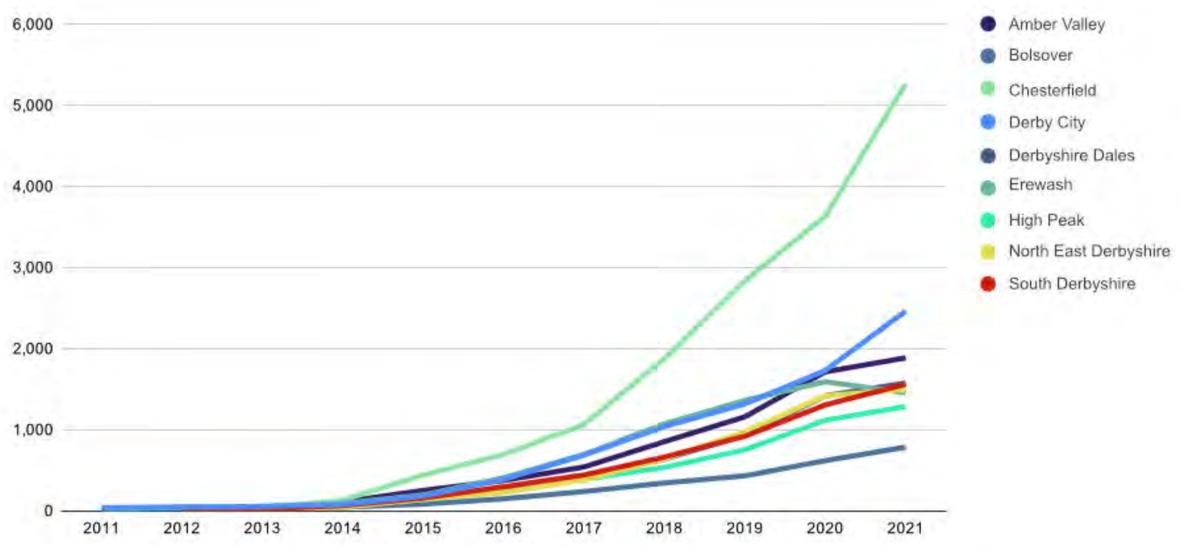


Figure 4.15 – EV uptake growth since 2011

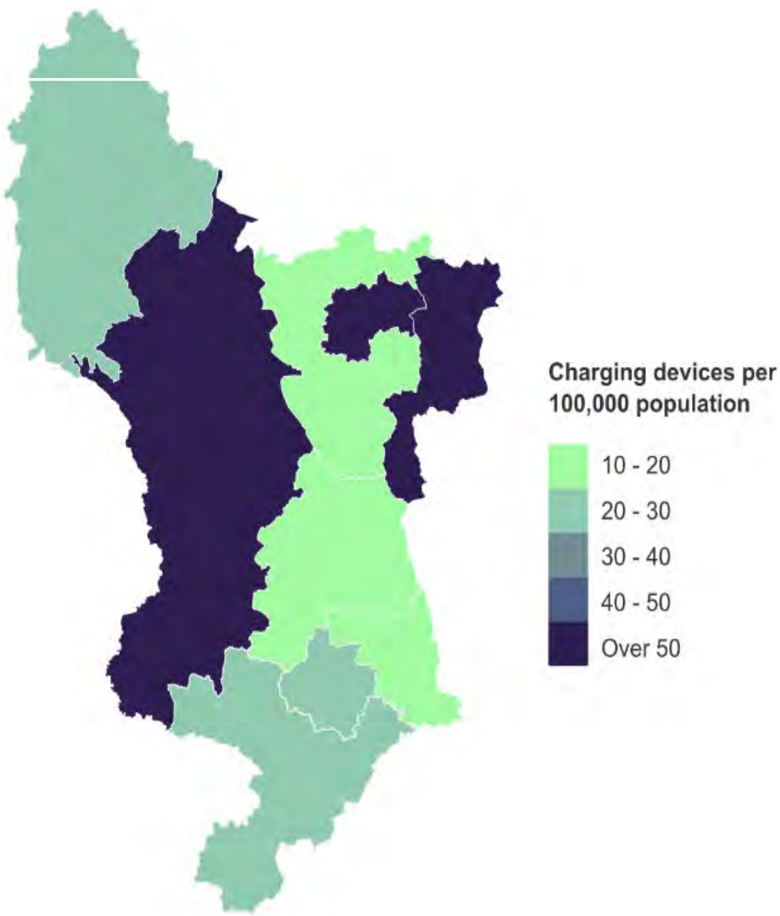


Figure 4.16 – Vehicle charging devices per 100,000 population in Derbyshire.

ULEV Uptake in Derbyshire				
Location	Devices per 100,000 population	Rapid charging devices (>25kW) per 100,000 population	New charging devices (2021 to 2022)	New rapid charging devices (2021 to 2022)
United Kingdom	42	7.7	+ 9.4% (2,448)	+ 4.7% (233)
East Midlands	32	7.7	+ 9.7% (137)	+ 7.5% (26)

Table 4.6 – Regional and National EV Charging Device Statistics

Table 4.7 highlights there are considerable differences between LEVI development across different local authorities in Derbyshire, ranging from a low of 10.8 charging devices per 100,000 people in North East Derbyshire, to a high of 56.2 charging devices in Chesterfield.

ULEV Uptake in Derbyshire			
Local Authority	Devices per 100,000 population	Total public charging devices	Total public rapid charging devices
Amber Valley	17.9	23	5
Bolsover	50.4	41	16
Chesterfield	56.2	59	9
Derby City	29.6	76	31
Derbyshire Dales	51.1	37	2
Erewash	18.2	21	10
High Peak	28.1	26	10
North East Derbyshire	10.8	11	2
South Derbyshire	20.1	22	5

Table 4.7 – Local Authority Charging Device Statistics

4.5. Carbon emissions

This section outlines the related emissions across each sector and each local authority. Local authority carbon emission data is available from 2005 onward. The data covers terrestrial CO_2 emissions across all industrial energy use, agriculture, commercial, public sector, domestic and transport.

The total carbon emissions for England in 2019 were 290,176 $ktCO_2$ across all sectors. Derbyshire accounted for 2.5% of this total. There has been a downward trend in emissions per km^2 and per capita across all local authorities in Derbyshire since 2005.

4.5.1 Overview

The total net carbon emissions across Derbyshire totalled 7,224 $ktCO_2$ in 2019. Figure 4.17 demonstrates that the largest contributor to carbon emissions comes from large industrial installations (36%), followed by transport (26%) and domestic energy emissions (18%).

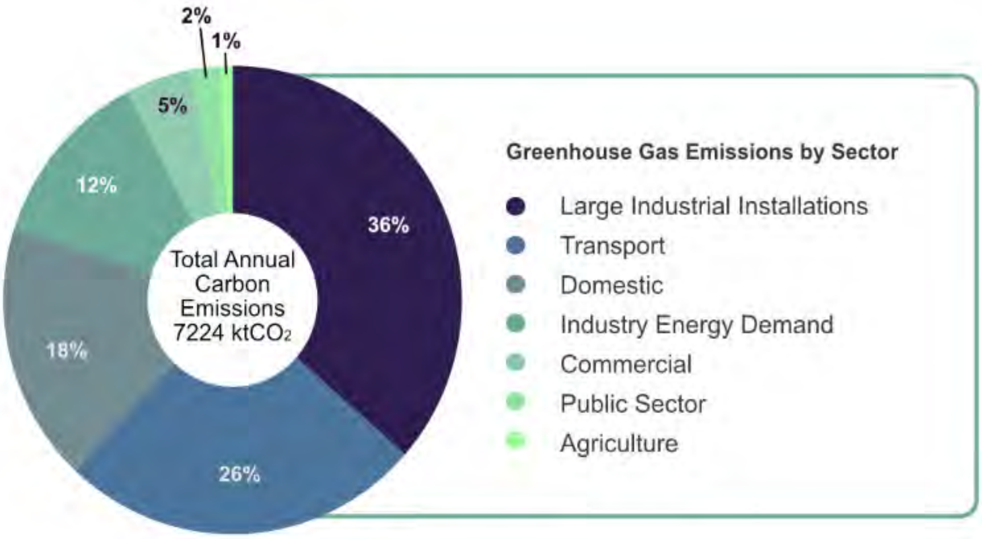


Figure 4.17 – Derbyshire carbon emissions by sector

Carbon emissions reductions have occurred within all Derbyshire local authority areas since 2005. Figure 4.18 shows that High Peak has notably higher levels of carbon emissions and little change in emissions since 2010, likely due to the high levels of industrial activity in that area (assumed related to minerals extraction and processing activities). The City of Derby has seen the largest decrease in emissions, dropping 37% since 2005.

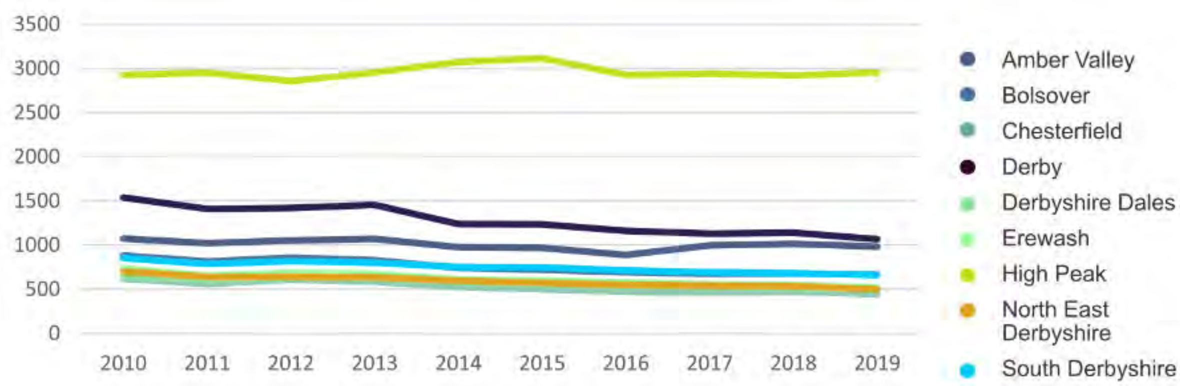


Figure 4.18 – Total carbon emissions in Derbyshire since 2005 ($ktCO_2$)

Table 4.8 details local authority per capita and per km^2 emissions, demonstrating that densely populated areas, such as Derby City, have lower emissions per capita but greater emissions per km^2. In comparison, Bolsover and High Peak have very high emissions per capita due to low populations and the presence of industrial emissions within these districts.

Carbon Emission Breakdown for Derbyshire in 2019 (CO_2)			
Local Authority	**Total Emissions (kt)**	**Per capita emissions (t)**	**Emissions per km^2 (kt)**
Amber Valley	663	5.2	2.5
Bolsover	983	12.2	6.1
Chesterfield	445	4.2	6.7
Derby City	1,067	4.1	13.7
Derbyshire Dales	501	6.9	0.6
Erewash	519	4.5	4.7
High Peak	2,953	31.9	5.5
North East Derbyshire	499	4.9	1.8
South Derbyshire	661	6.2	2.0
Derbyshire Total	7,224	9.0	2.8

Table 4.8 – Per capita and per km^2 emissions per local authority

4.5.2 Land Use, Land-Use Change and Forestry (LULUCF)

LULUCF refers to land uses which effectively reduce carbon emissions through carbon capture, such as forestry or peatland. Net LULUCF emissions are increasing annually across each local authority in Derbyshire, as demonstrated in Figure 4.19. In 2019, total LULUCF net emissions in Derbyshire was -129.5 kt CO_2 (BEIS, 2019), a marginal reduction in emissions across the County.

In general, forest lands, grasslands and wetlands are the most efficient at reducing local emissions. The land use with the greatest level of net emissions reduction in Derbyshire is forest land, whilst areas with the lowest levels of net emissions reduction are more active land uses, such as cropland and settlements.

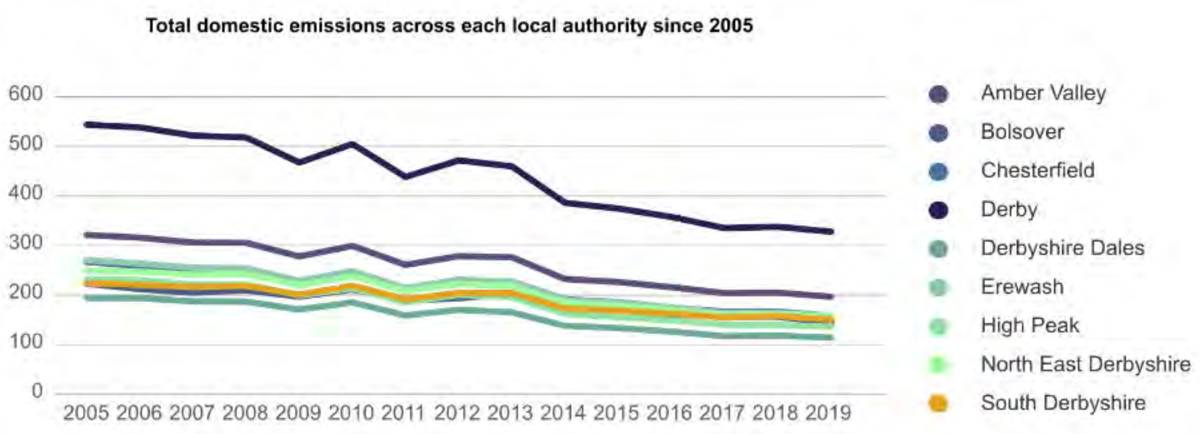


Figure 4.19 –Net emissions trajectories per local authority

LULUCF Net Emissions Reduction in Derbyshire in 2019 ($ktCO_2$)						
Local Authority	Forest land	Cropland	Grassland	Wetlands	Settlements	Total
Amber Valley	-12.4	6.2	-10.7	0	4.3	**-12.6**
Bolsover	-10.1	4.1	-7.4	0	3.2	**-10.2**
Chesterfield	-5.3	1.5	-2.5	0	1.1	**-5.2**
Derby City	-2.2	2.0	-3.4	0	1.4	**-2.2**
Derbyshire Dales	-43.4	16	-24.2	-1.3	10.7	**-42.2**
Erewash	-4.0	2.6	-4.3	0	1.7	**-4.0**
High Peak	-24.9	7.0	2.5	-9.8	5.9	**-19.3**
North East Derbyshire	-22.9	6.0	-8.4	0	4.2	**-21.1**
South Derbyshire	-12.1	8.8	-15.4	0	6.2	**-12.5**
Derbyshire Total	**-137.3**	**54.2**	**-73.8**	**-11.1**	**38.7**	**-129.3**

Table 4.9 – Net emissions per local authority

4.5.3 Domestic Emissions

Emissions resulting from household energy use can be split into gas use, electricity use and ‘other fuels’ (e.g., oil or LPG). The carbon emissions associated with domestic energy use have reduced by an average of 0.55% per year across Derbyshire since 2005.

Table 4.10 demonstrates that the annual carbon emissions in Derbyshire were 1,658.5 kt CO_2 in 2019, with the largest contribution coming from household gas usage.

Domestic Carbon Emissions in Derbyshire in 2019 ($ktCO_2$)				
Local Authority	Electricity	Gas	Other Fuels	Total
Amber Valley	43.6	144.2	21.6	**209.4**
Bolsover	25.0	87.5	44.8	**157.3**
Chesterfield	31.8	115.4	23.4	**170.6**
Derby City	76.3	255.8	8.5	**340.6**
Derbyshire Dales	29.3	79.1	18.9	**127.3**
Erewash	36.8	124.1	9.8	**170.7**
High Peak	31.8	109.5	7.7	**149.0**
North East Derbyshire	32.8	119.7	17.8	**170.3**
South Derbyshire	35.4	102.5	25.4	**163.3**
Derbyshire Total	**342.8**	**1137.8**	**177.9**	**1,658.5**

Table 4.10 – Domestic carbon emissions per local authority

4.5.4 Non-Domestic Emissions

The non-domestic terrestrial emission records give headline emissions across all energy use in industrial and commercial properties as well as the public sector. Industry includes electricity demand, gas demand, other fuels, larger industrial emitters (e.g., power stations, manufacturing plants, and agriculture).

Non-Domestic Carbon Emissions in Derbyshire in 2019 (kt CO_2e)				
Local Authority	Industry	Commercial	Public Sector	Total
Amber Valley	155.9	61.1	24.5	**241.5**
Bolsover	64.3	33.5	13.1	**110.9**
Chesterfield	54.3	52.2	27.9	**134.4**
Derby City	202.3	107.8	52.3	**362.4**
Derbyshire Dales	138.5	34.7	12.2	**185.4**
Erewash	68.5	26.7	21.6	**116.8**
High Peak	297.8	64.8	19.7	**382.3**
North East Derbyshire	71.7	32.4	10.1	**114.2**
South Derbyshire	124.0	44.3	11.7	**180.0**
Derbyshire Total	**1177.3**	**457.5**	**193.1**	**1827.9**

Table 4.11 – Non domestic carbon emissions per local authority

4.5.5 Transport

In line with national efforts to decarbonise, emissions related to transport have also been decreasing in recent years. The largest area of carbon emissions within transport are associated with road vehicles, further highlighting the need to increase uptake of ULEVs and LEVI.

Total annual emissions resulting from transport use in Derbyshire in 2019 were 2,242 $ktCO_2$. This was primarily emitted via road transport, with a small proportion from railways and other transport types.

Transport Carbon Emissions in Derbyshire in 2019 ($ktCO_2$)				
Local Authority	Road transport	Diesel Railways	Other	Transport Total
Amber Valley	208.9	12.4	2.0	**223.3**
Bolsover	323.7	2.3	1.3	**327.3**
Chesterfield	139.0	5.3	0.7	**145.0**
Derby City	355.1	9.1	2.3	**366.5**
Derbyshire Dales	224.6	1.3	1.3	**227.2**
Erewash	221.3	7.0	4.4	**232.7**
High Peak	152.2	5.4	1.7	**159.3**
North East Derbyshire	226.2	6.6	1.2	**234.0**
South Derbyshire	296.4	14.7	15.9	**327.1**
Derbyshire Total	**2147.4**	**64.1**	**30.8**	**2,242.3**

Table 4.12 – Transport emissions per local authority

5. Future Energy System

The most effective method of understanding the future of our energy system is to project current trends, including energy generation and consumption, carbon emissions, consumer behaviour, and economic and policy trajectories into the future.

This chapter uses UK Government and wider energy sector data to create a credible projection for the UK energy system and generate a future energy scenario for Derbyshire by applying this national projection to regional data.

5.1. Future Population

Population is an important metric which underpins energy demand, as a higher population requires a greater energy input. By 2045, the UK population is estimated to be approaching 71 million, up from 67 million in 2020. The trend line in Figure 5.1 illustrates that population growth will slow down from approximately 2037, with the fastest rate of growth expected in the next decade (ONS, 2020)

These rates of growth can be extrapolated at regional levels, alongside information from local development plans to create detailed future energy scenarios for Derbyshire. With an increasing population predicted until at least 2050, this will require continued housing developments and property refurbishments, as well as supporting employment opportunities, services, and infrastructure.

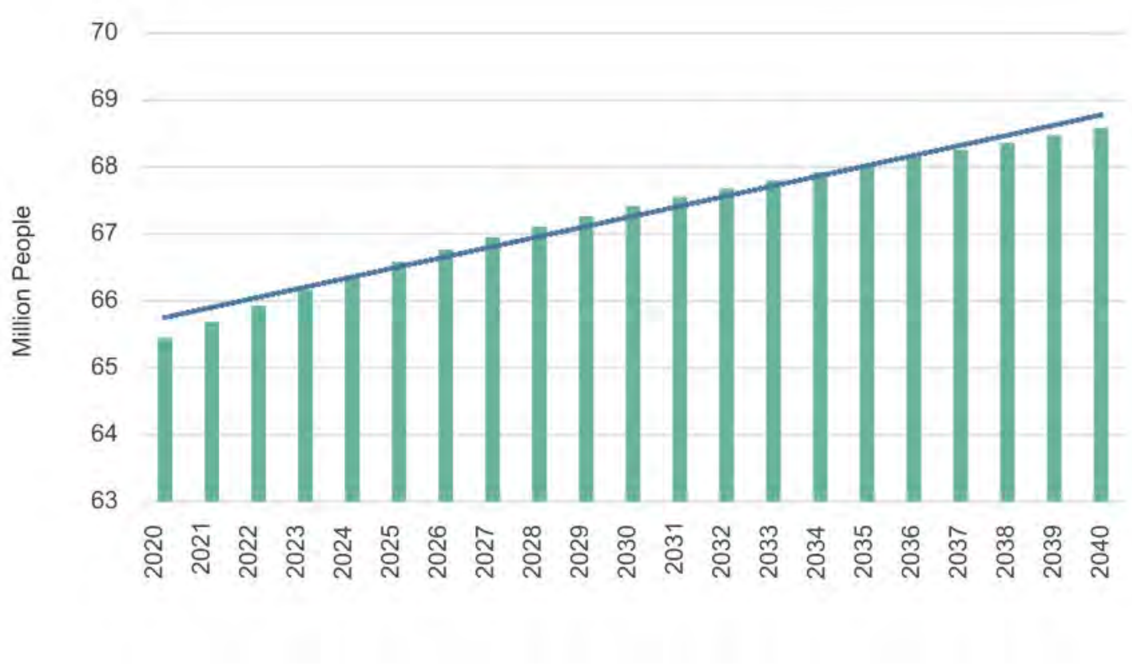


Figure 5.1 – UK population growth 2020 - 2040

5.2. Future Energy Demand

Whilst the UK population is growing, energy demand is projected to decrease in the coming decades. Figure 5.2 shows on one hand a reduced proportion of demand being met by fossil fuels and on the other hand an increased proportion being met by renewable energy and energy met from waste. National projections suggest that demand met by renewables and energy from waste will increase to 21% by 2040, whilst demand met by oil and solid fuels will decrease from 51% in 2000 to an estimated 38% in 2040.

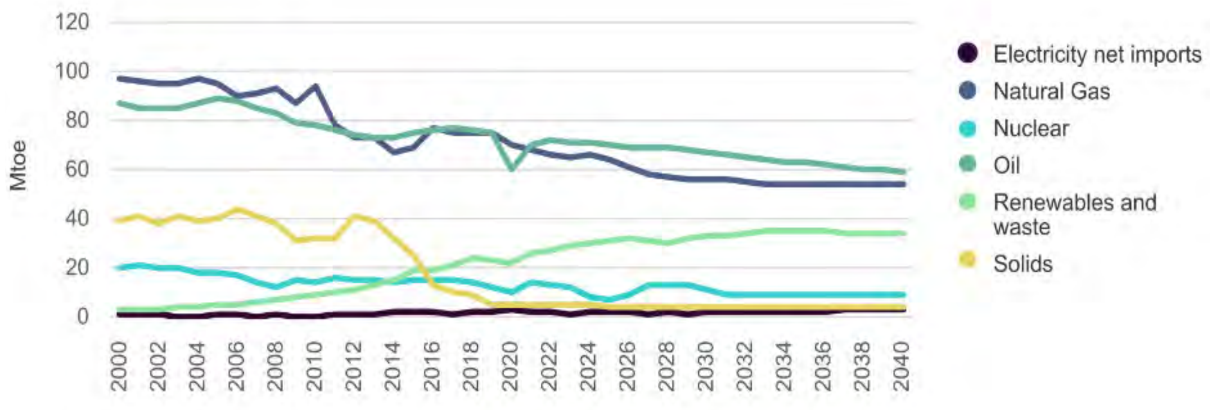


Figure 5.2 – Projection of UK primary energy demand by source

Figure 5.3 provides an overview of energy consumption in the UK, showing a decreasing level of demand across all industries. Transport and residential consumption continue to dominate energy consumption, demonstrating the need to reduce domestic energy demand and prioritise low carbon transport infrastructure to meet net zero targets.

Between 2022 and 2040, the transport sector consumption is projected to reduce by 16.5% due to greater transport efficiency through the uptake of ULEVs. In comparison the residential sector consumption is predicted to increase by 8.5% in line with increasing population and property numbers.

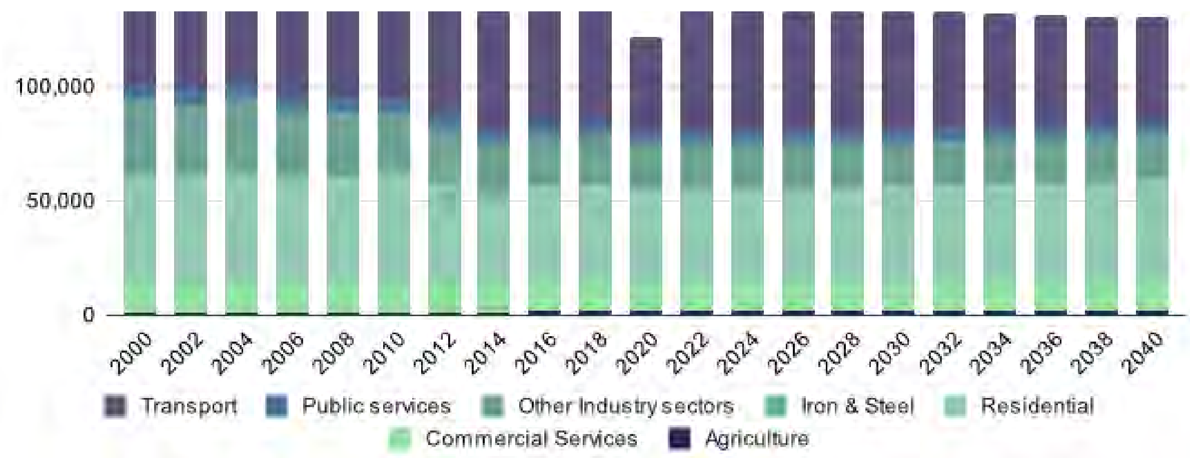


Figure 5.3 – Stacked chart of projected UK final energy consumption.

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5.3. Future Energy Generation

Future energy generation is expected to follow the current UK trend for greater deployment of decentralised low carbon generation, with localised exceptions of centralised technologies. Figure 5.4 details projected generation up to 2040, demonstrating a large increase in renewable energy generation and associated reductions in natural gas generation.

Electricity generation from natural gas is projected to drop by 56% between 2022 - 2040 and generation via nuclear power stations is projected to decrease by 32%. Renewable energy generation is predicted to increase by 113% supported by battery storage systems, with battery output capacity rising by from 1 TWh to 13 TWh.

Generation capacity in the UK will increase from 83 GW capacity in 2018 to a predicted 208 GW in 2040, with renewable generation reaching 288 TWh by 2040 (Figure 5.4). This greater generation capacity will enhance the energy security of the UK whilst supporting wider decarbonisation technologies such as heat pumps and electric vehicles.

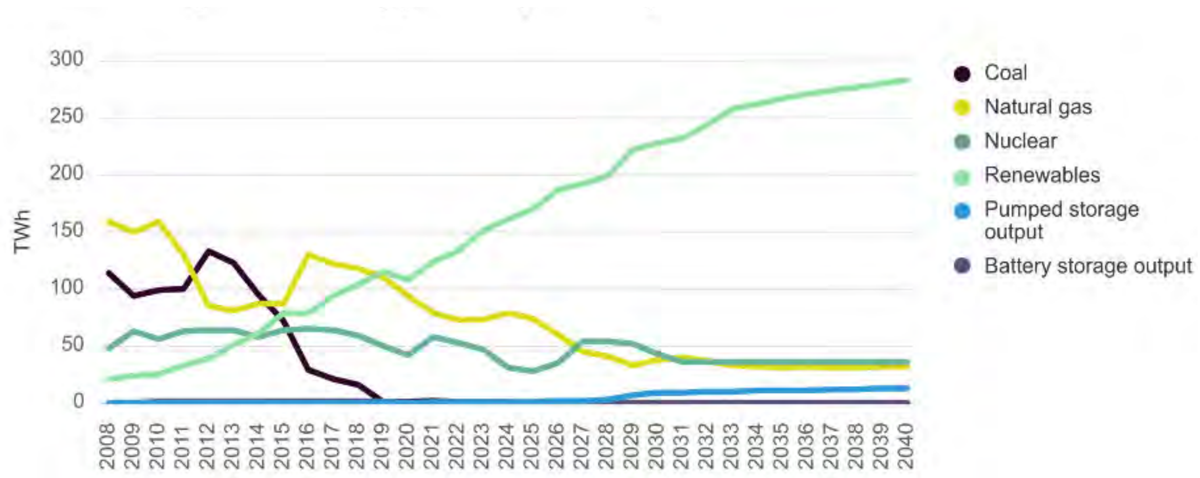

Figure 5.4 – Projection of electricity generation by source (major power producers)

5.4. Future Carbon Emissions

UK is currently in the 3rd carbon budget period (2018 to 2022) and is on track to reduce carbon emissions by 37% in comparison with 1990 levels. However, it is currently unlikely that the UK will meet the subsequent budgets at this rate without introducing more challenging measures.

The 6th carbon budget was introduced in April 2021 and has been hailed as the 'world's most ambitious target'. This budget was set in law, and for the first time will account for the UK's share of international aviation and shipping emissions. The 6th Carbon Budget recommends a reduction of 78% in UK territorial emissions by 2035 against 1990 levels. Previously the UK's goal was to reduce emissions by 80% by 2050, demonstrating how ambitious the new sixth budget is.

The UK's Climate Change Committee (CCC) believes that to achieve the current targets, faster and more efficient action is required. They have proposed methods to ensure the next carbon budgets are met, including:

- A "Net Zero Test", to ensure all policies and planning decisions are compatible with UK climate targets.
- A customer focused heat and buildings strategy.
- Strengthened plans for the power sector, industrial decarbonisation, North Sea oil and gas, peat and energy from waste.
- Faster engagement with public, to ensure more funding and quicker delivery at local levels.
- Delayed plans on surface transport, aviation, hydrogen, biomass, and food production must be delivered.

Table 5.1 outlines the UK carbon emissions trajectory and six carbon budget levels, as well as current progress as of 2022.

Overview of UK Carbon Emissions Budget Periods (2008 – 2050)				
Budget	Period	Carbon budget level	% Reduction below 1990 levels	Met?
1st	2008 to 2012	3,018 Mt CO_2e	25%	Yes
2nd	2013 to 2017	2,782 Mt CO_2e	31%	Yes
3rd	2018 to 2022	2,544 Mt CO_2e	37% by 2020	On track
4th	2023 to 2027	1,950 Mt CO_2e	51% by 2025	Off track
5th	2028 to 2032	1,725 Mt CO_2e	57% by 2030	Off track
6th	2033 to 2037	965 Mt CO_2e	78% by 2035	Off track
Net Zero	2050	-	At least 100%	Off track

Table 5.1 – Overview of UK Carbon Emissions Budget Periods (2008 – 2050)

5.5. Future Energy Scenarios (FES)

The National Grid plays a critical role in outlining pathways to net zero based on stakeholder engagement, research, and modelling. With ambitious emissions targets, there is a requirement for rapid transformation of the energy system in the UK. The national grid has outlined four credible pathways to achieving net zero between now and 2050. These scenarios are intended to inform network planning, investment decisions and government policy making.

Figure 5.5 illustrates the four future energy scenarios outlined by the National Grid. Of the four, only 'Steady Progression' does not meet the requirements for Net Zero by 2050. 'Consumer Transformation' and 'System Transformation' will meet net zero targets by 2050 but differ in pathway, driven by consumer behaviour and energy system transformation, respectively. The fourth scenario, 'Leading the Way', is a combination of both consumer behaviour and systemic change to enable the quickest path to decarbonisation.

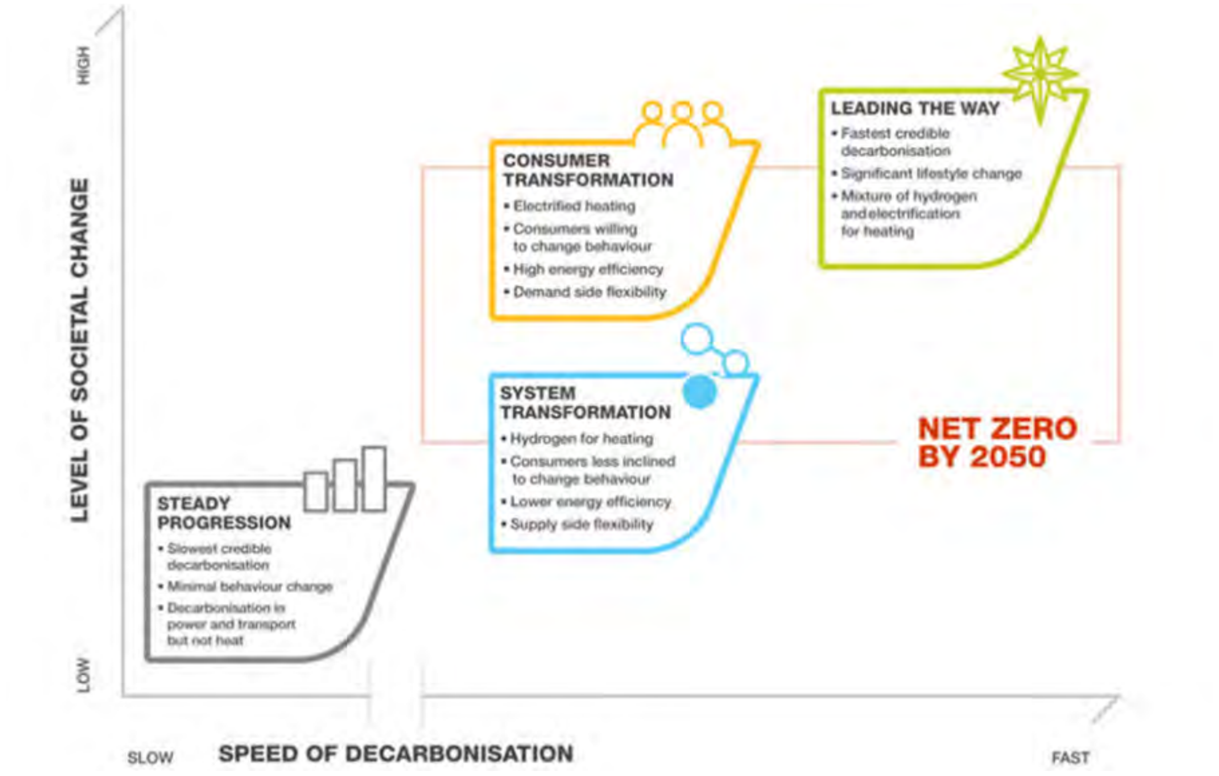

Figure 5.5 – National grid's future energy scenarios

5.6. Regional Future Energy System

National Grid (previously Western Power Distribution) produce Distribution Future Energy Scenarios (DFES) for all of their licence areas, including the East Midlands. The projections are created on an annual basis and describe changes in demand, electricity storage and distributed generation, including electrified transport and heat up to 2050.

The East Midlands region is projected to see increases in domestic and non-domestic energy demand, as well as a large increase in distributed renewable energy generation connected to the energy network and greater deployment of supporting low carbon technologies, such as electrical storage and ULEVs.

The factors used to forecast energy deployment at a local level are the result of consultation with developers, local authorities, technology companies and community energy groups, as well as analysis of existing trends, spatial data, and future innovations in technology.

5.6.1 Carbon Budgets

Similar to national carbon budgets, regional carbon budgets can be extrapolated across local authorities to understand decarbonisation trajectories at a more local level. The Tyndall Centre (2022) presents the required targets of each local authority in Derbyshire to achieve national Paris Agreement commitments, presented in Figure 5.6.

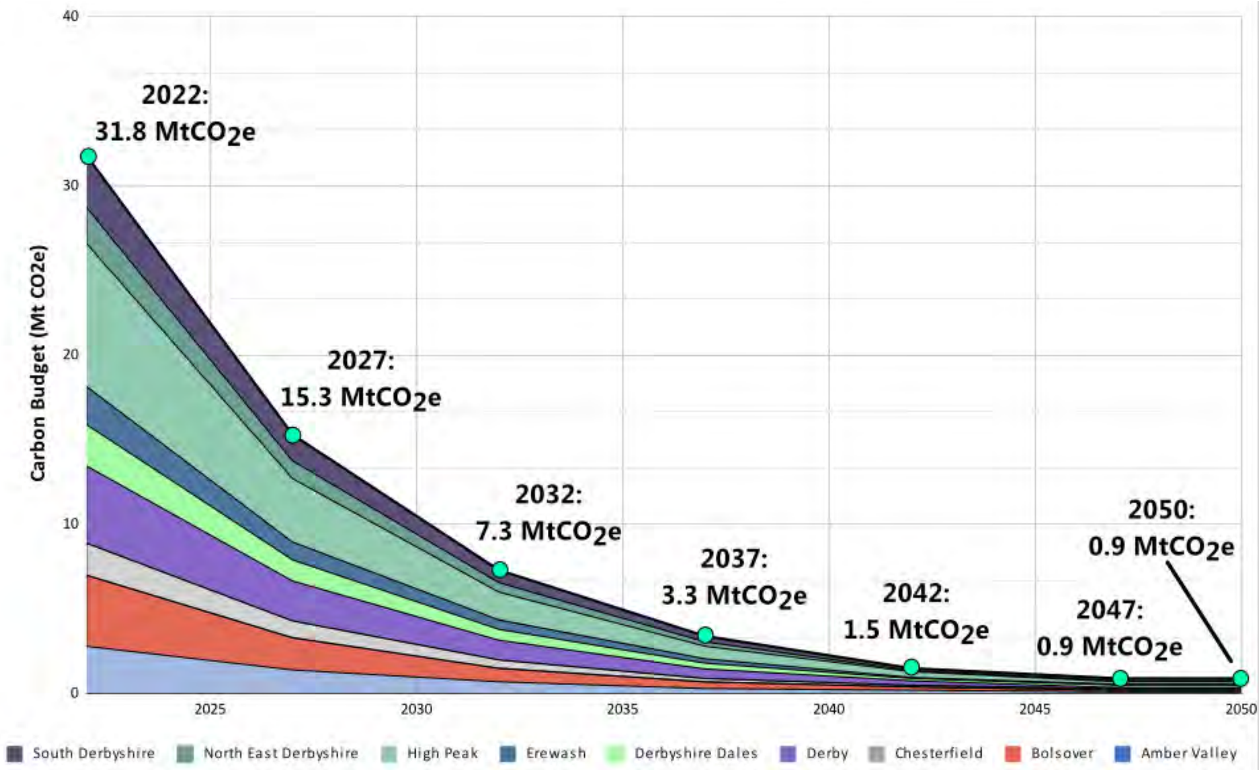

Figure 5.6 – Carbon budgets, per Local Authority in Derbyshire, up to 2050.

This data is derived from the Setting City Area Targets and Trajectories for Emissions Reduction methodology (2022), funded by BEIS to calculate local authorities carbon emissions targets in line with the UN Paris Climate Agreement. The figures do not include aviation and shipping emissions, as they cannot be as readily broken down to local authority level.

Table 5.2 below shows associated data analysis, highlighting which local authorities may have to work more rapidly than others to decarbonise. Percentage reduction refers to the average annual mitigation rate of CO_2e required to stay within the UK's Paris Agreement carbon budget.

Comparative Reduction Analysis of Derbyshire Carbon Budgets (2022)				
Local Authority	Years to Net Zero	% Average Annual Reduction Required	Carbon budget 2020 -2100 (Mt CO_2e)	Year with 5% Budget Remaining
Amber Valley	7	13.5%	4.2	2040
Bolsover	6	15.3%	5.5	2038
Chesterfield	7	13.3%	2.9	2041
Derby City	7	13.1%	7.1	2040
Derbyshire Dales	7	13.7%	3.6	2041
Erewash	7	13.6%	3.4	2041
High Peak	6	15.8%	10.8	2038
North East Derbyshire	7	13.2%	3.4	2042

Comparative Reduction Analysis of Derbyshire Carbon Budgets (2022)				
Budget	Years to Net Zero	% Average Annual Reduction Required	Carbon budget 2020 -2100 (Mt CO_2e)	Year with 5% Budget Remaining
South Derbyshire	6	14.1%	4.3	2040
Derbyshire	**6**	**14.3%**	**45.2**	**2040**

Table 5.2 – Decarbonisation recommendations

5.6.2 Energy Demand

Projecting energy demand requires an understanding of future domestic and non-domestic (i.e., commercial) development in Derbyshire. This section provides an assessment of energy demand in Derbyshire, comprising domestic demands, and commercial / industrial demands.

Housing Developments

Derbyshire has a population of 1,063,997 with approximately 451,347 households (ONS, 2020) . Figure 5.7 and Figure 5.8 provide an overview of expected population and housing growth within Derbyshire, predicting both increased population and housing across the county up to 2040.

Derbyshire had a regional average housing growth rate of 18% between 2001 – 2022, with the greatest growth seen in South Derbyshire (45%) and least in Chesterfield (13%). Regional housing growth between 2022 and 2043 is projected to be 14%.

Similarly, population growth was highest in South Derbyshire (37%), and lowest in High Peak (4%), with a regional population increase between 2001 - 2022 of 11%. The regional population increase between 2022 and 2043 is projected to be 9%, following a similar trend to national population projections with growth slowing down in the 2030s.

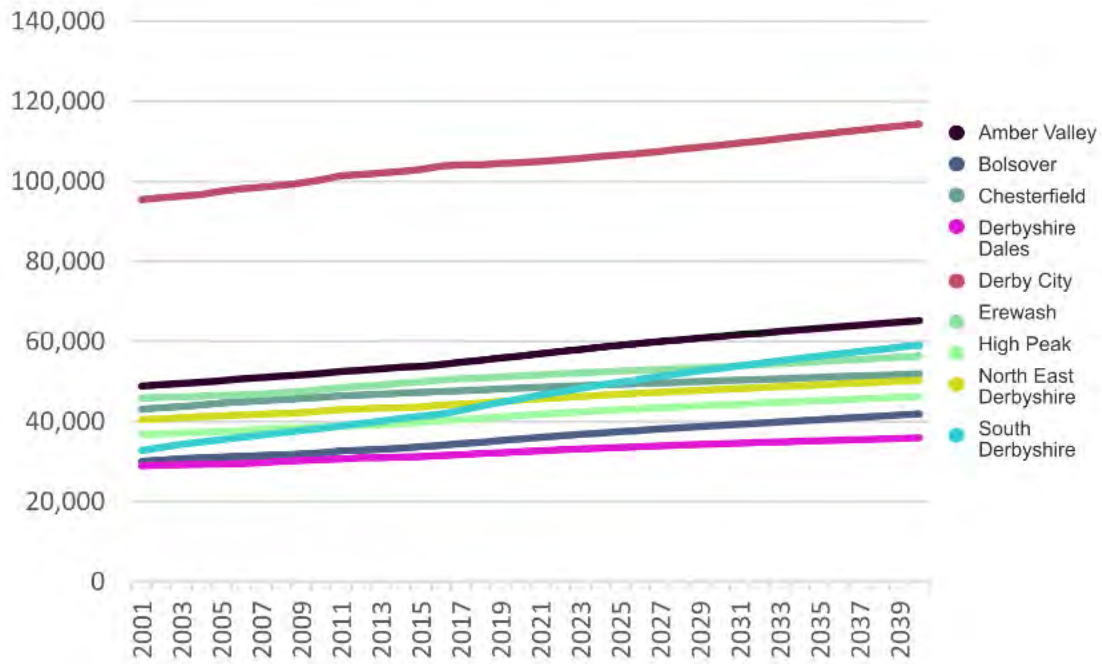

Figure 5.7 – Derbyshire local authority housing projections (2001 – 2040)

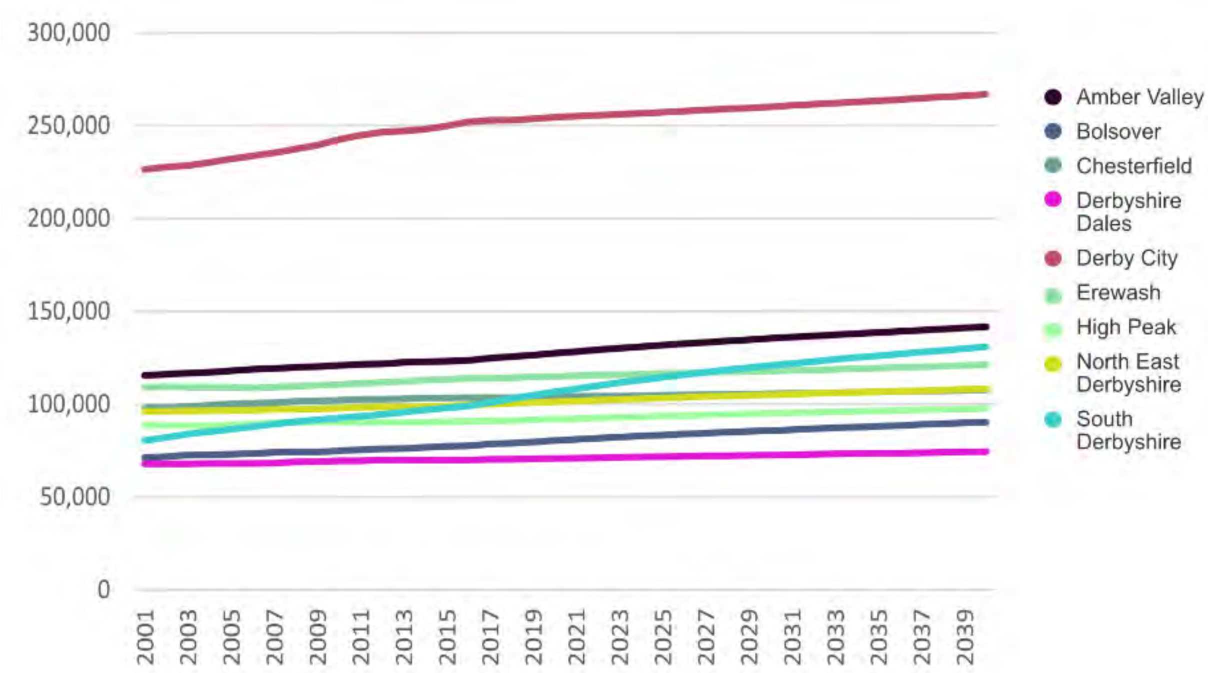

Figure 5.8 – Derbyshire local authority population projections (2001 – 2040)

Based on existing and emerging local development plans, the annual projected growth in housing stock across all local authorities is 4,126 – 4,298 per year depending on the methodology used (Table 5.3). Based on current mean electricity and gas meter consumption, an additional 4,212 homes (median growth) would increase the county's annual electricity demand by 15.4 GWh, and gas demand by 59.3 GWh.

Housing Growth Projections in Derbyshire (2022)	
Local Authority	**LA housing needs per year**
Amber Valley	376
Bolsover	317
Chesterfield	240
Derby City	1,255
Derbyshire Dales	230 – 302
Erewash	386
High Peak	250 – 350
North East Derbyshire	330
South Derbyshire	742
Total	**4,126 – 4,298**

Table 5.3 – Housing growth projections in Derbyshire

Non-domestic Development

Non-domestic development in Derbyshire comprises those developments within current and emerging local plans defined as employment land (Table 5.4). Whilst employment land may not be currently allocated for development, there are a number of sites currently within the planning process or under consideration for development in Derbyshire.

Development of these sites would increase non-domestic energy demand in their local authority areas and Derbyshire as a whole, whilst also offering opportunities for local low carbon development, energy generation and low carbon mobility.

Employment Land Allocations in Derbyshire (2022)	
Local Authority	Employment Land Allocations (ha)
Amber Valley	42 – 55
Bolsover	65 – 100
Chesterfield	50
Derbyshire Dales	24
Derby City	199
Erewash	55
High Peak	40 – 80
North East Derbyshire	26
South Derbyshire	19
Total	**571**

Table 5.4 –Employment land allocations across local authorities

5.6.3 Energy Development

As of 2022, there are a number of energy developments within the planning system in Derbyshire. These are primarily low carbon or renewable energy generation projects, including large scale solar PV and energy from waste installations. In line with national trends, Derbyshire is projected to see continued development of grid-connected renewable energy projects, with a particular focus on solar PV. Further to this, domestic and commercial low carbon systems will be an increasing focus, including uptake of rooftop solar PV, heat pumps and other small-scale energy technologies.

Table 5.5 provides an overview of planned development in Derbyshire as of April 2022. In addition to the planned energy developments outlined in the REPD, there is also a 50 MW solar park that has been granted permission subject to conditions at Manor House Farm, Hasland in December 2021.

Planned Energy Developments in Derbyshire (2022)			
Technology	Planning Application Submitted	Planning Permission Granted	Under Construction
Advanced Conversion Technologies			15 MW
Battery	90.15 MW	129.1 MW	
Solar Photovoltaics	65.4 MW	21.3 MW	
Wind Onshore	2 MW		

Table 5.5 – REPD low carbon technology installations in Derbyshire

5.7. Future Energy in Derbyshire

This section sets out credible future energy scenarios for Derbyshire, describing the expected proliferation of operational low carbon and renewable energy technologies in the county and the extent of development required to meet net zero emissions by 2050. These figures have been obtained from WPD's Future Energy Scenarios for Derbyshire and the wider East Midlands area.

5.7.1 Energy Generation

This section sets out projections for electricity generation technologies in Derbyshire, based on the proposed future energy scenarios. Each projection below includes the total installed capacity of renewable technologies as of 2022, and the total installed capacity estimated by 2040 across the four future energy scenarios.

Domestic Solar PV

Table 5.6 illustrates the current estimated installed capacity of solar PV on domestic properties, and the projected increases in capacity between 2022 - 2040. Due to the need for solar PV to be installed on private properties, it is no surprise that the Consumer Transformation scenario predicts the greatest increase in installed capacity.

These scenarios indicate that public engagement with the community and government incentives will be required to achieve the growth highlighted in the Consumer Transformation pathway. Consumer Transformation also includes the highest uptake of electrification of heating systems, so added generation at the point of use will be required for this scenario to work.

Non-domestic rooftop PV

Similar to domestic PV projections, changing consumer behaviours is required for the largest extent of non-domestic rooftop solar PV deployment. Non-domestic rooftop Solar PV is classified as rooftop solar installations between 10 kW and 1MW capacity. Similarly, with the electrification of heat, rooftop solar will be required at an individual scale to provide the extra load needed.

Derbyshire Future Energy Scenario Domestic Solar PV Deployment by 2040					
Local Authority	Installed capacity 2022 (MW)	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	6.3	11.0	21.6	39.0	19.6
Bolsover	5.6	9.6	16.8	30.8	18.4
Chesterfield	7.7	12.8	23.1	42.7	23.9
Derby City	13.4	22.1	41.2	75.2	38.2
Derbyshire Dales	5.7	9.8	17.0	30.3	19.3
Erewash	5.5	9.4	18.5	33.3	17.6
High Peak	0.1	0.3	0.4	0.9	0.9
North East Derbyshire	5.5	9.8	17.8	33.1	19.3
South Derbyshire	6.1	11.7	21.9	40.2	23.0
Total	**55.9**	**96.5**	**178.3**	**325.5**	**180.2**

Table 5.6 – Derbyshire Future Energy Scenario Domestic Solar PV Deployment by 2040

Derbyshire Future Energy Scenario Non-Domestic Solar PV Deployment by 2040					
Local Authority	Installed capacity 2022 (MW)	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	3.3	6.6	13.8	26.8	14.2
Bolsover	1.9	3.3	6.3	11.6	6.3
Chesterfield	3.2	5.7	11.3	21.2	11.3
Derby City	3.1	7.2	16.0	31.8	16.0
Derbyshire Dales	5.1	10.5	22.4	43.6	22.4
Erewash	2.8	4.6	8.4	15.3	8.5
High Peak	0.1	1.1	3.2	7.0	3.2
North East Derbyshire	3.4	4.7	7.6	12.7	7.6
South Derbyshire	5.9	7.9	12.1	19.8	12.1
Total	**28.8**	**51.9**	**101.1**	**189.8**	**101.6**

Table 5.7 – Derbyshire Future Energy Scenario Non-Domestic Solar PV Deployment by 2040

Storage

The growth of storage technologies in both domestic and non-domestic settings is shown in Table 5.8. As expected, the Consumer Transformation and Leading the Way scenarios show the greatest increase in the installed capacity of storage, due to the need for consumer engagement for home or business battery installations.

Derbyshire Future Energy Scenario Storage Deployment by 2040					
Local Authority	Installed capacity 2022 (MW)	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	0	0.5	0.1	3.9	7.7
Bolsover	1	1.4	1.1	53.9	8.1
Chesterfield	1	1.8	1.1	25.9	11
Derby City	0	2.8	1.8	9.2	18.9
Derbyshire Dales	0	0.7	0.1	2.8	7
Erewash	0	0.4	0.1	3.4	7.1
High Peak	0	0	0	0.1	0.3
North East Derbyshire	0	0.4	0.1	8.6	12.5
South Derbyshire	10	10.5	10.1	58.9	67.6
Total	**12**	**18.5**	**14.5**	**166.7**	**140.2**

Table 5.8 - Derbyshire Future Energy Scenario Energy Deployment by 2040

Wind Energy

Whilst Derbyshire has a relatively sensitive region to wind development, projections still propose a modest level of onshore wind development in the county. The scenario with the largest projected increase in installed capacity of wind turbines is the Consumer Transformation scenario, as smaller wind turbines (e.g., small to medium scale development) dominate new installations.

Derbyshire Future Energy Scenario Onshore Wind Deployment by 2040					
Local Authority	Installed capacity 2022 (MW)	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	1	1.1	2.1	13.1	9.7
Bolsover	1.4	1.4	1.4	12.4	7
Chesterfield	1	1	1	1	1
Derby City	5.3	5.3	10.3	10.3	10.3
Derbyshire Dales	14.6	14.7	24	47.1	37.4
Erewash	0	0	0.1	6.5	3.4
High Peak	0	0	0	1.1	1.1
North East Derbyshire	0.1	0.1	0.1	6.8	3.5
South Derbyshire	0.1	0.2	0.2	120	6.7
Total	**23.5**	**23.8**	**39.2**	**218.3**	**80.1**

Table 5.9 - Derbyshire Future Energy Scenario Onshore Wind Generation Deployment by 2040

5.7.2 Decarbonising Heat

The decarbonisation of heat is key to the UK reaching net zero, as heating currently accounts for 37% of the total emissions in the UK, of which around 14% is used for heating our homes. National Grid Future Energy Scenarios outline the average energy required for heating a home under their four scenarios in MWh/year/household. Based on the estimated decreased demand across each scenario, average house heating demand for Derbyshire can be extrapolated across each future energy scenario (Table 5.10). The decreases in heat demand can be attributed to increase in retrofitting measures, more thermally efficient new build properties, and new and more efficient technology development.

Projected Future Average Domestic Heating Demand		
Future Energy Scenario	Decrease in domestic heating demand (%)	Average House Heating Demand (kWh / year)
Now	0%	14,073
Steady progression	29.7%	9,892
System Transformation	42.8%	8,056
Leading the Way	68.8%	4,385
Consumer Transformation	74.6%	3,469
Average decrease	**54.0%**	**6,451**

Table 5.10 - Average domestic heating demand under each NG FES

Building Efficiency

The UK Government has committed to upgrading all existing homes to a rating of C by 2035, where practical, cost-effective, and affordable. The current average EPC rating in Derbyshire is a D (65) meaning there is a need to improve thermal efficiency of the housing stock across the county. Improving properties by one level (i.e., D to C) can provide energy savings of up to 20% and annual energy bill reductions of over £200. These energy savings are dependent on the cost of energy, and highly reactive to price volatility.

Heat Pumps

Table 5.11 demonstrates the largest uptake of heat pumps under the consumer transformation scenario, as heat pump deployment requires a participative and active consumer to implement within private homes and businesses. Top-down approaches, such as with system transformation scenario do not yield the same level of development, with Leading the Way providing a hybrid approach that demonstrates effective deployment. The hybrid approach is a combination of both consumer behaviour and systemic change to enable the quickest path to decarbonisation.

With grants currently available for heat pump deployment and a commitment to phase out gas boilers by 2035, consumer transformation is seen as a likely pathway for heat pump uptake in Derbyshire.

Derbyshire Future Energy Scenario Heat Pump Uptake by 2040					
Local Authority	HP Units 2022	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	105	1,596	3,523	26,575	21,878
Bolsover	54	1,112	2,319	18,783	15,312
Chesterfield	53	1,375	2,810	25,136	20,538
Derby City	139	3,167	7,088	51,115	42,189
Derbyshire Dales	326	2,086	4,814	19,479	16,900
Erewash	92	1,469	3,220	24,606	20,205
High Peak	7	63	129	633	499
North East Derbyshire	79	1,232	2,549	20,062	16,434
South Derbyshire	185	1,747	3,652	24,282	19,789
Total	**1,040**	**13,847**	**30,104**	**210,671**	**173,744**

Table 5.11 – Future Energy Scenario heat pump uptake by 2040 (number of units)

District Heat Networks

The UK government has outlined in their recent report "Opportunity areas for district heating networks in the UK" that in England, 19% of the total heat demand could potentially be met by heat networks. However, the actual deployment is likely to be lower as local conditions may differ from the UK wide assumptions used in their report.

Whilst it is difficult to predict the level and extent of heat network development in Derbyshire, it is projected that 19% of total demand being met is likely to form an upper boundary for heat network development in the county. Further information on heat network areas has been produced by BEIS (2021), detailing opportunities areas in the UK which may enable 16% of the East Midlands heat demand to be met by heat networks.

5.7.3 Low Carbon Mobility

Due to the UK Government's intention to end the sale of new petrol and diesel cars and vans from 2030, it is estimated that there will be a significantly rapid uptake of low emission vehicles in the next decade. The WPD's Future Energy Scenarios (2021) note that around 2% of all vehicles in the area are currently plug in hybrid or battery electric vehicles.

Factors that will influence the rate of uptake include:

- Availability of off-street parking (for charging accessibility);
- Proportion of people owning more than one car;
- Increased development of electric vehicle charging infrastructure;
- Clean air zone initiatives.

The WPD Future Energy Scenarios outline projected electric car uptake under each scenario (1 EV Unit is 1 electric vehicle). The growth rates shown in the table below show the estimated number of electric cars in 2022 and the predicted growth by 2040. Leading the way and consumer transformation show the greatest change due to the requirement for change in purchasing behaviours from consumers.

Similar to EV uptake, charging infrastructure sees the largest projected increase under the Leading the Way scenario. National and regional efforts to increase the number of charging devices available, will work hand in hand with consumers uptake of EVs (Table 5.13). The data above differs from public charger data (Table 4.8), as it includes workplace, fleet/depot, national networks, car parks, and domestic on and off-street chargers.

Derbyshire Future Energy Scenario EV Uptake by 2040					
Local Authority	EV Units 2022	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	1062	47,541	62,905	72,512	73,307
Bolsover	682	33,531	44,060	48,587	48,707
Chesterfield	737	36,149	47,517	52,490	52,643
Derby City	1299	64,644	84,901	93,238	93,408
Derbyshire Dales	859	36,172	48,091	57,075	58,001
Erewash	791	37,856	49,842	55,686	55,963
High Peak	55	2,631	3,464	3,870	3,888
North East Derbyshire	812	36,702	48,532	55,732	56,300
South Derbyshire	988	42,629	56,570	66,413	67,362
Total	**7285**	**337,855**	**445,882**	**505,603**	**509,579**

Table 5.12 - Derbyshire Future Energy Scenario EV Uptake by 2040

Derbyshire Future Energy Scenario EV Charger Deployment by 2040					
Local Authority	EV Chargers 2022	Steady Progression (MW)	System Transformation (MW)	Consumer Transformation (MW)	Leading the Way (MW)
Amber Valley	954	32,636	43,535	51,146	51,272
Bolsover	581	20,940	27,644	32,212	32,222
Chesterfield	568	19,077	25,283	29,564	29,645
Derby City	799	24,769	33,052	38,603	38,803
Derbyshire Dales	937	31,021	41,505	48,540	48,692
Erewash	598	20,005	26,591	30,897	31,168
High Peak	63	2,400	3,165	3,831	3,683
North East Derbyshire	782	27,605	36,675	43,094	43,097
South Derbyshire	971	34,604	46,126	54,149	54,521
Total	**6,523**	**213,057**	**283,576**	**332,036**	**333,103**

Table 5.13 – Derbyshire Future Energy Scenario EV Charger Deployment by 2040

5.7.4 Future Energy Networks

This section sets out projections for electricity generation technologies in Derbyshire, based on the proposed future energy scenarios. Each projection below includes the total installed capacity of renewable technologies as of 2022, and the total installed capacity estimated by 2040 across the four future energy scenarios.

Energy Network Management

Energy network management includes flexible solutions such as Active Network Management (ANM), generation curtailment, and price driven signals (e.g., load shifting in response to Time of Use Tariffs).

The Energy Networks Association (ENA), Flexible Power and DNOs collaborate annually to provide this required flexibility. The DNOs regularly publish flexibility requirements, which gives Flexible Power the ability to create flexibility locations, requirement data, procurement notices, available assets, performance, and dispatch signals.

Flexibility figures for each DNO are provided by The Energy Networks Association, this data, as of July 2021 demonstrates the scale and size of local flexibility markets across each DNO within the Derbyshire area. This data is not currently available at a lower granularity than the full DNO serviced area.

DNO Flexible Connections (2021)				
DNO	Capacity of Flexible Connections (MW)	Curtailment (MWh)	Flexible Renewable Generation Mix (MW)	Storage Mix (MW)
Electricity North West	168	-	87.5	88
National Grid	736	-	572	3.2
Northern Powergrid	433	-	326	0

Table 5.14 - DNO Flexible Connections

Every year, DNOs procure customers to join a flexibility trial in network constrained areas (flexibility service providers). The DNOs then pay customers to change their behaviours (in terms of power generation curtailment or changing consumption patterns to balance the grid). This enables better value out of the existing network. For a customer to provide these benefits, they must be located in an area which is constrained and have controllable and non-intermittent flexible asset(s) that can be controlled in response to dispatch signals.

Some low carbon technologies such as EVs, batteries and thermal storage can provide flexibility services to electricity networks. This flexibility is enabled by releasing power back to the grid (e.g., charging EVs) at times of high demand and storing it (e.g., as thermal energy) at times of lower demand. This flexible solution also helps to add extra renewable capacity to the grid.

Active Management is when generation and / or demand is instructed, either manually, automated or via time controls, to limit customers power usage. Demand side response technology allows DNOs to see 'operational windows' in which, the time of year, time of day, and total anticipated MWhs needed are utilised. All of these energy management and flexibility services can increase DNO's abilities to accommodate increasing demand and increasing renewable technology uptake without having to upgrade the network.

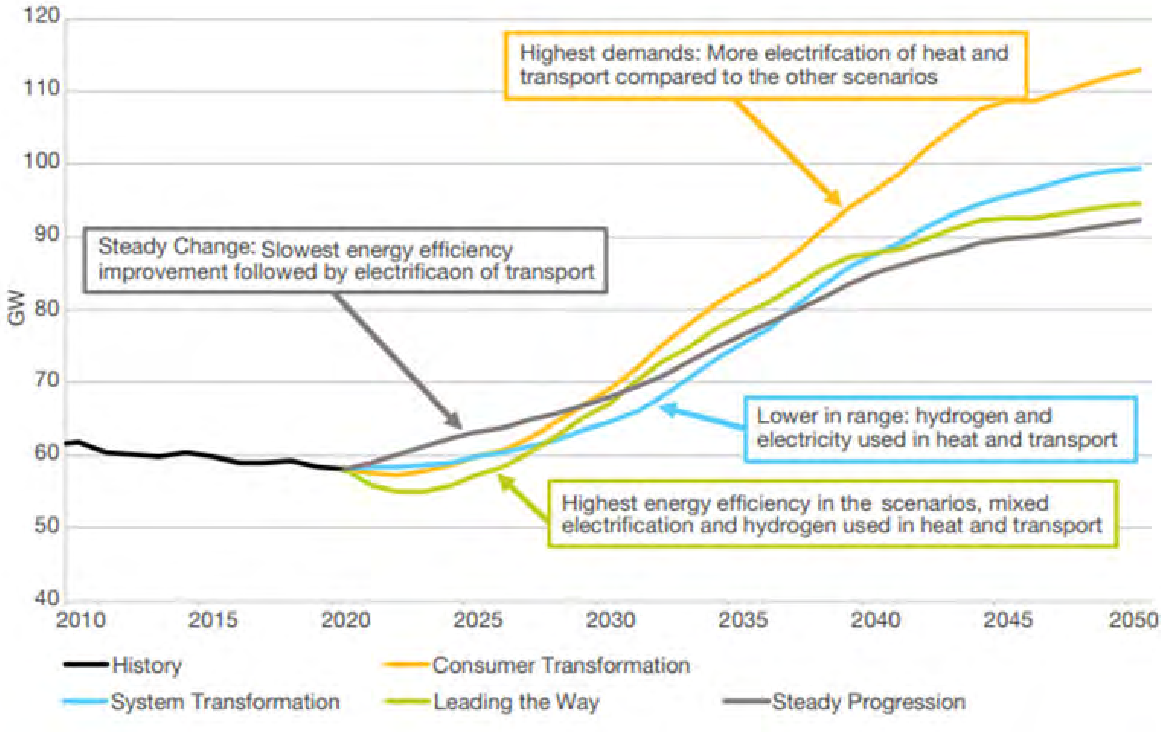

Figure 5.9 – UK Electricity peak demand projections

Smart Network Management

Digitisation is essential to managing an energy system with smart flexible demand. The National Grid projects increases in flexibility capabilities across the four scenarios in 2050, including:

- Up to 43 GW of electricity storage, compared to 3.5 GW today;
- 44 GW of demand side response, compared to 6 GW today;
- 58 GW of electrolysis (carbon-free hydrogen production) from close to zero today.

Electricity peak demand is set to continue to increase across all four NG scenarios, however the time of peak demands may shift as flexible solutions are integrated. Figure 5.9 demonstrates how the peak demand may increase across all potential scenarios.

Flexible solutions and demand side response technologies will be increasingly necessary to respond directly to short term changes in energy flows within the national energy network. However, this responsive behaviour may cause discrepancies in frequency. Therefore, more granular control of response times will be needed to avoid causing system operation issues, from national to street levels. For example, where large numbers of homes or businesses within an area decide to charge their EVs at the same time may lead to problems within the local electricity network. To overcome this, the National Grid and Distribution Service Operators (DSO[2]) will have to work together to ensure a coordinated response.

[2]DNOs are currently in the process of transitioning to become DSOs, in line with the more active role they must play in managing the energy network.

6. Spatial Energy Assessment

This chapter provides an overview of energy opportunities in Derbyshire, focusing on spatial distribution and potential of energy technologies up to 2040. This information will support the development of future energy policies, strategies and plans across the region to guide new development and inform decision making.

6.1. Introduction

A spatial understanding of energy is critical to defining the location, technology and scale of energy development which may occur in a given area. Derbyshire has a diverse landscape, encompassing a number of highly sensitive protected designations as well as varying degrees of landscape sensitivity, from remote uplands to urbanised lowland landscapes.

Energy technologies considered within this study were chosen as they currently, or are expected to, play a role in the UK energy system and meeting the UK's commitment to net zero carbon. All of the technologies set out below can play a part in improving Derbyshire's energy system, meeting regional net zero targets, and benefiting people and businesses throughout the region.

Energy developments considered within this assessment cover demand, generation, storage, and supply. In particular, they include:

- **Electricity Generation:**
  - Wind turbines
  - Solar photovoltaics (PV), including ground-mounted and roof-mounted installations
  - Hydroelectric power
- **Heat Generation:**
  - Solar Thermal
  - Heat pumps, including ground, water, and air-source variants
  - Energy from waste (EfW), including solid waste and biogas
  - Bioenergy, including biomass and anaerobic digestion
- **Energy storage**
- **Energy networks:**
  - Electricity networks
  - Heat networks
- **Low Carbon Mobility:**
  - Electric vehicles
  - Electric charging network

A number of energy technologies have been discounted on the basis of location, including offshore wind and marine energy, as well as technologies which have not yet been proven as feasible and economically viable within the UK energy industry, such as experimental solar power (e.g., floating and concentrated voltaic systems) and solar-assisted heat pumps.

This assessment builds on DECC (2010) "Renewable and Low-Carbon Energy Capacity Methodology," and a full methodology can be found in Appendix A. The chapter will set out the technologies assessed, providing an understanding of their relevance to the future of Derbyshire's energy system, an understanding of the spatial constraints and areas of opportunity for each technology, and an estimation of each technology's potential to contribute to the net zero transition.

The analysis provided in this report details areas of potential opportunity via a categorised system – highly constrained, moderately constrained, and less constrained. Beyond the constraints detailed in the methodology, all energy developments in Derbyshire must be considered in the context of site-specific landscape character and sensitivity, areas of multiple environmental sensitivity (AMES) and Tranquillity (DCC, 2013)

6.2. Methods

A number of key considerations in relation to the underlying methodology and terminology are provided in this section. Further information and a full methodology may be found in Appendix A.

6.2.1 Constraint Terminology

Specific terminology has been used within this study in reference to levels of constraints on each energy technology and, in turn the resulting areas of opportunity for energy development. This terminology has been developed using DECC (2010) methodology and revised in line with the aims of this spatial energy study.

- **More Constrained:** This location is severely constrained for this type of energy development. Whilst is is highly unlikely that this technology would be permissible within the chosen area, it is not impossible.

- **Constrained:** This location is constrained to a notable degree for this type of energy development. Development in this area would require in-depth engagement with the planning authority and regulators.

- **Less Constrained:** This location has minimal constraints for this type of energy development. Site-specific analysis is required and engagement with the planning authorities and regulators should be conducted to confirm the suitability of the site.

It is important to note that this is a high-level study seeking to define more or less constrained areas and that any energy development within Derbyshire must be designed and implemented in close coordination with the relevant local planning authority and, where required, through application for planning permission.

6.2.2 Landscape Sensitivity

This study provides a constraints-led approach to spatial energy opportunity assessment. One key development constraint is the impact that energy projects can have on the environment, affecting the quality and character of the landscape.

A landscape sensitivity assessment was undertaken for each landscape character type as identified by Derbyshire County Council (2013) and the Peak District National Park Authority (2009). The assessment considered:

- **Scale and complexity of land form**, including topography, distinctiveness and land features.
- **Scale and complexity of land use and field patterns**, including landscape scale, field types, and human scale features.
- **Visual exposure**, including internal and neighbouring exposure, openness and visual screening.
- **Development and activity**, including industrial development, settlements extents, rural human activity, and historic character.

Within this study, wind, ground-mounted solar PV and anaerobic digestion analysis has taken into account the sensitivity of landscapes in Derbyshire. For each of the assessments carried out, technologies were assigned a sensitivity value (low to high) in each landscape character type. An overview of sensitivity in Derbyshire is presented in Figure 6.1.

The landscape character and sensitivity assessment enables this study to account for constraints and planning limitations which are not as clearly defined and managed as international, national or local designations. It accounts for the intrinsic value and quality of the landscape in Derbyshire, and ensures that all recommendations are made with a clear understanding of how energy development may impact upon this value.

Within Derbyshire there is a high degree of landscape sensitivity, most notably in the north west, within and surrounding the Peak District National Park. Further information on landscape character and sensitivity assessment can be found in Appendix A.

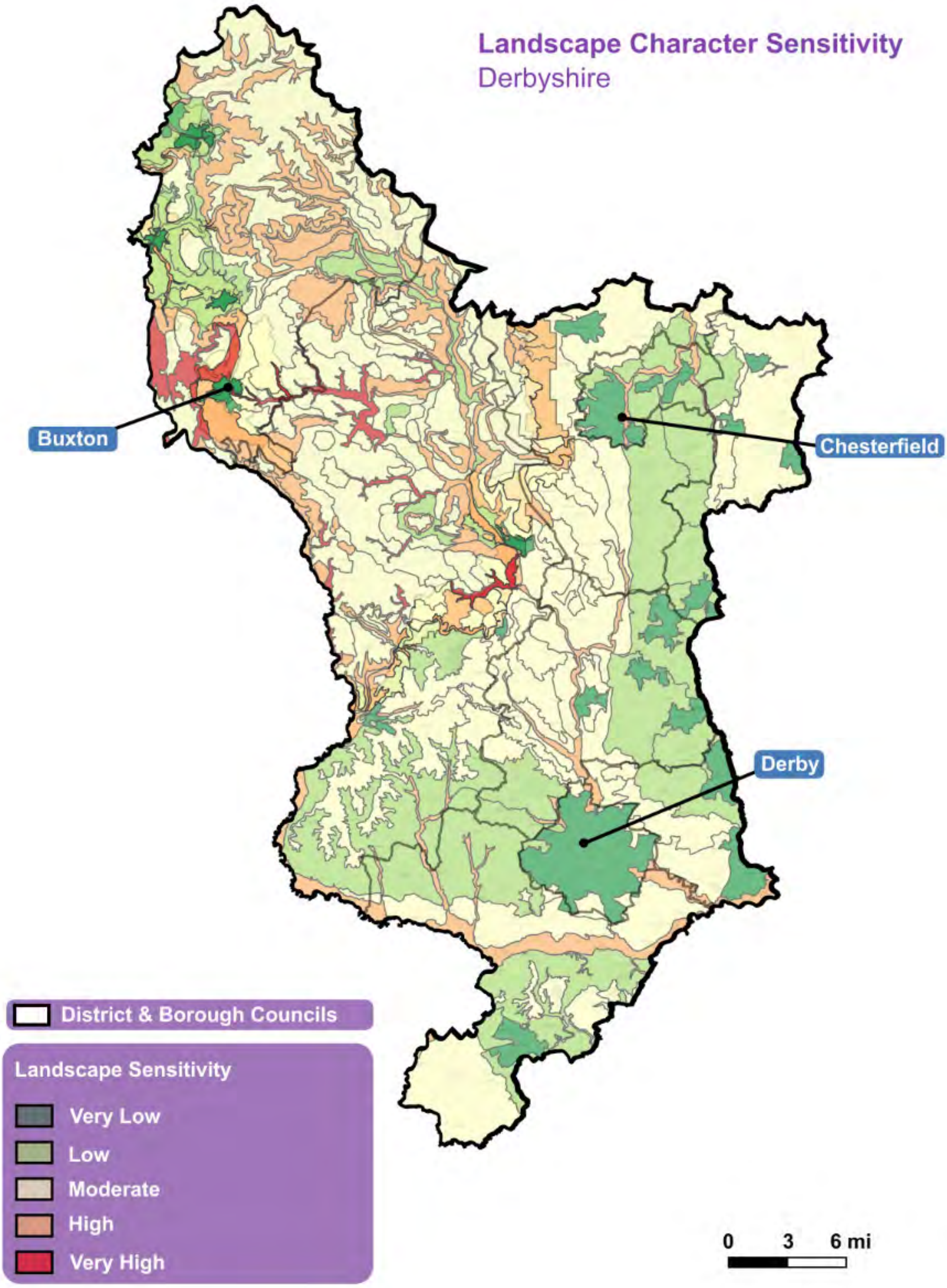

Figure 6.1 - Landscape Sensitivity in Derbyshire and the Peak District National Park

6.3. Energy Demand

Understanding the current and projected energy demand baseline is an important first step in defining energy solutions in Derbyshire. An overview of domestic, commercial, industrial and transport demand is provided below, including projections up to 2040. Further information on the regional demand, and the underpinning data and assumptions, can be found in Sections 4.1 and 5.2.

Derbyshire accounts for 1.6% of the UK population but comprises 1.6% of all domestic, and 1.9% of all non-domestic (i.e., commercial, and industrial) electricity demand. The county consumes a comparatively higher percentage of non-domestic heat (2.1%) but lower percentage of domestic heat (1.3%) against the UK average. Total annual electricity demand in Derbyshire is 4,547 GWh, comprising 1,735 GWh domestic and 2,812 GWh non-domestic demand. Total annual heat demand is 10,046 GWh, comprising 6,171 GWh of domestic and 3,875 GWh of non-domestic demand.

There has been a general downwards trend in energy consumption as energy efficiency improves across residential building stock, including retrofit measures and new building standards, and as technologies become more efficient, leading to reductions in electricity and heating fuel demand. General patterns of demand across use types changed in response to the coronavirus pandemic from 2020, which led to an increase in domestic demand – as people spent more time in their homes -– and a decrease in non-domestic demand due to the national lock downs and reduced consumer activity.

Figure 6.2 and Figure 6.3 provide an overview of electricity and heat demand in Derbyshire, providing the context and backdrop to this spatial energy assessment.

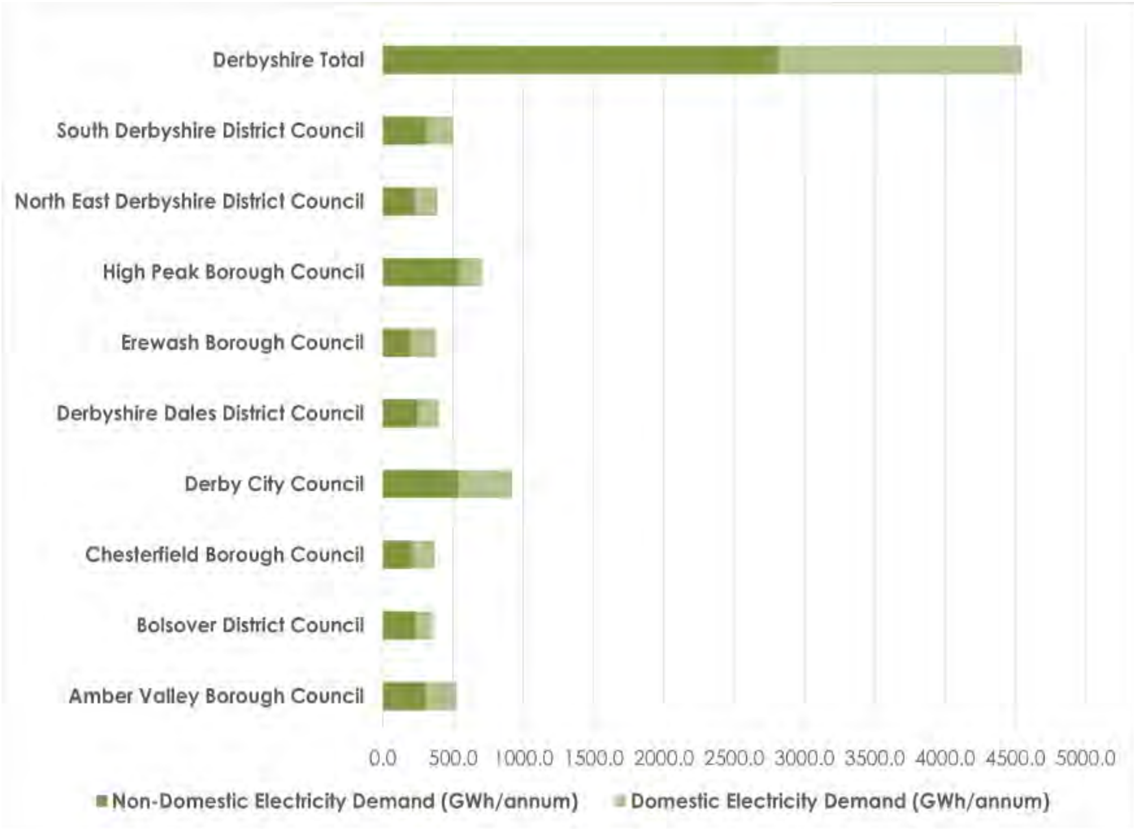

Figure 6.2 – Current electricity demand in Derbyshire (2022)

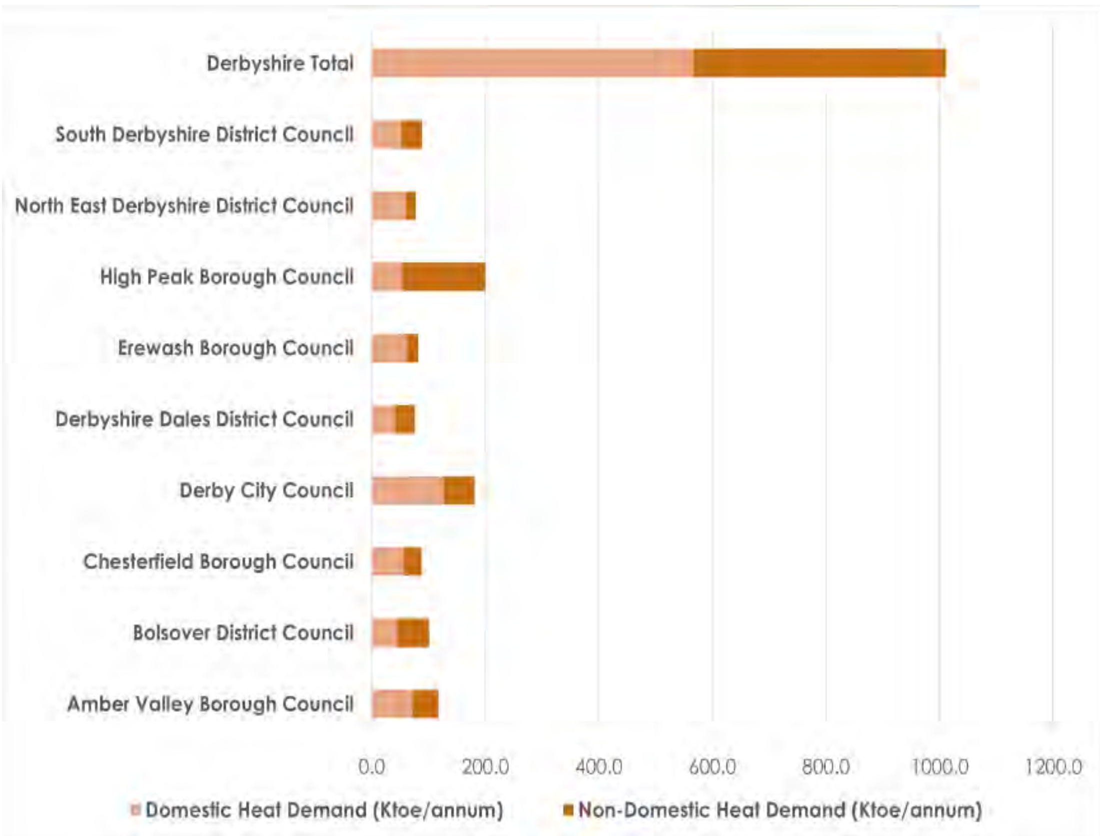

Figure 6.3 – Current heat energy demand in Derbyshire (2022)

6.4. Electricity Generation

Electricity may be supplied either directly – such as with domestic solar PV or private wire networks – or via the national electricity grid. The viability of new electricity generation sources in Derbyshire is therefore tied to local demand and the availability of national grid infrastructure and capacity.

The electricity network at the distribution level is managed by Distribution Network Operators (DNO), with three of the six organisations covering Derbyshire. Figure 6.4 provides an overview of the region's DNOs, current transmission network extent and an overview of available capacity in the distribution network. This capacity, or headroom, at key substations is critical for the integration of larger scales of energy generation development, such as wind farms or large-scale solar PV. Smaller scales of energy development typically use the lower voltage distribution energy network for electricity export, meaning these scales are more likely to be feasible where there are existing and robust networks, such as in urban areas.

The Derbyshire distribution network is relatively unconstrained in comparison to the UK average, demonstrating some capacity for development. Key areas with significant generation headroom include the City of Derby and the surrounding area – including Erewash and Amber Valley – as well as Chesterfield and nearby locations in North East Derbyshire. More rural districts have greater generation constraints, although there is notable headroom available near to Chapel-en-le-Frith, High Peak.

The UK energy network is transitioning from a system based on centralised generation and distribution to one which integrates distributed generation. Figure 6.5 demonstrates this change, with > 200 MW of distributed electricity generation installed and a further 67 MW of infrastructure planned for the future (REPD, 2022). A full breakdown of existing and planned generation infrastructure is provided in Table 6.1.

Electricity Generation Infrastructure in Derbyshire (2022)				
Technology	Existing		Planned	
	Rated Capacity (MW)	Est. Generation (GWh / annum)	Rated Capacity (MW)	Est. Generation (GWh / annum)
Wind	27.8	64.4	2.0	7.0
Hydro	1.7	5.9	0.0	0.0
Solar PV	206.1	202.2	265.4	255.0
Energy from Waste	13.8	43.3	15.0	47.0
Landfill Gas	9.2	31.5	0.0	0.0
Sewage Gas	3.5	15.0	0.0	0.0

Electricity Generation Infrastructure in Derbyshire (2022)				
Technology	Existing		Planned	
	Rated Capacity (MW)	Est. Generation (GWh / annum)	Rated Capacity (MW)	Est. Generation (GWh / annum)
Anaerobic Digestion	0.4	2.2	0.0	0.0
Biomass	7.9	7.9	0.0	0.0
TOTAL	**270.4**	**372.4**	**82.4**	**117.0**

Table 6.1 – Existing and planned electricity capacity and generation in Derbyshire

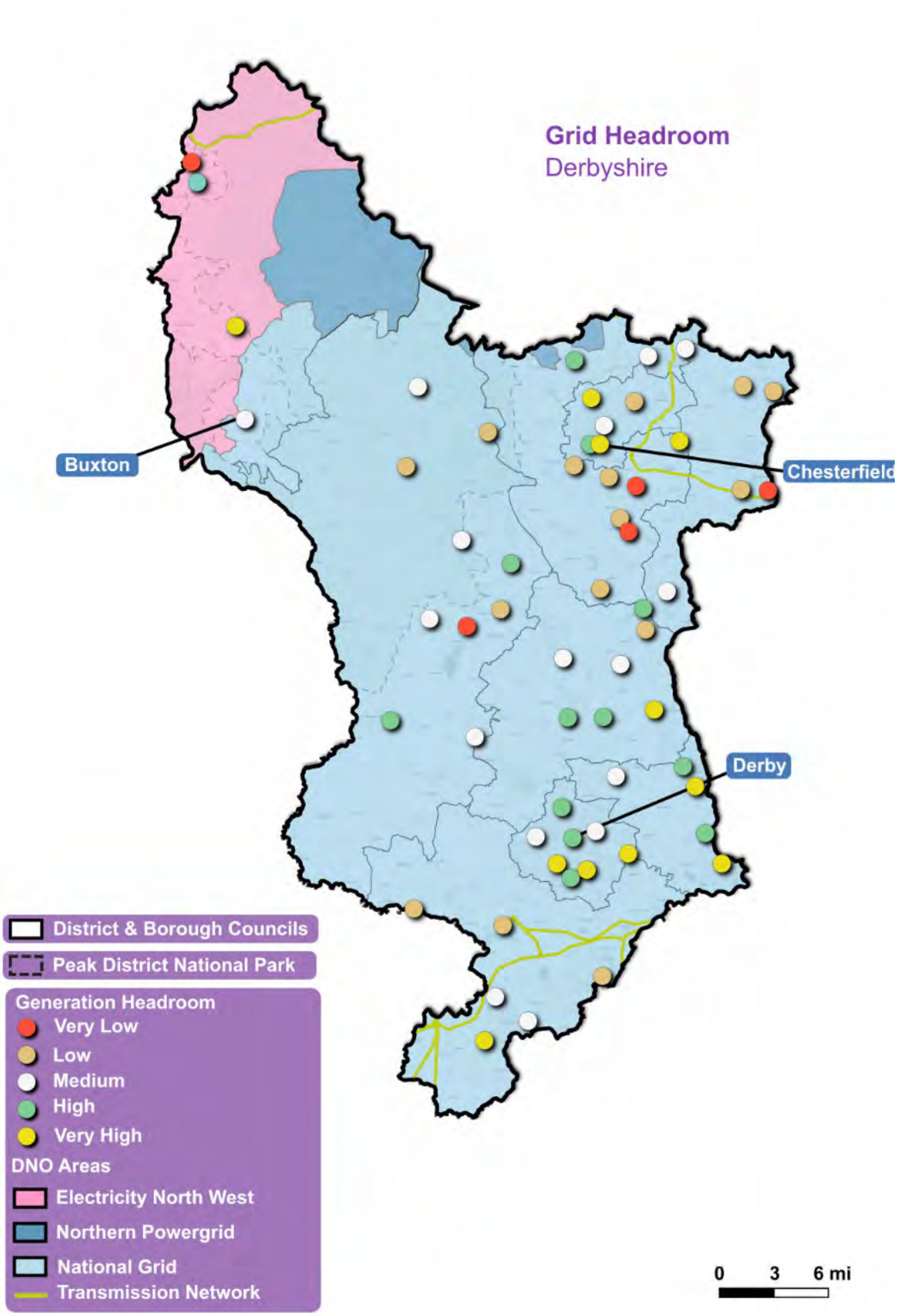

Figure 6.4 - Energy Network Capacity at primary substations in Derbyshire (2022)

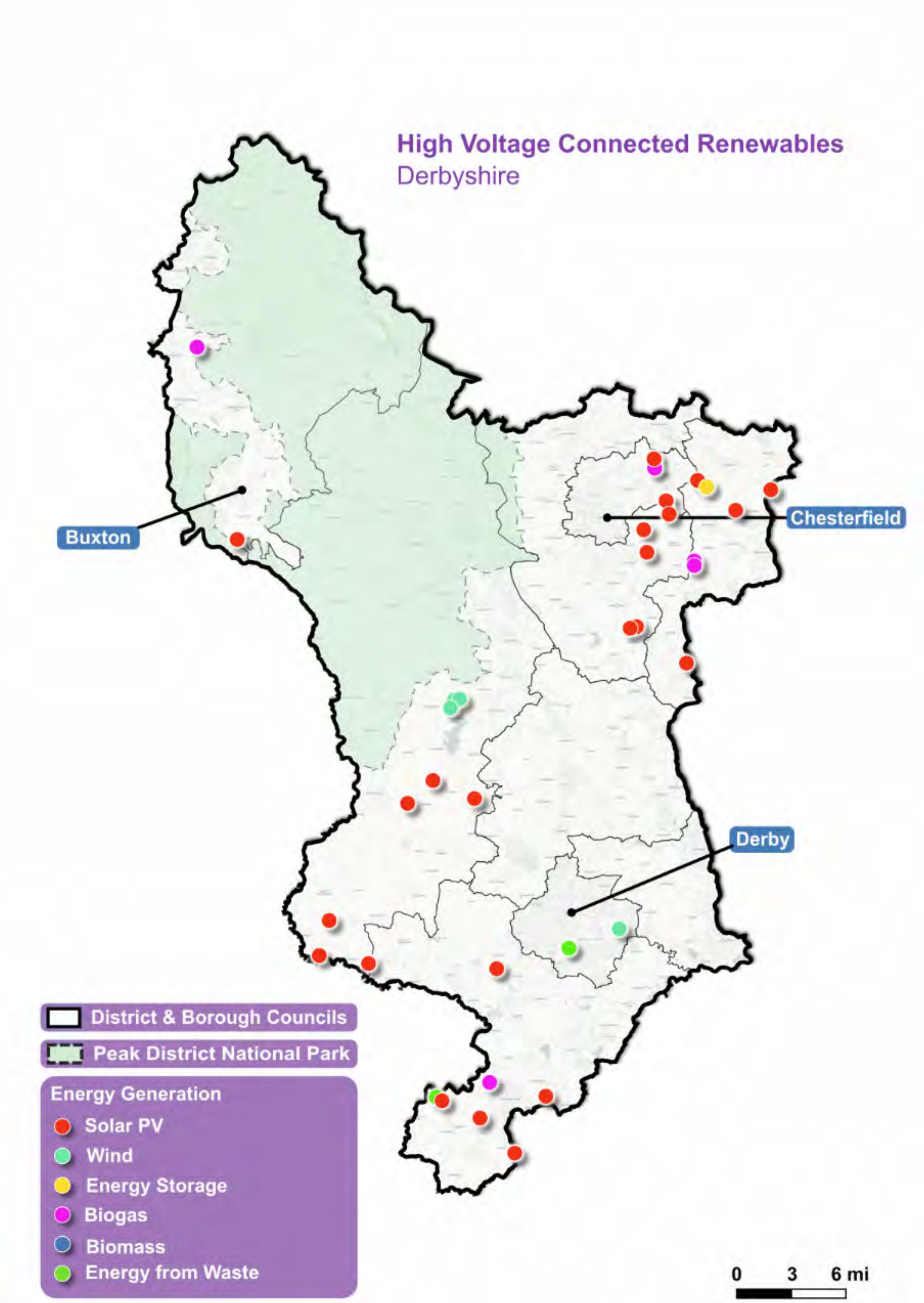

Figure 6.5 - Installed Utility-scale Electricity Generation and Storage in Derbyshire (2022)

6.4.1 Solar Photovoltaics (PV)

Solar PV is the dominant form of renewable energy deployment in Derbyshire, comprising 76% of the total installed capacity of energy generation in the region. This figure comprises 126.7 MW of large scale, and 143.7 MW of microgeneration, installations. Large scale installations are located predominantly in the south of Derbyshire, with notable clusters around Swadlincote, and to the east of both Ashbourne and Uttoxeter, and with an installation to the east of Chesterfield. Outlying this distribution, a single 2.2MW installation borders the National Park, South of Harpur Hill.

Typically, Solar PV is broken down into two forms:

- Ground-mounted systems, which can cover all scales of development but are more often deployed at larger commercial megawatt (MW) scale installations;
- Roof-mounted systems, which are constrained by roof sizes and are therefore smaller. Rooftop solar averages 2 – 5kW for domestic properties and up to 500 kW on larger buildings such as industrial and commercial premises.

From a spatial planning perspective, these forms of development should be treated differently as they are subject to different planning regulations, are deployed in different environments, and can have drastically different impacts on the landscapes. Visual impact from solar PV is typically less than that of wind turbine developments due to the low-lying nature of installations, although both the modernising effect of solar panels on building stock and specific visual effect – such as glint and glare from panel reflectivity – are important considerations in sensitive locations, for example around the safeguarded zone for East Midlands Airport.

Figure 6.6 provides an overview of solar irradiance across Derbyshire[3], demonstrating values of between 2.3 – 3.2 kWh / m2 / day. Minimal variation is seen across the region, with the highest output areas generally found towards the south.

[3] Global Horizontal Irradiance (GHI) is the potential kWh solar PV generation which is theoretically feasible from a metre squared (m^2) of land.

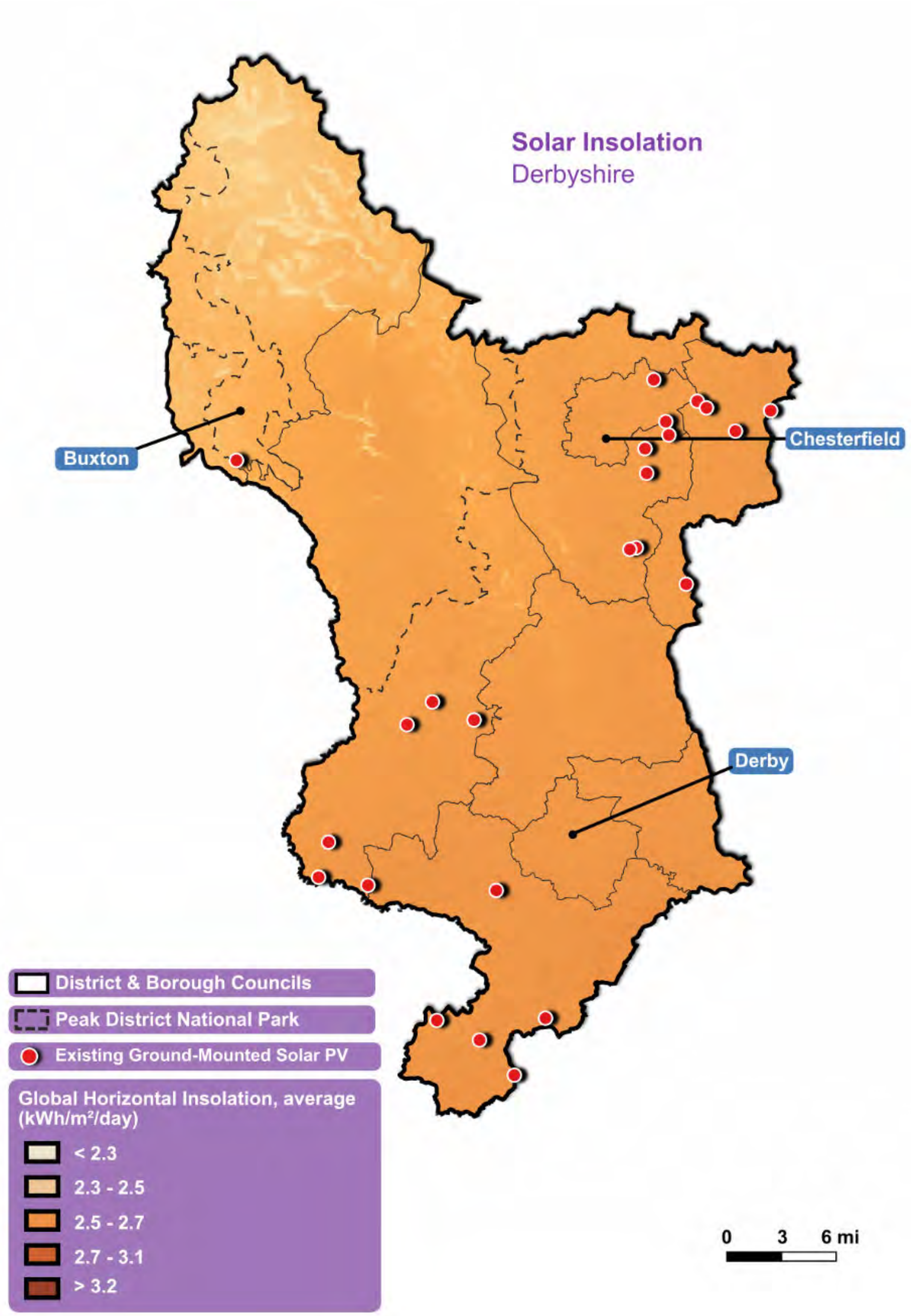

Figure 6.6 - Solar Insolation (kWh/m2/day) and existing developments in Derbyshire

6.4.2 Ground Mounted Solar PV

Ground mounted solar PV requires suitable space for development and minimal shading, meaning the technology is feasible in a wide range of situations. Potential opportunities for ground-mounted systems include low value agricultural land, brownfield sites, contaminated land, industrial land, and quarries.

From a technical perspective, scale is defined by scale of available land (i.e., land parcel size) and grid connection costs. Within this study, a range of scales has been proposed which aligns with existing and planned scales of ground mounted solar PV development in Derbyshire, including:

- Micro (< 0.1 MW)
- Small (0.1 – 0.9 MW)
- Medium (1 - 5 MW)
- Large (6 - 20 MW)
- Very Large (21 - 50 MW)

This study does not consider the availability or potential costs of grid connection due to uncertainty around future grid improvement, although there is generation headroom in most areas of Derbyshire which would enable solar PV development.

In terms of development constraints, ground mounted solar PV is not considered acceptable within the National Park or any other national or internationally designated area, including the green belt and National Forest at larger (>1MW) scales. Further to this, high value agricultural land is not considered suitable for development and limitations on proximity to key infrastructure is necessary to negate glint and glare impacts on airports, roads, and railways.

Landscape character has been treated as a constraint within this study, with areas of high sensitivity to solar PV development considered highly constrained, moderate sensitivity as moderately constrained, and low sensitivity as less constrained. It is essential to note that landscape sensitivity is an important variable in the acceptability of energy infrastructure of this type. Full information on the methodology applied in the below analyses can be found in Appendix A.

Figure 6.7 provides an overview of land which may be suitable for ground-mounted solar PV development in excess of 1 MW (>2ha). In general, development potential is located across a corridor running south west to east across the region. The greatest development potential is located to the north west of Derby and south of Chesterfield, outside of the green belt and encompassing lower value agricultural areas.

Figure 6.8 shows the greater area of land available for installations below 1MW (<2ha), with the potential for development at more constrained sites, such as within the city of Derby and in locations within the High Peak and sub-peak regions.

Cumulative impact should also be considered a limiting factor in any development's prospects. Cumulative impact assessments require specific analysis of lines of sight and visualisation of impacts prior to the planning stage.

Within less constrained land, as identified within this study, ground-mounted solar PV has a potential technical capacity of 327 MW in Derbyshire. Developing ground mounted solar PV to this theoretical extent would meet 7% of Derbyshire's total electricity demand. In reality, only a small proportion of this land area will be developed for solar PV installations.

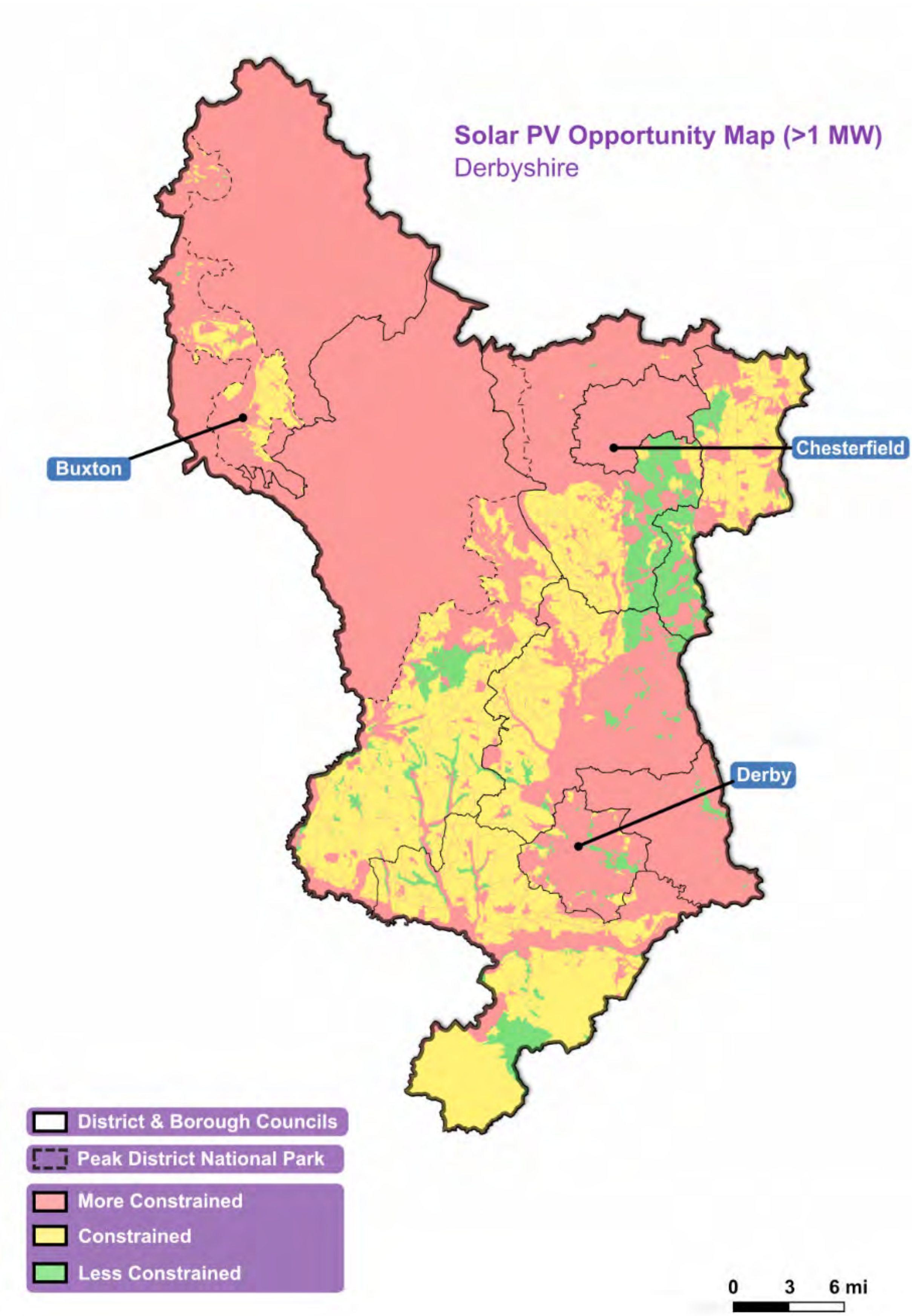

Figure 6.7 - Ground Mounted Solar PV Opportunity Areas >1 MW

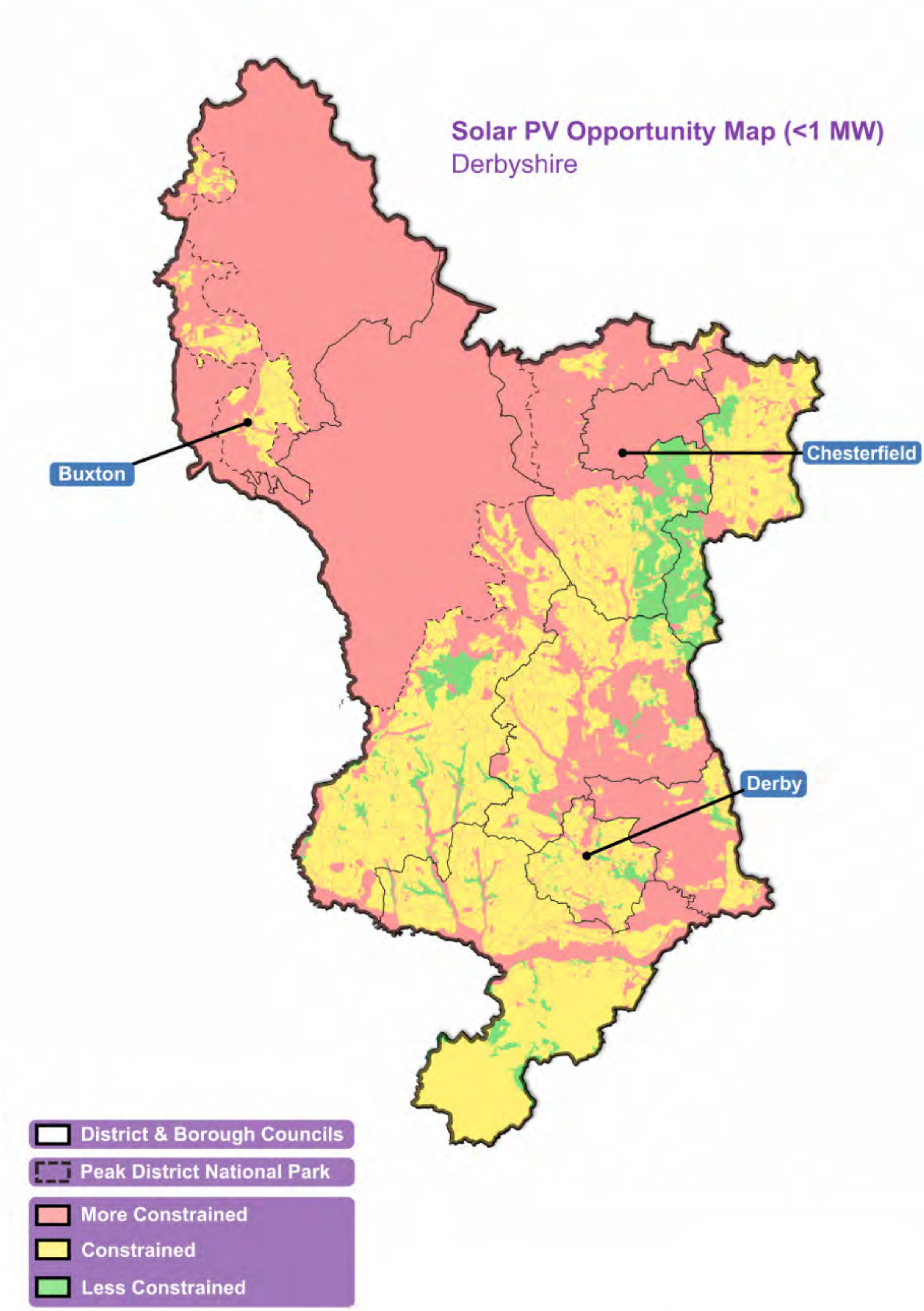

Figure 6.8 - Ground Mounted Solar PV Opportunity Areas <1MW

6.4.3 Roof Mounted Solar PV

Roof-mounted solar PV is most often installed as microgeneration, under 50 kWp, on domestic and non-domestic premises. These systems can provide electricity directly to the building on which they are installed or export to the national grid, most often via the low voltage (LV) distribution network. There are currently around 18,000 domestic and non-domestic small scale solar PV installations in Derbyshire, primarily accounted for by roof mounted systems.

Key opportunities for rooftop solar PV include:

- Domestic building stock.
- Commercial and industrial buildings.
- Schools and other educational facilities.
- Hospitals and other healthcare facilities.
- Locations where other low carbon technologies may be integrated, such as solar PV canopies at car parks combined with EV charging.

From a technical perspective, roof-mounted solar PV is limited initially by roof size, configuration, and orientation, with average domestic installations of around 2.5 kWp. Structural considerations may limit the viability and sizing of solar PV panels installed, although this may be remedied with reinforcement. Output is limited by building orientation, with south-facing roofs providing optimal generation output.

There are far fewer development constraints on roof-mounted in comparison to ground-mounted systems. Roof-mounted solar PV is covered by the General Permitted Development Order (2015), meaning that developments are permitted under certain classes of building and design conditions. Development in protected areas – including World Heritage Sites and Conservation areas – are less likely to be permitted unless hidden from view, particularly from highways, as well as on listed buildings and scheduled monuments.

In line with DECC (2010) methodology, the assumptions set out in Table 6.2 have been used to define the potential distribution and scale of rooftop solar PV development.

Roof mounted solar PV potential assumptions		
Type	Percentage of potential installations	Average installation size
Domestic (existing)	25%	2.5 kW
Domestic (new)	100%	2.5 kW
Commercial (existing & new)	40%	5.0 kW
Industrial (existing & new)	80%	50.0 kW

Table 6.2 – Roof mounted solar PV potential assumptions

Table 6.3 details the generation potential of rooftop solar PV across each of Derbyshire's council areas. It demonstrates high potential across the region, particularly in areas with higher density urban development such as Derby, Chesterfield, and Amber Valley. Based on the total potential capacity of 913.4MW, rooftop solar PV could generate up to 880 GWh/annum, fulfilling 19% of Derbyshire's total annual electricity demand.

Roof mounted Solar PV capacity in Derbyshire (MWp)					
	Domestic (Existing)	Domestic (New)	Commercial (Existing & New)	Industrial (Existing & New)	Total
Amber Valley	36.6	9.0	5.4	50.4	101.4
Bolsover	22.9	8.0	3.0	37.6	71.5
Chesterfield	31.2	6.0	5.4	63.6	106.2
Derbyshire Dales	22.2	7.0	6.8	42.4	78.4
Erewash	32.9	6.0	4.3	59.6	102.8
High Peak	26.8	6.0	5.2	45.6	83.6
North East Derbyshire	29.0	8.0	3.9	38.0	78.9
South Derbyshire	29.2	18.0	3.1	36.0	86.3
Derby City	69.5	15.0	12.3	107.2	204.0
TOTAL	**300.3**	**83.0**	**49.4**	**480.4**	**913.1**

Table 6.3 - Total potential roof-mounted solar PV capacity in Derbyshire

6.4.4 Wind Energy

There is currently 27.8 MW of installed wind energy capacity in Derbyshire, including four projects totalling 20.3 MWp delivered by 9 large scale (>2 MW) turbines. The rest of the regional capacity comprises smaller scale wind development below 150 kW.

Onshore wind development has been limited in Derbyshire in comparison to other regions in the UK. This is likely to be due to a number of reasons:

- Wind energy efficiency improves with wind speed, which is greater at higher altitudes. Much of Derbyshire's upland area is designated as a national park or part of the national park sub-region and is therefore a particularly sensitive landscape and unsuitable for wind development.
- Generally, landscapes in Derbyshire are considered of high sensitivity to wind development, through a combination of landscape character, environmental and cultural designations, proximity to urban areas, and visual impact in lowland areas.
- Planning rules in England for wind energy development imposed restrictions from 2015 which greatly reduced onshore deployment. These restrictions are under

review in 2022 and may be relaxed on the basis of national energy security and the net-zero transition.

The technical viability of wind energy development depends on suitable wind speeds. Figure 6.9 provides an overview of wind speeds across Derbyshire, demonstrating that most of the region has annual average wind speeds in excess of 6 metres per second (m/s) at 45m, and some upland areas demonstrating wind speeds in excess of 15 m/s at 45m. As noted, the most viable resource is found within areas which are protected or otherwise sensitive to wind development.

Due to the visual impact of wind turbines, a constraints-led approach to energy development has been used for this study, in line with DECC (2010). The scales of development assessed include:

- Micro (<15m)
- Small (15 – 50m)
- Medium (51 – 80m)
- Large (80 – 120m)
- Very Large (>120m)

These scales reflect the dominant scales of wind energy development in the UK. The largest wind turbines installed in Derbyshire are located at Derby Sewage Treatment Works, comprising 2 turbines at 132m, with a rated output of 5MW.

The constraints considered were selected to ensure minimal impacts to the landscape and people of Derbyshire, through degradation, visual and noise impacts. They include:

- National and internationally designated landscapes, environmental and cultural sites, including Green Belt areas.
- Built up areas and individual dwellings.
- Transport infrastructure, including roads, railways, waterways, and airports.
- Ministry of Defence (MOD) sites.

Within the National Park, wind turbines below 15m may be permissible depending on the specific benefits and impacts of any proposed development.

As detailed in section 6.2, landscape character has been used as an underpinning constraint for this study. Assessment of landscape character and capacity for wind development was undertaken and includes assessment of impacts resulting from wind turbine scale (i.e., height, rotor diameter), quantity (i.e., number of turbines), and cumulative impact on each land character area. These sensitivities are built into the analysis presented. The study does not account for cross-boundary impacts outside of the Derbyshire area.

Figure 6.10, Figure 6.11 and Figure 6.12 provide an overview of opportunity areas for wind development across the different scales of development – micro (<15m), small (15 – 50m) and medium to very large (>51m). Due to the similarity in constraining factors, all turbines > 50 m were found to have similar areas of opportunity in Derbyshire. In practice, greater turbine heights would have more extensive impacts and be subject to more stringent planning restrictions and will therefore be acceptable in fewer areas.

In general, all scales of development are theoretically viable in a number of areas from the south west to the east of the county, between Sudbury and Chesterfield.

In respect to medium, large, and very large typologies, the largest areas can be found in proximity to Darley Dale, Mugginton and Bolsover. There is also some scope of development around Buxton in the north of the region but the proximity to the National Park is highly likely to be a constraining factor due to visual impacts into the national park itself.

Smaller scales of development are expected to be permissible in a wider range of locations, including a greater number of sites throughout the corridor described above, as well as areas to the south of Derby and a large number of sites in the High Peak region. At the micro scale, a much larger range of sites are considered permissible, including large portions of the national park.

The statements above are based on a specific set of constraints and opportunities, as detailed in the methodology (Appendix B). This information is designed as a theoretical understanding of potential opportunity areas which will guide future local planning and therefore provides broad guidance rather than policy or decision making relevant to wind energy developments. In practice a site-specific feasibility study and potentially much more extensive environmental impact assessment (EIA) and landscape and visual impact assessment (LVIA) would be required for any potential development sites, so the content of these maps does not necessarily indicate that wind turbines would definitely be acceptable or unacceptable at any given point.

Based on the land identified, Derbyshire has a technical capacity of 2,529 MW across all identified land (Table 6.4). It provides an indicative theoretical capacity of the landscape to contain wind energy developments, which in practice would be unfeasibly high. A conservative estimate of 5% utilisation of identified land would result in a rated output of 126 MW and annual generation capacity of 299 GWh, which is 6.4% of Derbyshire's annual electricity demand. This deployment extent is in line with the future energy scenario maximum prediction for Derbyshire.

Wind Energy Potential in Derbyshire				
Scale	Micro	Small	Large	Total
Total Area (km^2)	777	234	47	**1,058**
Rated Capacity (MW)	1,050	1,053	427	**2,530**
Generation Potential (GWh / annum)	2,482	2,489	1,010	**5,981**
Number of Turbines	19,082	1,403	171	**20,656**

Table 6.4 - Wind energy potential in Derbyshire

Turbine Resource Assessment Typologies and Assumptions			
Scale	Height (m)	Rated Capacity (MW)	Power Density (kW / m^2)
Micro	15	0.055	1.35
Small	50	0.750	4.50
Large	100	2.500	9.00

Table 6.5 - Turbine resource assessment typologies and assumptions

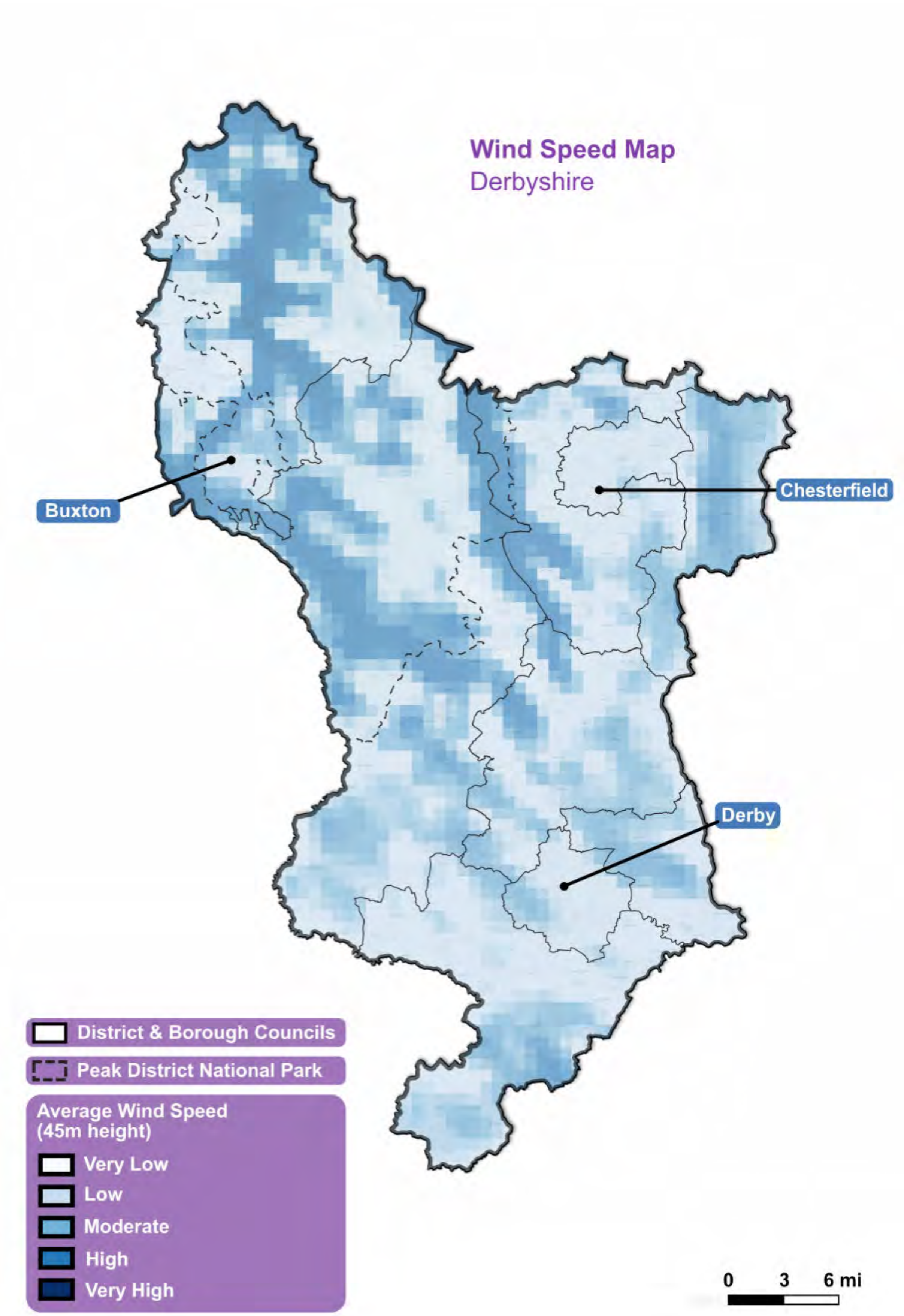

Figure 6.9 – Average Annual Wind speed in Derbyshire

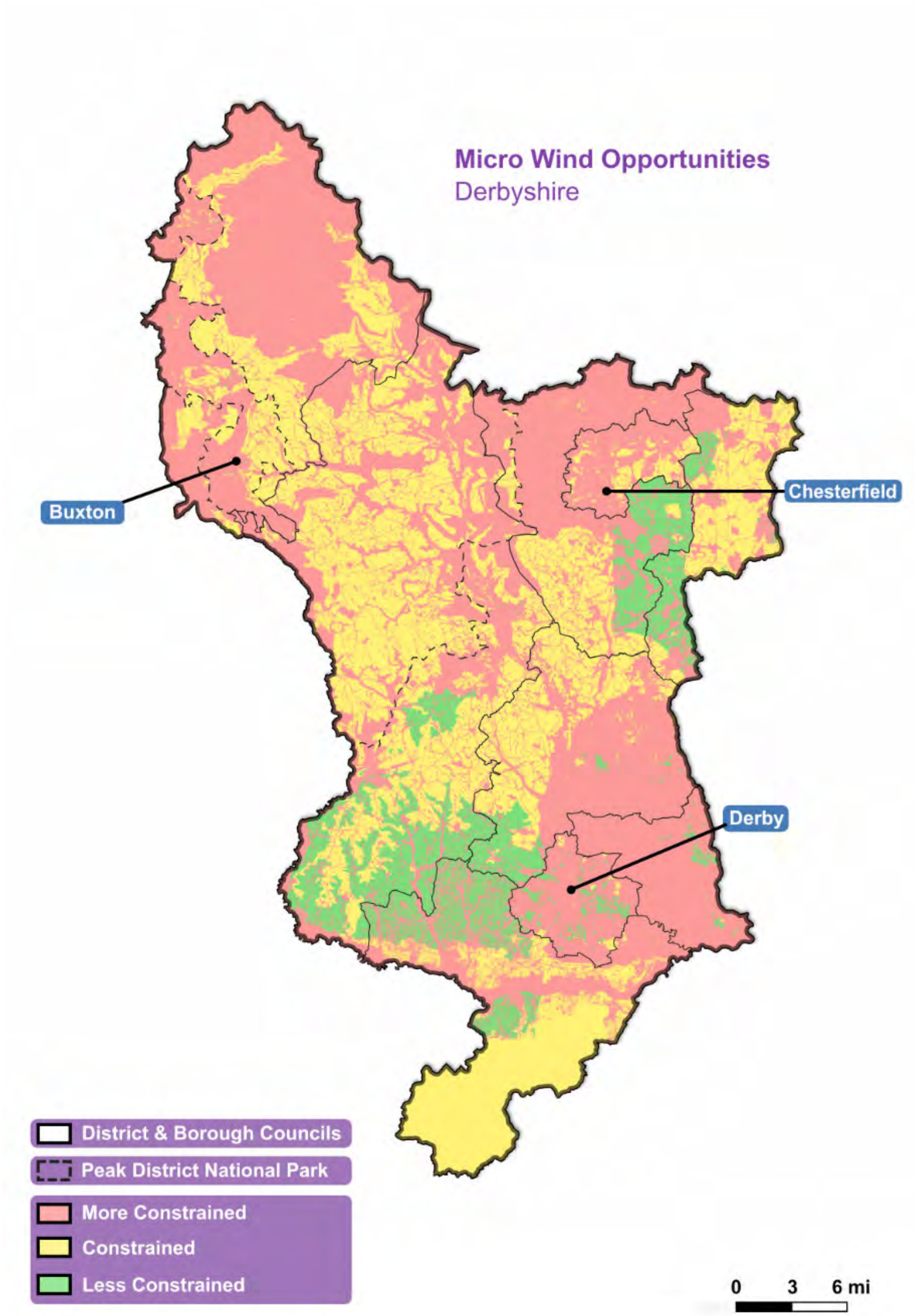

Figure 6.10 - Micro Wind (<15m) Opportunities in Derbyshire

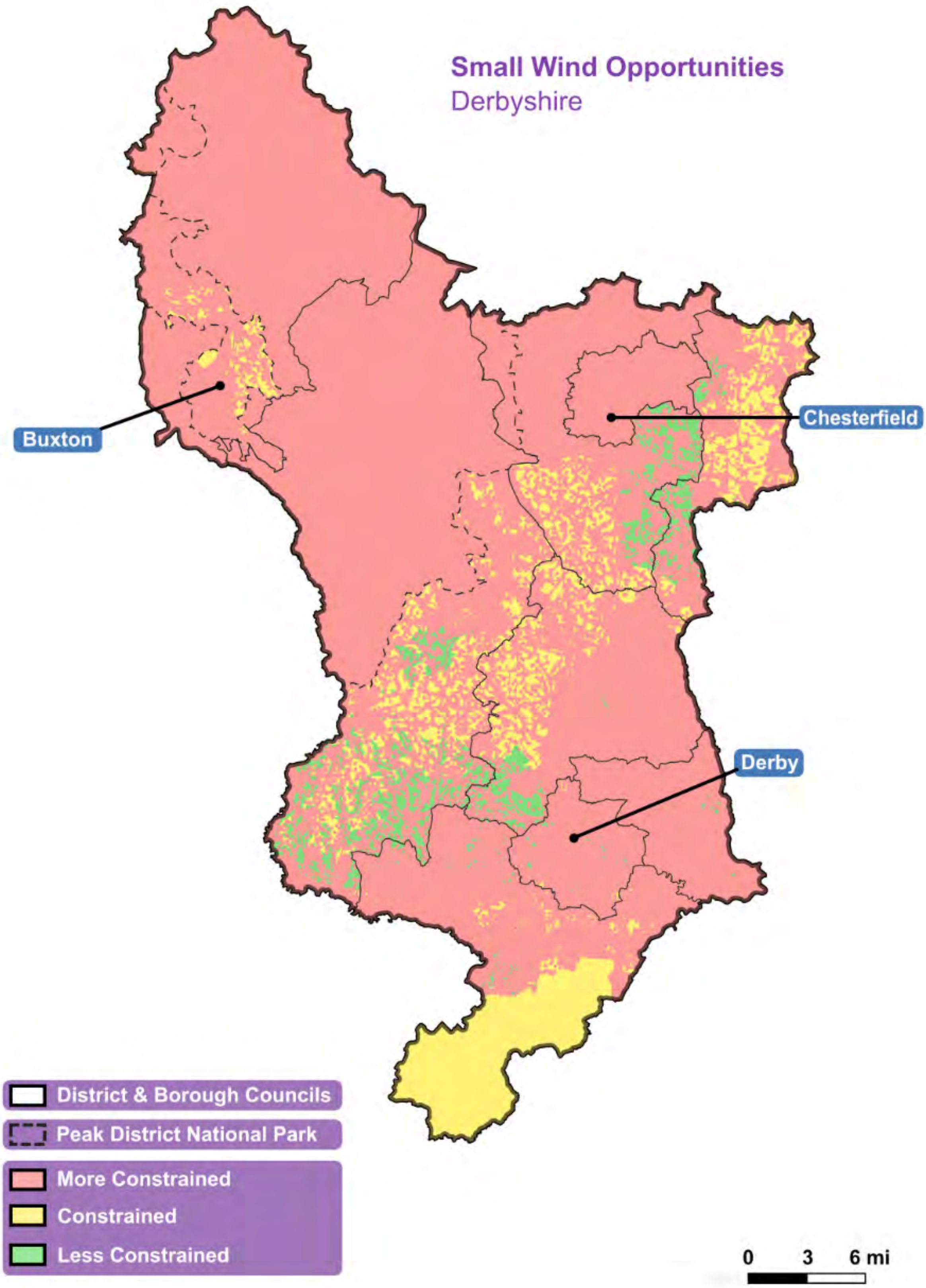

Figure 6.11 - Small Wind (16 - 50m) Opportunities in Derbyshire

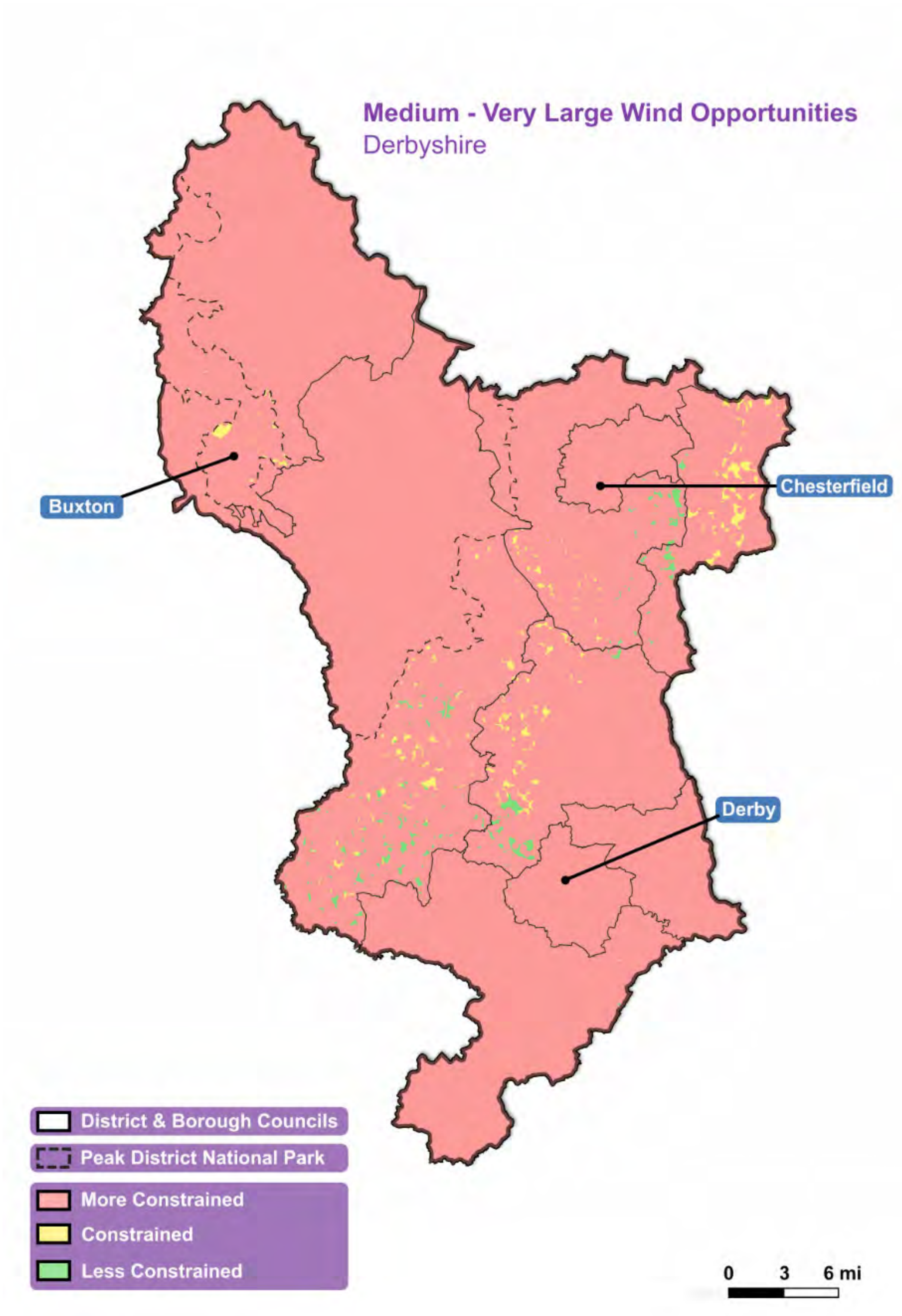

Figure 6.12 - Medium to Very Large Wind (>51m) in Derbyshire

6.4.5 Hydropower

Hydroelectric generation relies on specific site conditions for viability, particularly at larger scales. BEIS (2013) notes that larger scales of development are considered unlikely in the UK due to the fact that the most attractive sites have already been developed and as a result of more stringent environmental and planning regulations relating to large scale hydro.

Hydro requires an increasing level of resource to justify scales of development, including flow rate of the watercourse and the gradient the watercourse transits (i.e., head height). Key opportunities therefore include high gradient streams and rivers, as well as locations with existing infrastructure which may be utilised, such as weirs and some existing watermills.

Currently there are 14 hydroelectric installations in Derbyshire, totalling 1.7MW, many of which were installed in the 1990s and early 2000s. This includes a number of small-scale schemes such as Milford (150kW), Belper Hydro (350 kW), Borrowash Mill (179 kW), and the community-owned Torrs Hydro (63 kW) in New Mills. These installations are all integrated into existing infrastructure, including historic mill buildings and weirs.

Based on a review of existing hydro generation sites in Derbyshire as well as available resource (i.e., rivers and streams), only small-scale installations are included in this study (< 100kW). Hydro schemes are limited by international and nationally designated areas, as well as requiring attentiveness to river conditions, including water quality, ecology, and protected habitats. Small-scale hydro has a minimal level of visual impact, both in terms of installed infrastructure and impacts on river form and flow. There is lower likelihood of new major river barriers being acceptable, therefore use of existing infrastructure such as weirs and waterwheels would be appropriate in more low-lying regions and on larger rivers.

Figure 6.13 sets out possible opportunities for hydroelectric development, detailing the major watercourses in Derbyshire and the level of constraint to each. Generally, sites in the south are likely to be unconstrained and the largest and highest flow rivers – including the Rivers Trent and Derwent – are more likely to be suited to low-head hydro installations. Watercourses in the north of Derbyshire, particularly within the National Park are severely constrained, with the most notable opportunities found across a number of streams in the High Peak region. There are 1,068 identified weirs in Derbyshire that may provide opportunities for hydro development.

Whilst it is not possible to ascertain the exact level of resource available and development potential for hydroelectric generation, the historically modest level of development (1.7 MW) suggests that the technology is unlikely to provide large generation potential in Derbyshire in future.

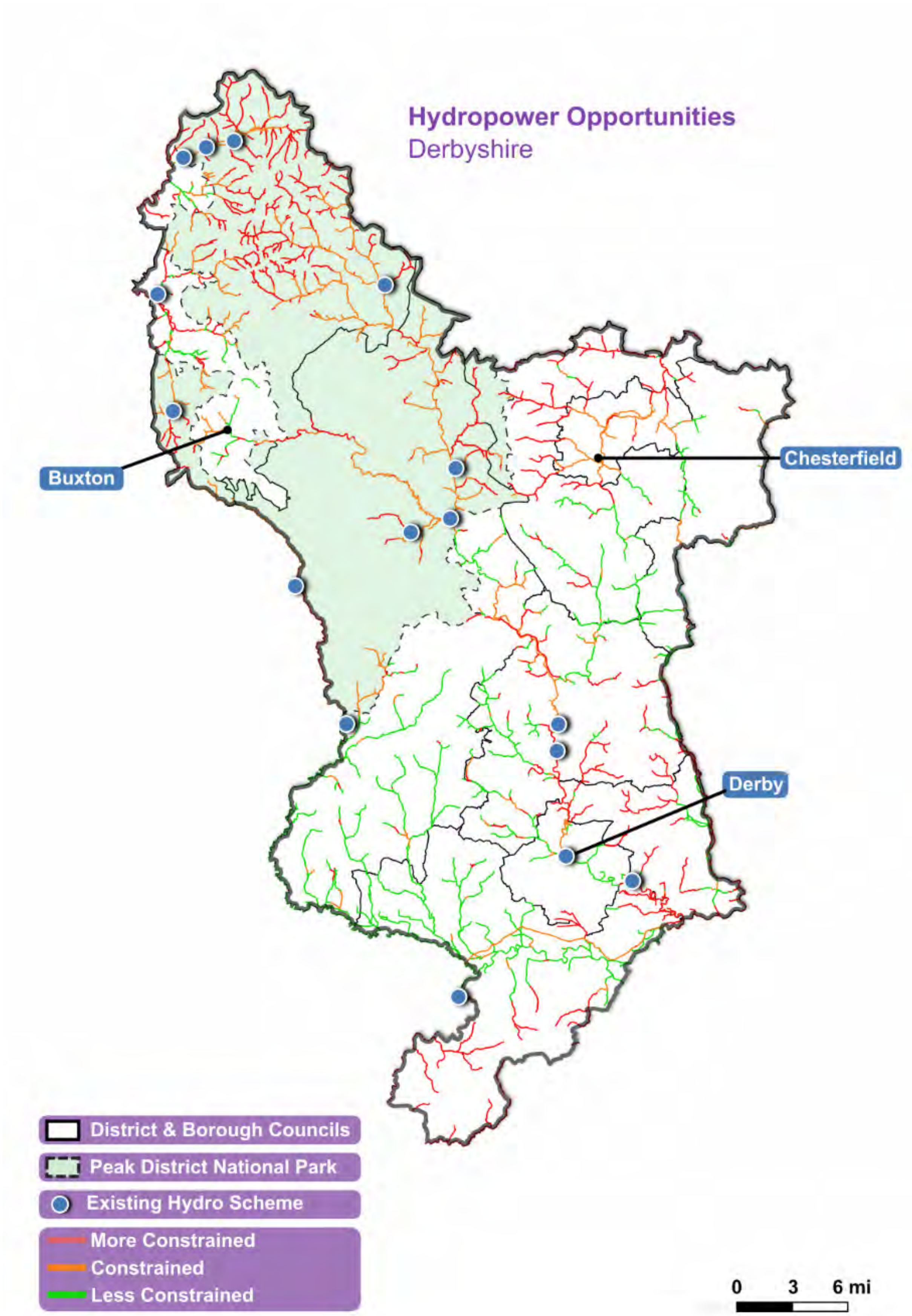

Figure 6.13 - Hydro Opportunities in Derbyshire

6.5. Heat Energy

Decarbonising heat has been recognised as a priority in the UK, both as a means of achieving net zero targets and to combat rising fossil fuel energy costs. Space and water heating account for 21% of all UK carbon emissions (BEIS, 2018). Heating in the UK is largely provided by the national gas network, serving domestic and non-domestic gas boiler systems. Off gas grid properties largely rely on oil, direct electric heating and wood fuel for their heating needs.

In 2021, the UK Government set out the Heat and Buildings Strategy (HABS), which aims to incentivise the move away from fossil fuel heating systems to reduce fossil fuel dependence and increase national energy security. The measures include a £3.9bn fund to decarbonise heat and buildings up to 2035, indicating that dramatic changes are expected in the generation and supply of heating in the UK in the short term.

This section provides spatial analysis and resource assessment for key heating technologies in Derbyshire, including:

- Solar Thermal.
- Heat pumps, including ground-, water-, and air-source variants.
- Bioenergy, including biomass, biogas, anaerobic digestion, and energy from waste (EfW).
- Heat supply, via district heating networks.

Heat demand in Derbyshire totals 10,046 GWh per year, of which 61% is domestic and 39% non-domestic demand. Table 6.6 provides an overview of the number of non-fossil fuel heat generators in the region, with a total generation capacity of 73.3 MW.

Heat Generation in Derbyshire		
Technology		Number of Installations
Heat Pump		1,261
	Ground-source	228
	Air-source	1,033
Solar Thermal		84
Domestic Biomass		192
Large Biomass		6
Anaerobic Digestion		3
-	**TOTAL**	**1,546**

Table 6.6 – Non-fossil fuel heat generation in Derbyshire (as of 2021)

6.5.1 Solar Thermal

Solar Water Heating (SWT), or solar thermal, uses solar radiation to heat a thermal storage system which in turn heats hot water and/or central heating systems. Whilst solar thermal can theoretically meet all heating needs in domestic properties, on average around 50% of water heating demand is met by solar thermal installations. Whilst solar thermal is relatively inexpensive and high efficiency, only 84 systems were recorded as installed between 2011 – 2021 in Derbyshire.

Due to the similarities in external infrastructure between solar thermal and PV, the planning and technical constraints are considered consistent. The installation of, and space required for, internal thermal storage system is a barrier which may explain the lower uptake of solar thermal systems in Derbyshire and the UK.

Table 6.7 utilises the DECC (2010) methodology for solar PV assessment, applying the same assumptions regarding technical viability and consenting to provide a theoretically feasible level for solar thermal deployment in Derbyshire. It demonstrates that solar thermal could meet 18% of Derbyshire's total heat demand, helping to displace existing fossil fuel boiler systems.

Demand may be met by providing heat for uses besides space and water heating, such as industrial processes. This has been accounted for by estimating a total solar thermal capacity of 100 kilowatt thermal (kW^{th}) across all industrial properties. Whilst deployment of solar PV and solar thermal are inherently linked, this report assesses the technical potential for each and therefore does not consider the potential impacts between technologies.

Solar thermal capacity in Derbyshire (MW^{th})			
Local Authority	Domestic	Non-Domestic	Total
Amber Valley	45.6	154.4	200.0
Bolsover	30.4	105.0	135.4
Chesterfield	36.9	181.2	218.1
Derbyshire Dales	29.4	153.0	182.4
Erewash	39.4	162.2	201.6
High Peak	33.3	143.4	176.7
North East Derbyshire	36.9	115.0	151.9
South Derbyshire	46.8	103.0	149.8
Derby City	84.9	337.8	422.7
TOTAL	**383.6**	**1,455.0**	**1,838.6**

Table 6.7 - Theoretical Solar thermal capacity (MW^{th}) in Derbyshire

6.5.2 Heat pumps

Heat pumps utilise environmental heat, extracting heat from air, the ground or water, to improve the efficiency of electric heating. Heat pumps are similar in scale and operation to gas boilers and are therefore being supported by the UK government through the Boiler Upgrade Fund, which provides £5,000 grants to homeowners to upgrade their heating systems. This is part of a wider package of support that prioritises heat pumps as a future domestic and non-domestic low carbon heating source.

There are a number of heat pump technologies which utilise the same basic principles but require differing infrastructure to function.

- **Air-source heat pumps** (ASHP) are mounted outside a property and extract heat from the outside air.
- **Horizontal Ground-source heat pump** (GSHP) use horizontally laid sub-surface heat collector coils to gather heat from soil. GSHP require available land for installation, as well as excavation during the installation phase, but offer more consistent year-round performance than ASHP.
- **Borehole or Vertical Ground-source heat pump** (GSHP) vertical GSHP use boreholes which extend into the ground and bedrock to depths of 100m+. These boreholes give access to higher temperature and more consistent heating resource and require less space than the horizontal variant. Borehole systems typically cost more than either air or horizontal GSHP systems.
- **Water-source heat pump** (WSHP) are similar in operation to GSHP but extract heat from a water source such a river, canal, or lake. WSHP are relatively uncommon in the UK due to the need for a nearby water source, but they offer high performance efficiency.

Heat pumps are generally considered an acceptable form of development, with the major constraints relating to areas of international and national areas of cultural importance, such as visual impacts on World Heritage sites and conservation areas as well as a low likelihood that installations in listed buildings would be permissible. Specific constraints relating to groundwater protection, flood risk, ecology and habitat protection apply to ground and water-source variants. Borehole-fed systems - and more innovative minewater systems – require a clear understanding of impacts on bedrock and sub-surface water abstraction. Noise impacts from ASHPs may also need to be considered, particularly in higher density residential areas.

Heat pumps use electricity, so their carbon emissions are tied to the carbon intensity of the energy source – usually the national grid – and the efficiency of the heat pump themselves, as detailed in Table 6.8. Coefficient of performance (CoP) refers to the efficiency improvement provided by the heat pump over direct electrical power – for example, a COP of 2.5 means that the heat pump supplies 2.5 times as much heat energy to the property as it consumes in electrical energy. This compares to a CoP of 1 for electric heating, or 0.9 or less as the conversion factor from fuel to heating from a gas (methane or hydrogen) or oil boiler.

One important consideration with heat pumps is the energy efficiency level of the property. Heat pumps often require a reasonable level of efficiency measures to be installed - particularly in older and less well insulated properties - to function optimally. A fabric-first approach is typically recommended with heat pump deployment, where building efficiency standards are increased to ensure the efficiency benefits of heat pumps can be realised.

Overview of Heat Pump Coefficient of Performance (CoP)	
Type	Coefficient of Performance (CoP) Range
Air-source heat pump	2.5 – 3.0
Water-source heat pump	3.0 – 5.5
Ground-source heat pump (horizontal)	2.5 – 4.0
Ground-source heat pump (borehole)	3.0 – 5.5

Table 6.8 - Heat Pump Coefficient of Performance range comparison

This study applies a range of heat pump options to domestic and non-domestic properties in Derbyshire, in line with DECC (2010) methodology. Table 6.9 provides an overview of the typologies used and all assumptions regarding system sizing and performance. Full details may be found in Appendix A.

Heat Pump Assessment Assumptions		
Type	Percentage of potential installations	Average installation size
Off Grid Residential	100%	
Detached / Semi-detached	75%	
Terraced	50%	5 kW
Flats	25%	
New Residential	100%	
Non-Domestic	50%	100 kW

Table 6.9 - Heat pump assessment assumptions

Table 6.10 demonstrates a theoretical impact of installing heat pumps in 359,000 domestic and 18,360 non-domestic properties throughout Derbyshire, providing an estimated thermal capacity of 3,635MW. In theory, 32% of this capacity would meet Derbyshire's current total heat energy demand - however, in practice heat pumps are typically installed to supply one single building, so the proportion of demand met is directly linked to the number of installations, rather than the capacity.

Replacement of existing gas systems with heat pumps to meet current demand would lead to an increase in electricity demand of between 3,349GWh and 4,018 GWh per year[4]. This figure does not account for the spatial distribution of energy demand and energy network capacity, which would require further in-depth study to understand. Further detail on future energy scenarios can be found in chapter 4.

Theoretical heat pump capacity in Derbyshire (MW)							
	Property Type						
	Off-Grid Residential	Detached & Semi-Detached	Terraced	Flats	New Residential	Non-domestic	Total
Amber Valley	18	128	33	5	36	197	**417**
Bolsover	7	75	20	3	30	122	**257**
Chesterfield	9	104	23	8	23	215	**382**
Derbyshire Dales	25	72	18	4	29	224	**372**
Erewash	11	117	27	6	26	182	**369**
High Peak	16	68	38	7	26	188	**343**
North East Derbyshire	12	108	16	4	31	145	**316**
South Derbyshire	19	109	24	4	70	123	**349**
Derby City	30	205	74	22	61	443	**835**
TOTAL	**147**	**986**	**273**	**63**	**332**	**1,839**	**3,640**

Table 6.10 - Theoretical heat pump opportunities in Derbyshire

Figure 6.14 provides an overview of heat pump opportunities in Derbyshire. This includes available resources, such as rivers, canals and water bodies, as well as areas of greenspace which may be suitable for larger ground-source heat pump systems[5].

Figure 6.15 provides an overview of resource availability for open loop GSHP systems. Open loop systems differ in that the piping infrastructure which feeds the heat pump is not self-contained (i.e., closed loop) but sources groundwater directly from sub-surface aquifers or other sources, such as abandoned mines.

Both figures show greater resource availability in the south and east of Derbyshire, with high suitability in all areas for open loop systems, with marginally less favourable areas around Tissington and Kniveton, as well as in the north surrounding Buxton.

Figure 6.16 provides an overview of vertical ground-source opportunities in Derbyshire, including mine locations for minewater source opportunities. Minewater sourced heating is very rare in the UK, with only a handful of active installations as of 2022. Due to high capital costs, minewater systems are more suited to larger opportunities, such as commercial or industrial heating or district heat networks. Due to the number of mine workings throughout Derbyshire, in particularly between Derby and Chesterfield, and in the north surrounding New Mills, there is potential for minewater source heating in the region.

[4] Based on a conservative year-round CoP of 2.5 – 3.0.

[5] Possible (2019) "Powering Parks - Unearthing the ground source heat potential from parks and public green spaces across Great Britain"

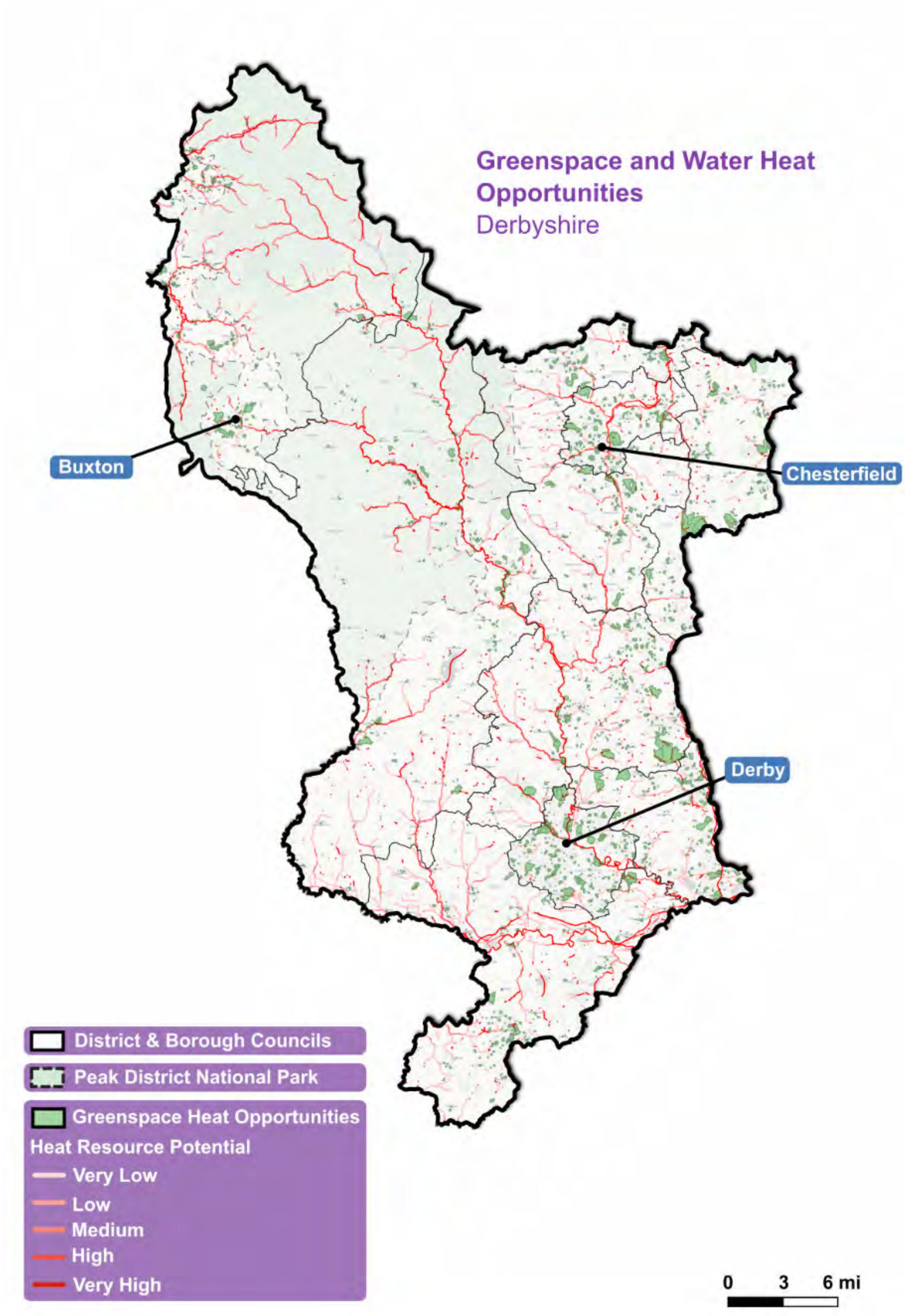

Figure 6.14 - Heat pump Opportunities in Derbyshire

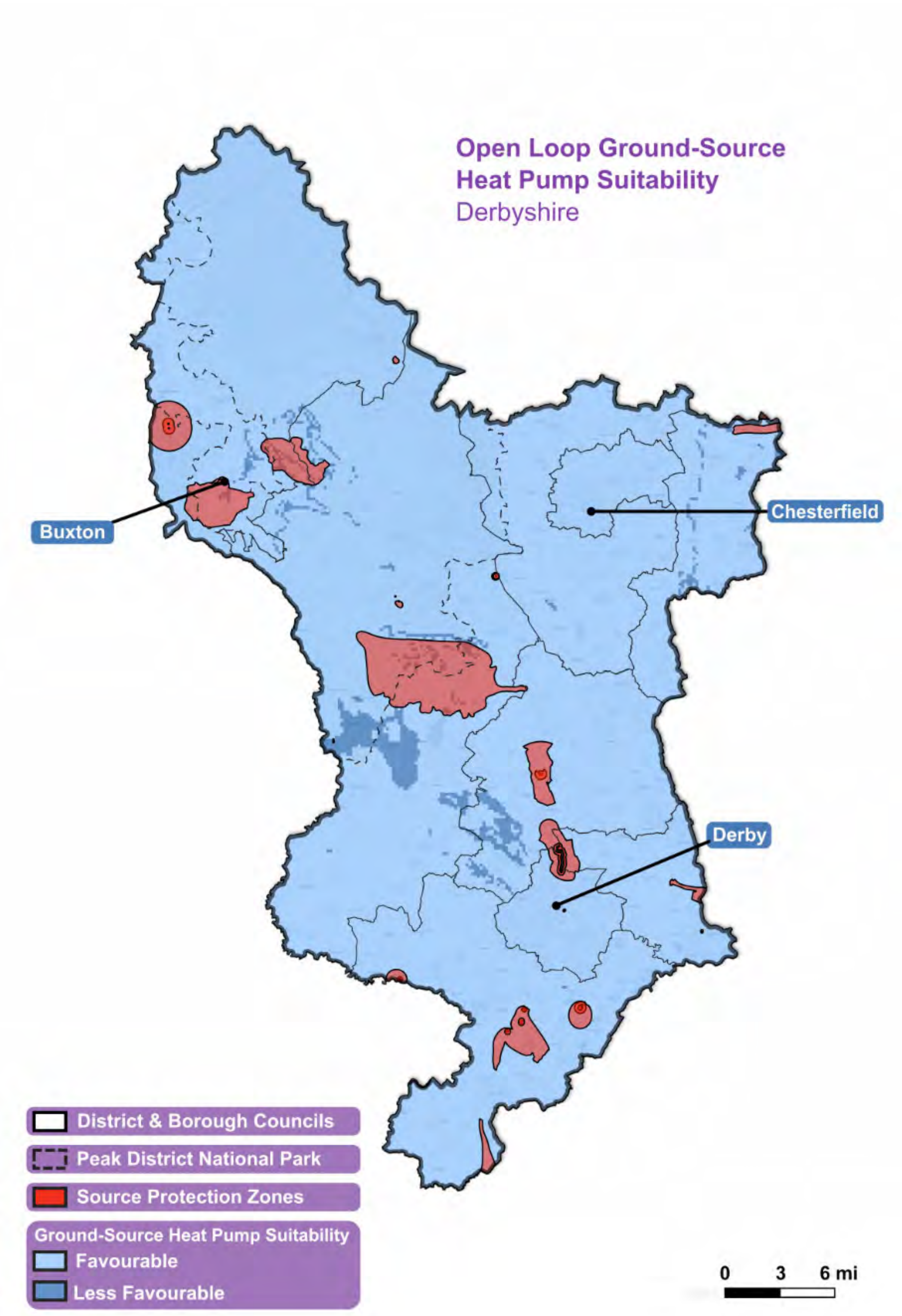

Figure 6.15 - Open Loop Ground Source Heat Opportunities in Derbyshire

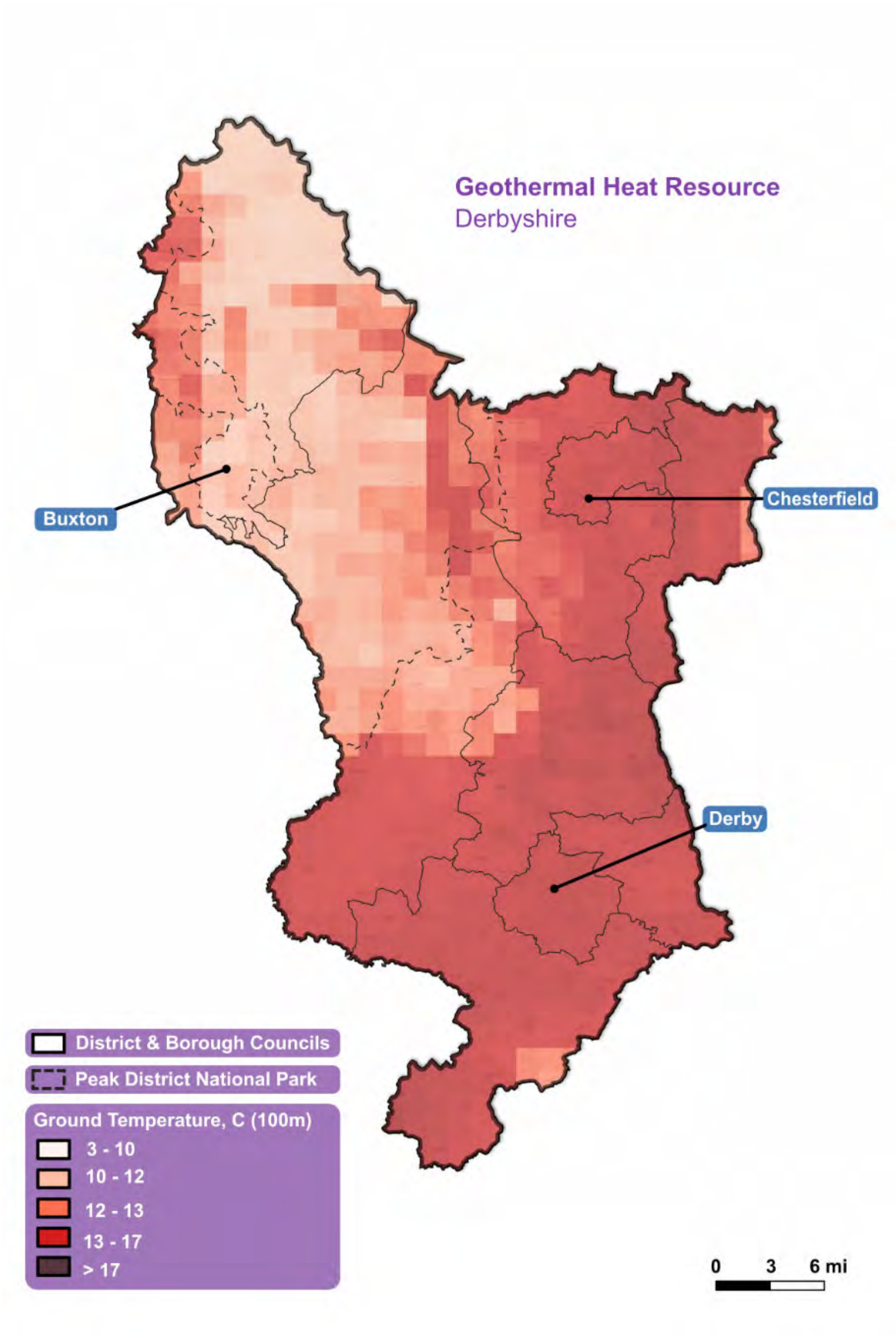

Figure 6.16 - Geothermal heat source opportunities in Derbyshire

6.5.3 Bioenergy

Bioenergy includes all forms of energy generation that utilise organic materials. This includes both domestic and commercial biomass heating, anaerobic digestion, biogas, and energy from waste. As of 2022, there is 34.8 MW of installed bioenergy generation in Derbyshire, comprised of a mixture of small-scale domestic biomass heating systems (7.9 MW), farm-scale anaerobic digestion (0.4 MW) and large-scale landfill and sewage-fed biogas and energy from waste plants (26.5 MW).

The sustainability of bioenergy as an energy source is reliant on sourcing low carbon feed stocks, meaning local sourcing and use of low value products is critical. The UK Government Biomass Policy Statement (2021) states that around a third of bioenergy feed stock comes from net imports and emphasises the importance of understanding and defining how feed stocks can be sourced from within the UK. With sustainable sourcing, biomass could make a significant contribution to energy decarbonisation, estimated at 10% of UK energy demand by 2050.

This section sets out the potential for energy generation from bioenergy in Derbyshire, with a focus on sourcing of feed stock within the Derbyshire region.

6.5.4 Biomass

Biomass refers to generation of heat via burning of feed stocks derived from plants and / or human activity. This can include waste wood, processed wood products (e.g., wood pellets), energy crops, agricultural by-products, and wet organic wastes (e.g., livestock manure).

Biomass systems require suitable space for a boiler unit and feed stock storage, as well as requiring regular deliveries of fuel for the system to run on. This is a larger space requirement than typical gas boilers or low carbon alternatives, such as air-source heat pumps, as well as requiring good access for fuel delivery. Furthermore, biomass has a local pollution component due to on-site combustion or thermal treatment, meaning emissions such as PM2.5 are released directly into the atmosphere adjacent to the biomass system. This means biomass is less appropriate in urban contexts, as well as not permissible in current or future air quality management zones (AQMA) or smoke control zones, such as the Derby AQMA (Figure 6.17).

Table 6.11 sets out an assumed deployment limit of biomass within existing and future domestic and non-domestic properties. Based on the Biomass Policy Statement (2021), it is anticipated that off-grid properties are likely to form the greatest opportunity area for biomass deployment, with only some on gas grid properties suitable from a technical and regulatory perspective. Biomass is expected to be suitable for many industrial properties and may be able to provide heat for certain industrial processes.

Table 6.12 demonstrates a theoretical impact of installing biomass heating systems in 33,394 domestic and 3,672 non-domestic properties throughout Derbyshire, providing an estimated thermal capacity of 1,202MW.

Figure 6.19 demonstrates farmland type and quality across Derbyshire. Energy crops may be grown across marginal and poor quality land (agricultural grades 4 and 5), providing a high value use for land which typically has lower economic value and productivity.

Biomass System Assumptions		
Type	Percentage of potential installations	Average installation size
Off Grid Residential	50%	
Detached / Semi-detached	5%	
Terraced	2.5%	25 kW
Flats	2.5%	
New Residential	2.5%	
Non-Domestic	10%	100 kW

Table 6.11 - Biomass system assumptions

Theoretical Biomass capacity in Derbyshire (MW)							
	Property Type						
	Off-Grid Residential	Detached & Semi-Detached	Terraced	Flats	New Residential	Non-domestic	Total
Amber Valley	45	43	8.4	2.5	4.5	39.4	**142.8**
Bolsover	18	25	5.1	1.4	3.8	24.3	**77.6**
Chesterfield	22	35	5.7	3.9	2.9	42.9	**112.4**
Derbyshire Dales	62	24	4.6	2.0	3.6	44.7	**140.9**
Erewash	28	39	6.7	2.8	3.2	36.4	**116.1**
High Peak	40	23	9.4	3.4	3.2	37.5	**116.5**
North East Derbyshire	29	36	3.9	1.8	3.9	29.0	**103.6**
South Derbyshire	48	36	6.0	1.8	8.8	24.5	**125.1**
Derby City	75	68	18.5	11.1	7.7	88.5	**268.8**
TOTAL	**367.0**	**329.0**	**68.3**	**30.7**	**41.6**	**367.2**	**1,203.8**

Table 6.12 - Theoretical Biomass Capacity in Derbyshire

The three most viable biomass feed stock options which could be sourced from within Derbyshire are woodland products and energy crops. Figure 6.18 provides an overview of the distribution of existing forestry sites and cropland. There is high potential for wood fuel production from within the region, with 236 km^2 of currently developed woodland which could contribute to biomass production.

Just 2km^2 of land is currently used for energy crop production, including short rotation coppicing (SRC) and Miscanthus. There is 1,734 km^2 of lower grade land considered appropriate for energy crop development, of which 42% would be required for energy crop growth to meet the theoretical maximum demand[6].

To meet the annual theoretical demand, around 1.5m tonnes of wood pellets would be required across all installations and 2.0m tonnes of energy crops[7].

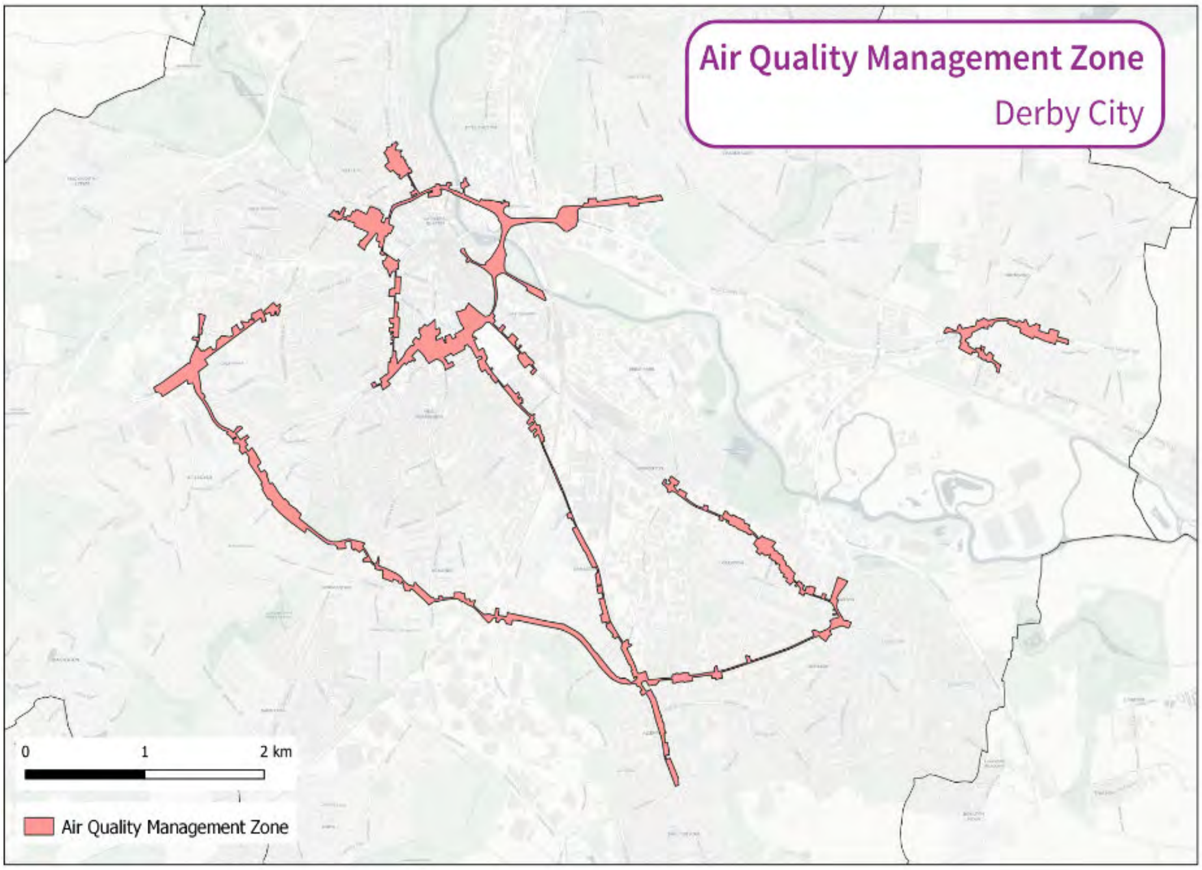

Figure 6.17 - Derby Air Quality Management Zone

[6] Based on an average dry yield of 2.72 kg/m2 (Shepherd et al., 2020)
[7] Based on a guideline 4.8 kWh/kg of wood pellets and 3.6kWh/kg energy crops (miscanthus) (Forest Research, 2022).

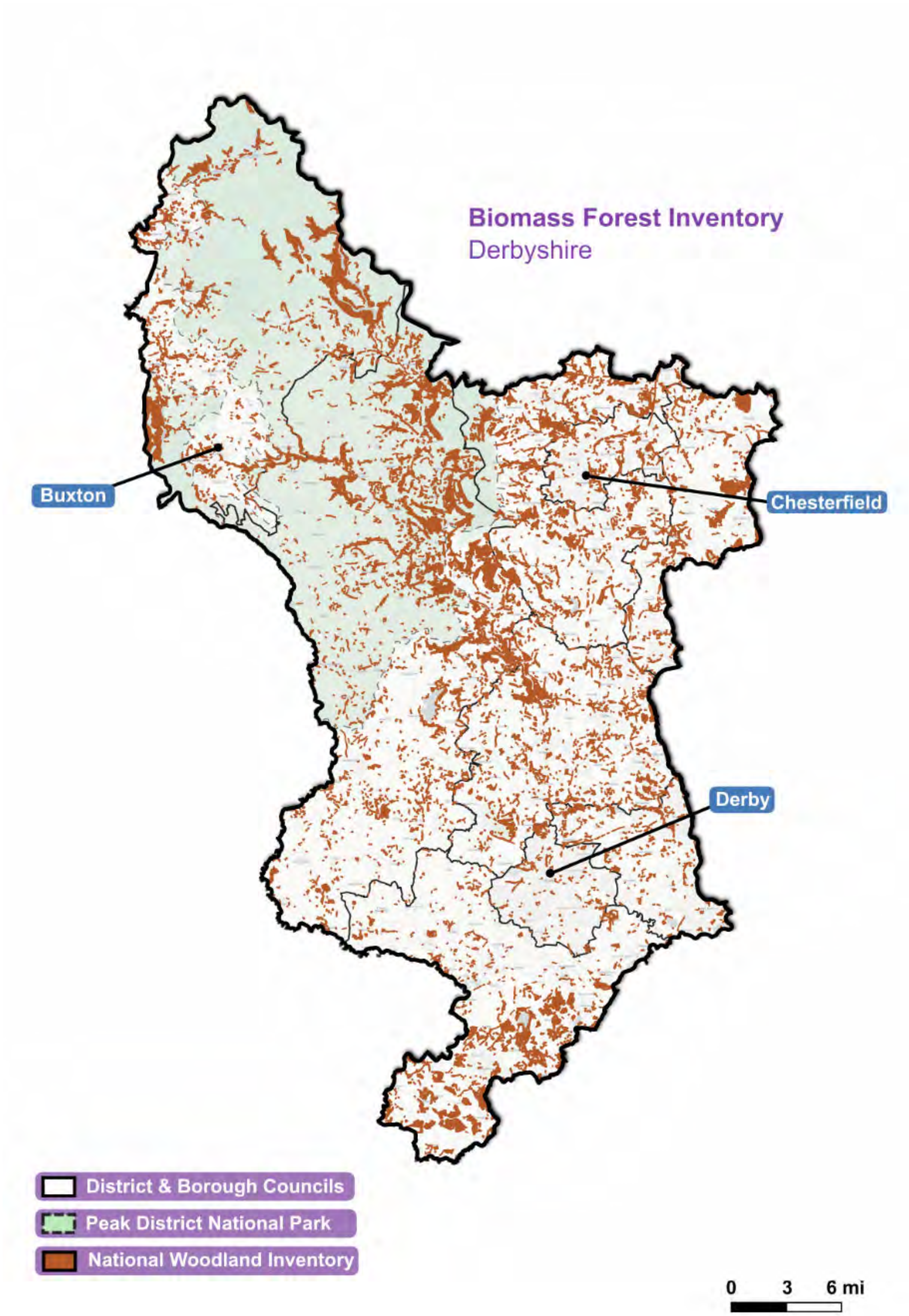

Figure 6.18 - Woodland Biomass Map of Derbyshire

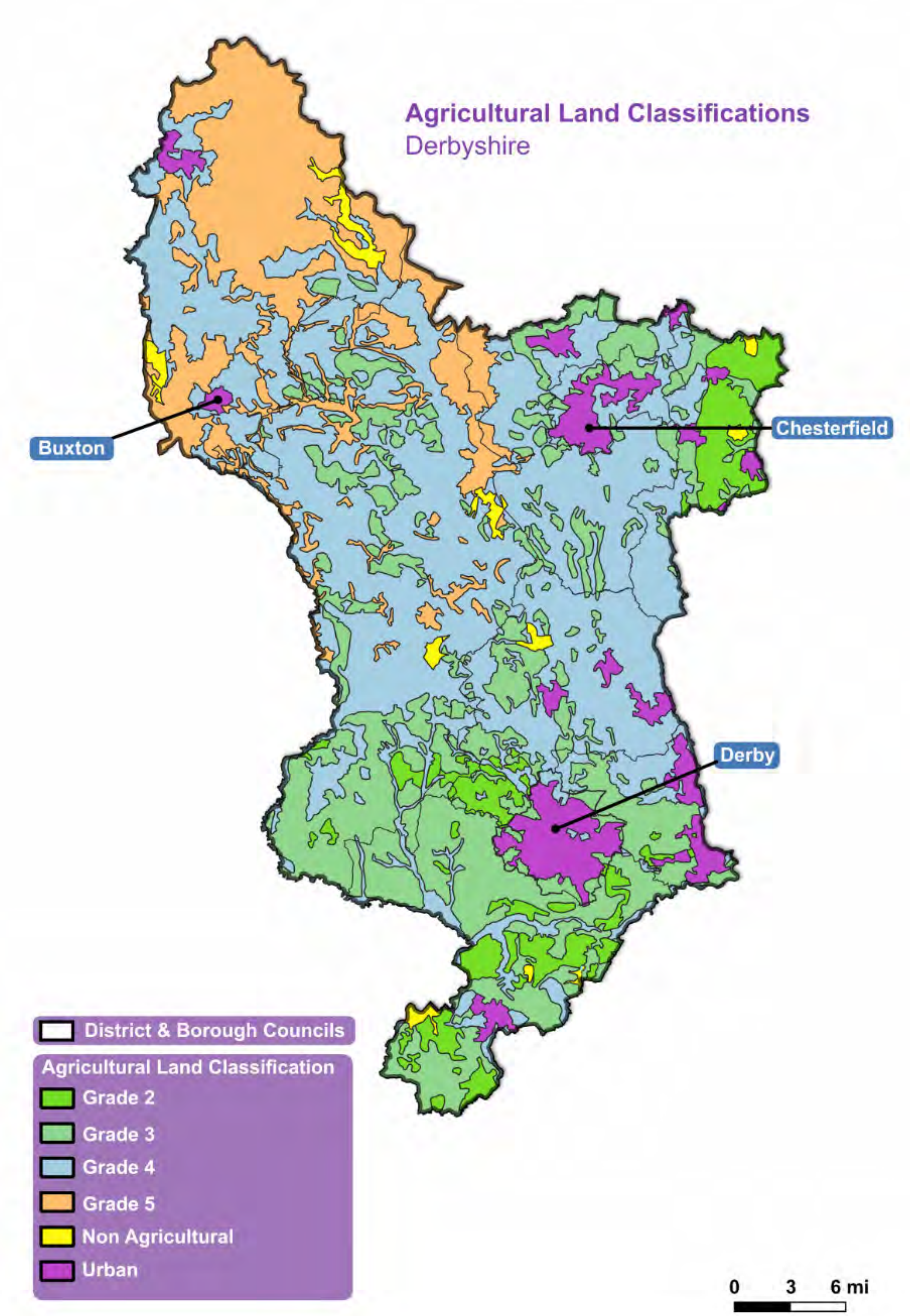

Figure 6.19 - Agricultural Land Classification (ALC) in Derbyshire

6.5.5 Anaerobic Digestion

Anaerobic Digestion uses organic waste and occasionally purpose-grown crops as a fuel source, with decomposition via biological processes producing biogas which can be utilised for heat, electricity and / or transport. In the UK, anaerobic digestion is primarily co-located on farms and fuelled via manure or slurry (17%), crops (30%) and waste products (53%), such as food waste.

There are 3 existing anaerobic digestion plants in Derbyshire with a total capacity of 0.4 MW, all of which generate combined heat and power (CHP). As with other forms of bioenergy, feed stock transport has a large effect on the carbon emissions of anaerobic digestion plants. As a result, local fuel supply is considered an important consideration, particularly within the National Park, where anaerobic digestion is permissible only where feed stocks are produced onsite or within a short distance for communal infrastructure.

Figure 6.20 provides a spatial overview of where anaerobic digestion may be permissible within Derbyshire. The most important factor in the development of future anaerobic digestion facilities is the availability of feed stock, requiring an understanding of specific opportunities for a given location. The main areas of agricultural development to the west and south of Derby as well as east of Chesterfield present potential opportunities for larger scale generation, whilst smaller scales of development may be suitable across much of the region.

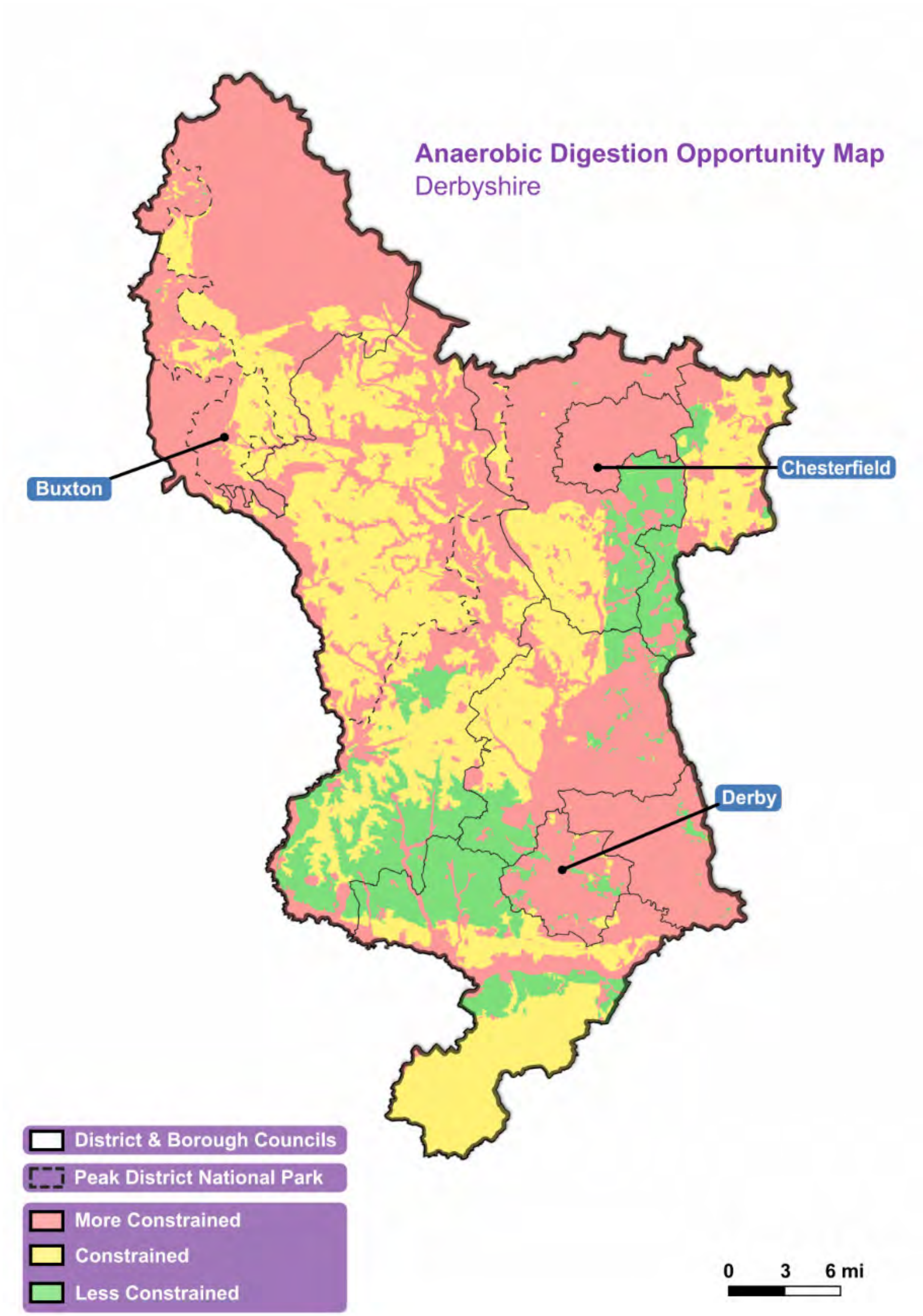

Figure 6.20 - Anaerobic Digestion Opportunities in Derbyshire

6.5.6 Energy from Waste

Energy from Waste (EfW) includes heat and electricity generation from waste sources, typically at large scales. Fuel sources include direct generation from landfill waste (e.g., solid municipal waste, commercial and industrial (C&I) waste) as well as biogas production from sewage and landfill gas. EfW plants are primarily used to generate electricity but, due to the amount of heat produced during combustion or gasification processes, may provide a heat resource which could be utilised by local buildings.

There are a large number of constraints that would affect the development of EfW plants, therefore areas of opportunity have been defined in terms of lowest impact areas – including industrial and urbanised landscapes – and proximity to fuel source.

Figure 6.21 provides an overview of the 7 existing and planned EfW plants, including biogas production plants, in Derbyshire with a combined capacity of 32.4 MW. In planning developments include both consented (i.e., secured consent within the last 3 years) and yet to be determined proposals. This includes the 7.5 MW Sinfin plant, Derby and 3.1 MW Arden Quarry Landfill Gas plant near New Mills. It further demonstrates that there are undeveloped EfW opportunities in all major settlements in the region, including landfill, recycling, and treatment centres.

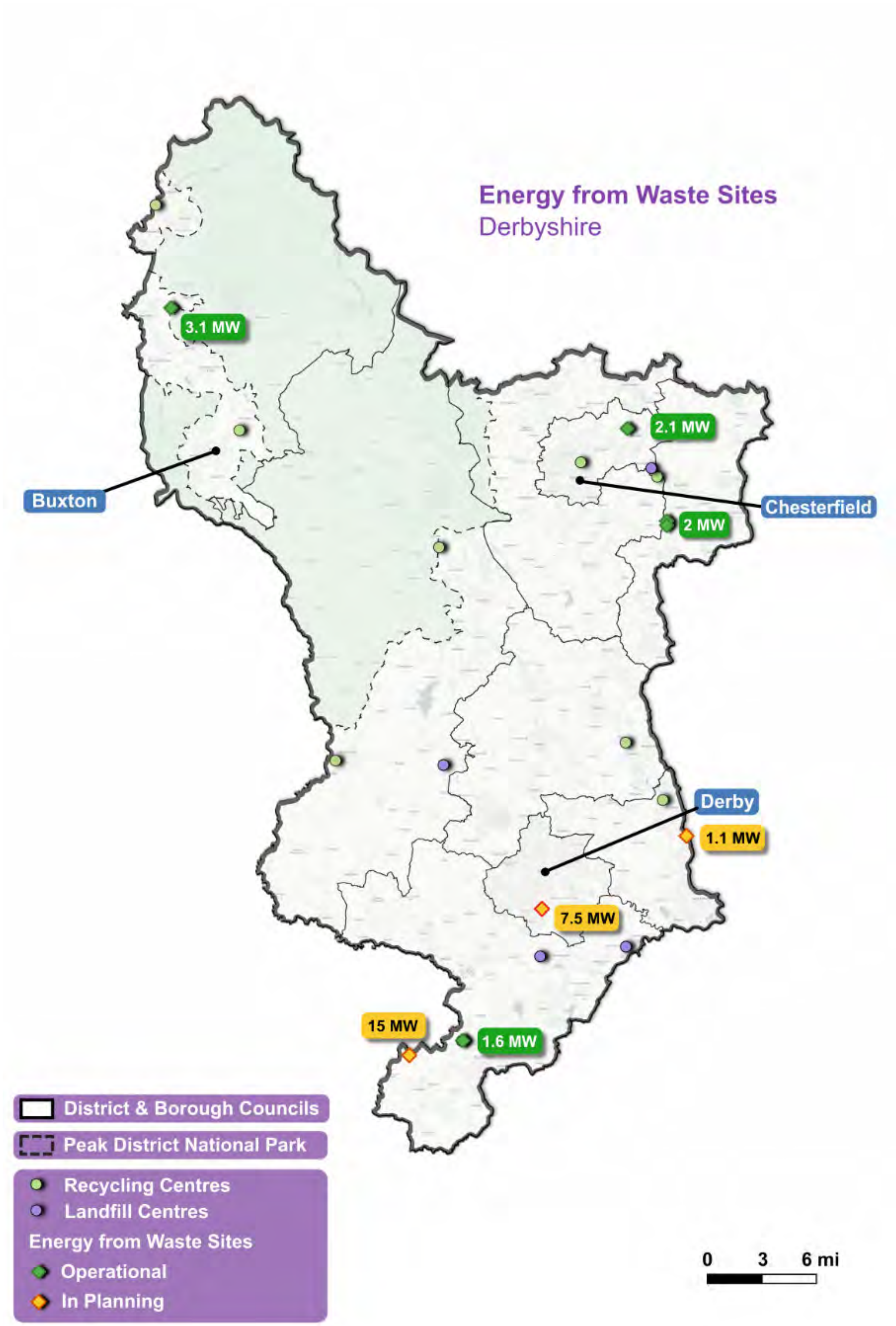

Figure 6.21 - Energy from Waste Opportunities in Derbyshire

6.5.7 District Heating

The UK Climate Change Committee recommends that around 18% of UK heat should come from heat networks by 2050 as part of a least cost pathway to meeting net zero. In 2018, AECOM produced a Heat Mapping and Energy Master plan, which sets out key priority areas of heat development in Derbyshire. Figure 6.22 provides an overview of these priority areas in Clay Cross, Matlock, and Chesterfield.

Heat network development is a demand-led process, prioritising heat demand density and anchor loads (i.e., high demand properties such as hospitals, industrial sites, or schools), primarily due to the costs of heat transmission infrastructure. Constraining factors are associated with the generation technology, such as biomass or heat pumps, although there are specific district heating constraints such as flood risk, infrastructure barriers (e.g., railways) and topography (e.g., hills) which may affect heat transmission routes. Heat networks may be centralised, with a single or multiple heat generation energy centres, or decentralised, such as those with distributed heat pump systems fed by a communal heat source.

Figure 6.23 provides an overview of property density in Derbyshire, as a proxy for heat demand density. It shows expected high distribution of demand in urban areas, particularly in the south of the region. The UK National Heat Map was decommissioned in 2018 and therefore analysis of spatial heat demand is not currently possible for the study area.

Priority areas of development include:

- District Heat Network (DHN) priority areas, as identified by AECOM (2018).
- New housing developments, where infrastructure may be integrated into site design from the outset.
- High demand centres, including high density urban areas, industrial parks, hospitals, etc.
- Locations with accessible heat resource, including water-source, ground-source, or waste heat potential.

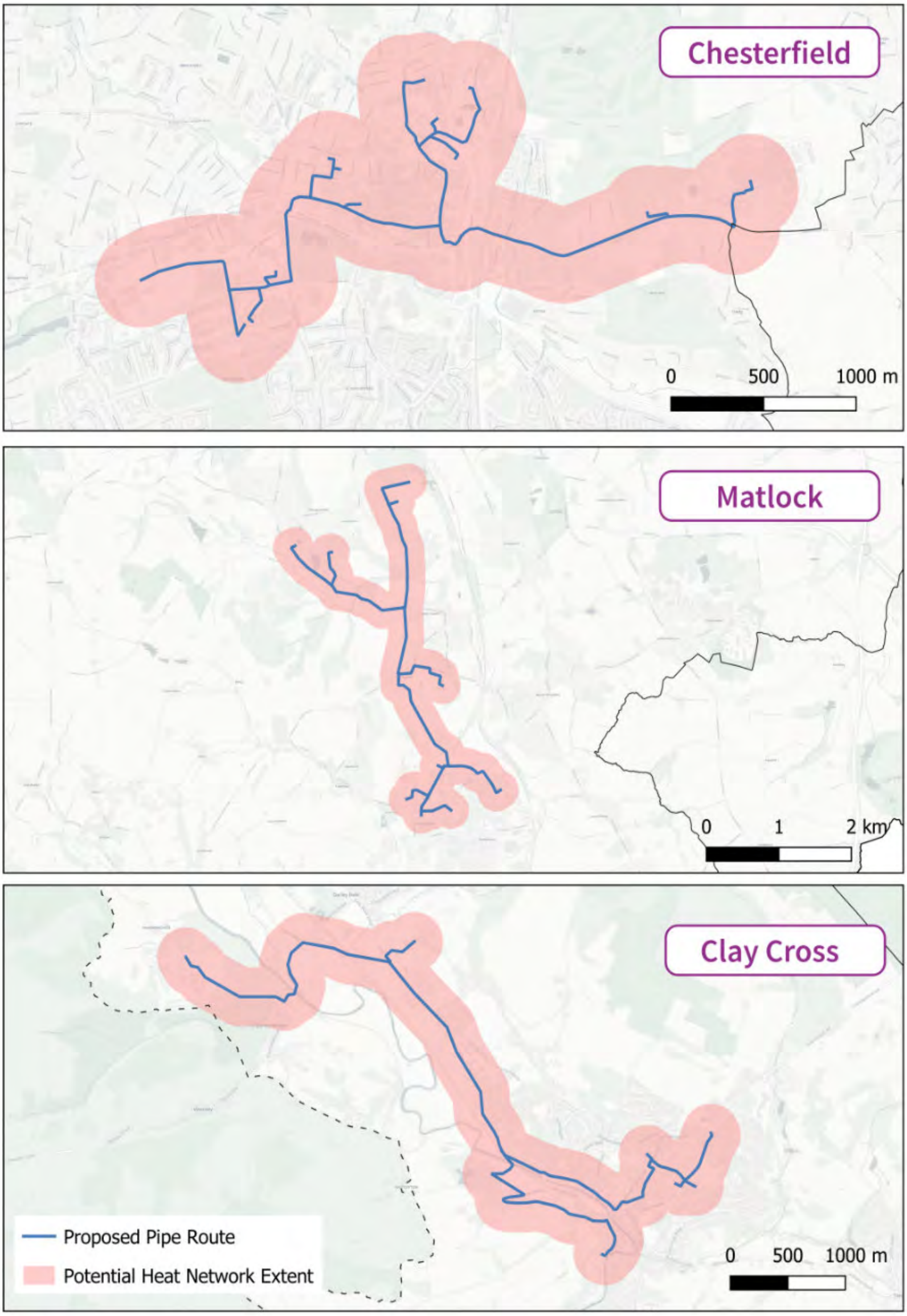

Figure 6.22 - Potential District Heat Network Projects in Derbyshire (AECOM, 2018)

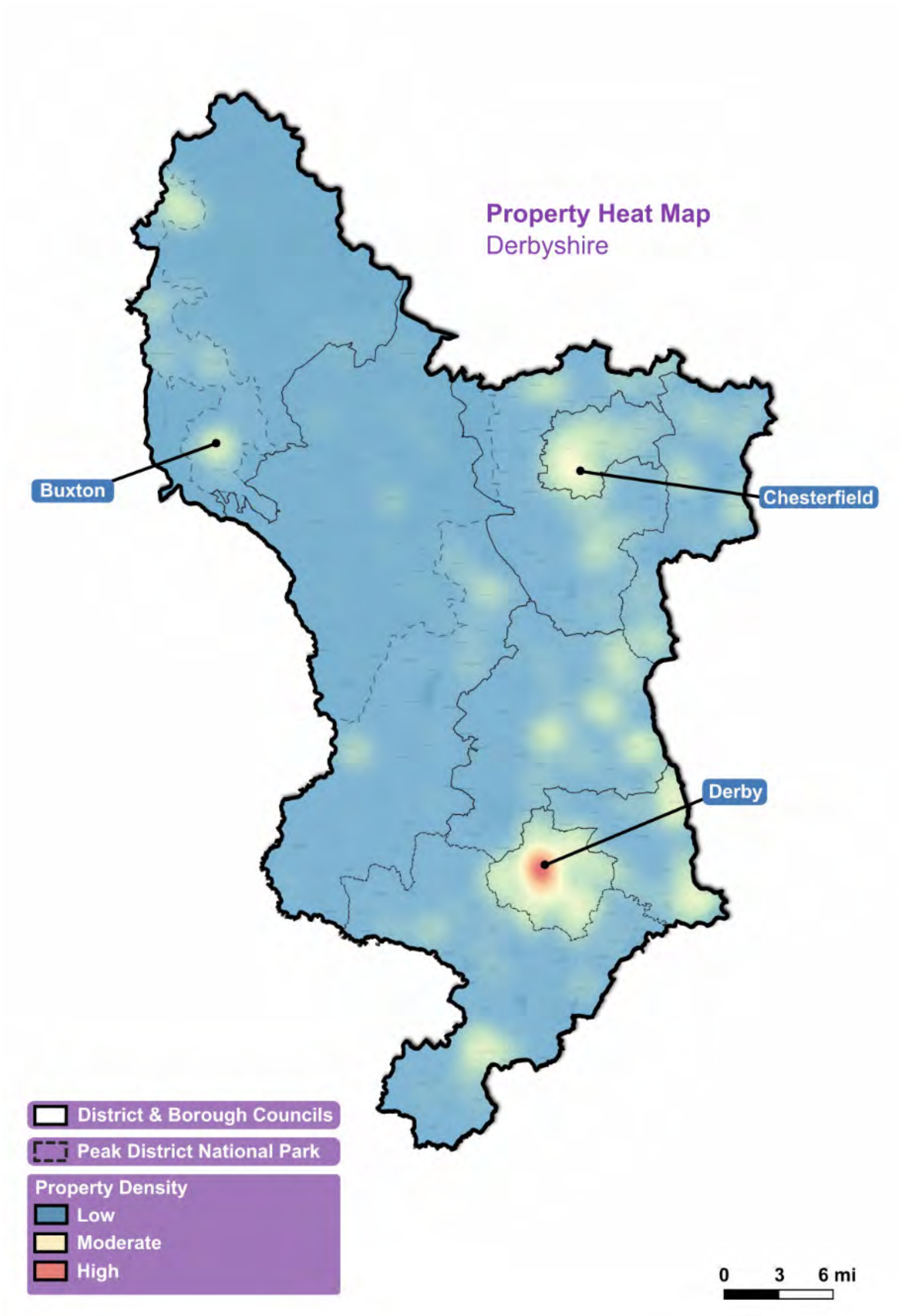

Figure 6.23 - Property Density Map of Derbyshire

6.6. Energy Efficiency

Demand reduction will play a critical role in the UK energy system and the transition to net zero emissions. As well as reducing carbon emissions, energy efficiency measures can decrease fossil fuel and national grid energy demand, reduce consumer bills, and improve thermal comfort. Energy efficiency measures can be wide ranging, both in terms of scale of intervention and costs, but typically cover insulation, draught proofing, energy control systems, and heat distribution systems (e.g., radiators).

Energy efficiency measures are generally considered a permitted development, particularly for internal works, although changes to the external construction or look of a property (e.g., external wall insulation) may require specific permissions and consents. One of the major constraints to energy efficiency improvements is the age of properties. This includes constraints to what measures can be implemented within listed properties and properties which lie within conservation areas or World Heritage Site designations. Another is the disruption to residents.

Table 6.13 provides an overview of existing levels of energy efficiency throughout Derbyshire. It shows that the lowest median energy efficiency ratings are found in the Derbyshire Dales, which is particularly influenced by older and harder to treat properties. Bringing all properties up to a rating of 69 or above (C) would lead to an annual heat energy demand reduction of around 743 GWh and aggregate energy bill reduction of over £58m per annum across 292,574 properties[8].

Domestic Energy Efficiency Ratings in Derbyshire					
	Property Age				
	Pre 1900	1900 to 1929	1930 to 1982	1983 to 2011	2012 onward
Amber Valley	52	52	62	69	83
Bolsover	51	54	64	70	83
Chesterfield	56	55	65	69	83
Derbyshire Dales	47	52	61	69	83
Erewash	52	51	62	69	83
High Peak	56	57	65	70	83
North East Derbyshire	51	54	61	68	83
South Derbyshire	50	53	63	70	83
Derby City	54	56	62	70	83

[8] Based on an estimated annual average saving of £200 per property and associated heat energy use reduction of 20%.

Domestic Energy Efficiency Ratings in Derbyshire					
	Property Type				
	Detached	Semi-detached	Terraced	Flats and maisonettes	All dwellings
Amber Valley	64	64	65	72	65
Bolsover	67	67	62	74	67
Chesterfield	64	64	67	74	66
Derbyshire Dales	59	61	61	73	62
Erewash	61	61	67	73	64
High Peak	64	64	63	72	65
North East Derbyshire	63	63	65	72	64
South Derbyshire	69	68	71	75	70
Derby City	63	61	65	74	65

	Property Type		
	Median	% Dwellings EPC 'C' or above	% Dwellings EPC 'D' or below
Amber Valley	65	37.0	62.2
Bolsover	67	44.8	63.1
Chesterfield	66	41.1	55.2
Derbyshire Dales	65	37.8	46.5
Erewash	62	32.8	58.9
High Peak	64	36.5	67.2
North East Derbyshire	65	36.7	63.5
South Derbyshire	64	33.7	63.3
Derby City	70	53.5	66.3
Derbyshire	65	**39.3**	**60.7**

Table 6.13 - Overview of energy efficiency ratings in Derbyshire

6.7. Energy Storage

Energy storage is playing an increasingly significant role in the UK energy sector and as an important technology in the transition to net zero. Battery storage – including both electrical and thermal storage – is a supporting technology which can reduce issues relating to intermittent energy generation as well as offering necessary energy balancing and flexibility services to energy networks. As the cost of energy storage falls, both large scale utility-level storage and smaller commercial and domestic storage systems are becoming increasingly viable.

- **Utility-scale storage** typically has a storage capacity of several MWh and is most often used to provide grid operation services, such as frequency response, to defer investments in grid reinforcement through energy shifting, or through co-location with variable renewable generation such as wind and solar PV to deliver more consistent energy output.
- **Commercial storage** ranges from 50 – 500kWh and can provide a number of functions, including backup power (e.g., hospitals), maximising renewable generation use, and supporting electric vehicle charging.
- **Domestic Storage** encompasses widely used thermal storage, such as hot water cylinders or immersion heaters, and less common electric storage. These forms of storage offer benefits to heat and electricity generation, respectively, enabling property owners to maximise captured generation through latent energy use.

In Derbyshire there is currently 1 commissioned utility scale battery storage system, providing 10 MWh of frequency control and renewable capacity firming. A further 199 MWh of battery storage is planned in the County, including further grid operation services and a planned solar PV and battery system within a social housing development in North East Derbyshire. Battery storage at the utility scale requires access and proximity to large scale generation assets or the grid network to maximise its beneficial impacts.

Whilst energy storage will play a supporting role in the development of decentralised energy networks, heat generation and electricity generation, it is not possible to provide a spatial analysis of where these opportunities lie. Energy storage should be viewed as a means of maximising the efficiency of energy generation and supply and should be supported where it can be proven to have demonstrable technical, economic, and social benefit.

6.8. Low Carbon Mobility

Low carbon mobility within this study focuses on ultra-low emissions vehicles (ULEV), as the dominant form of low emissions transport in the UK. National Grid Future Energy Scenarios predict that electric vehicles (EV) will form the majority (>98%) of all vehicles by 2050, with the potential for a small number of hydrogen fuelled vehicles. In line with this scenario, this study focuses specifically on EV deployment in Derbyshire.

In 2019, Derbyshire County Council released a Low Emissions Vehicle Infrastructure Strategy (LEVI). The LEVI sets out aims to switch public sector vehicle fleets to ULEVs and support commercial and private ULEV deployment and infrastructure support. As of 2022, there are around 7,300 EVs currently used within Derbyshire, primarily by private owners. This is expected to rise to between 200,000 – 350,000 by 2040. From a spatial perspective, EV car uptake and use will follow population density dynamics, with the greatest number of EVs within urban areas.

This level of increased uptake will require transformative change in the provision of EV charging infrastructure, including private and public EV charger deployment. At present, there are 310 chargers in Derbyshire, with the greatest availability per 100,000 population found in Derby, Bolsover and Chesterfield (Table 6.14).

EV Charger Distribution in Derbyshire			
Local Authority	Number of EV Chargers	% Rapid Chargers	Chargers per 100,000 population
Amber Valley	23	5	17.9
Bolsover	41	16	50.4
Chesterfield	59	9	56.2
Derby City	70	25	27.3
Derbyshire Dales	37	2	51.1
Erewash	21	10	18.2
High Peak	26	10	28.1
North East Derbyshire	11	2	10.8
South Derbyshire	22	5	20.1
TOTAL	**310**	**-**	**31.1**

Table 6.14 - EV Charger Distribution in Derbyshire

Figure 6.24 provides an overview of the existing publicly available EV charging locations in Derbyshire alongside the major road network. It demonstrates that there are clusters of charging infrastructure around major settlements, whilst there are large areas, particularly in the west of the region and throughout the National Park, which have very little infrastructure in place. Whilst EV charging is unlikely to be a major impact on landscape or visual sensitivity, it is expected that areas of international and national environmental and cultural importance – including the National Park and World Heritage Site – are likely to require consents for new EV charging infrastructure.

It is expected that EV charging networks will need to be improved and expanded further across the entirety of Derbyshire due to the large-scale deployment of EVs in the coming decades. Key locations which should be considered for EV development should include:

- Major travel corridors, including A roads, motorways, and routes into Derbyshire from neighbouring population centres, such a Manchester, Nottingham, and

Sheffield.

- Existing transport infrastructure, such as petrol stations.
- High population density areas where EV uptake and charging demand are expected to be consistently high.
- Tourist locations and travel corridors, such as areas within the National Park, Derwent Valley Mills World Heritage Site, and historic towns in the region, such as Buxton, Bakewell, and Ashbourne. As mentioned, EV charging in these areas may require planning permission to minimise impacts on these sensitive locations.
- Locations with high or long-term parking requirements, such as airports, retail, and business parks.

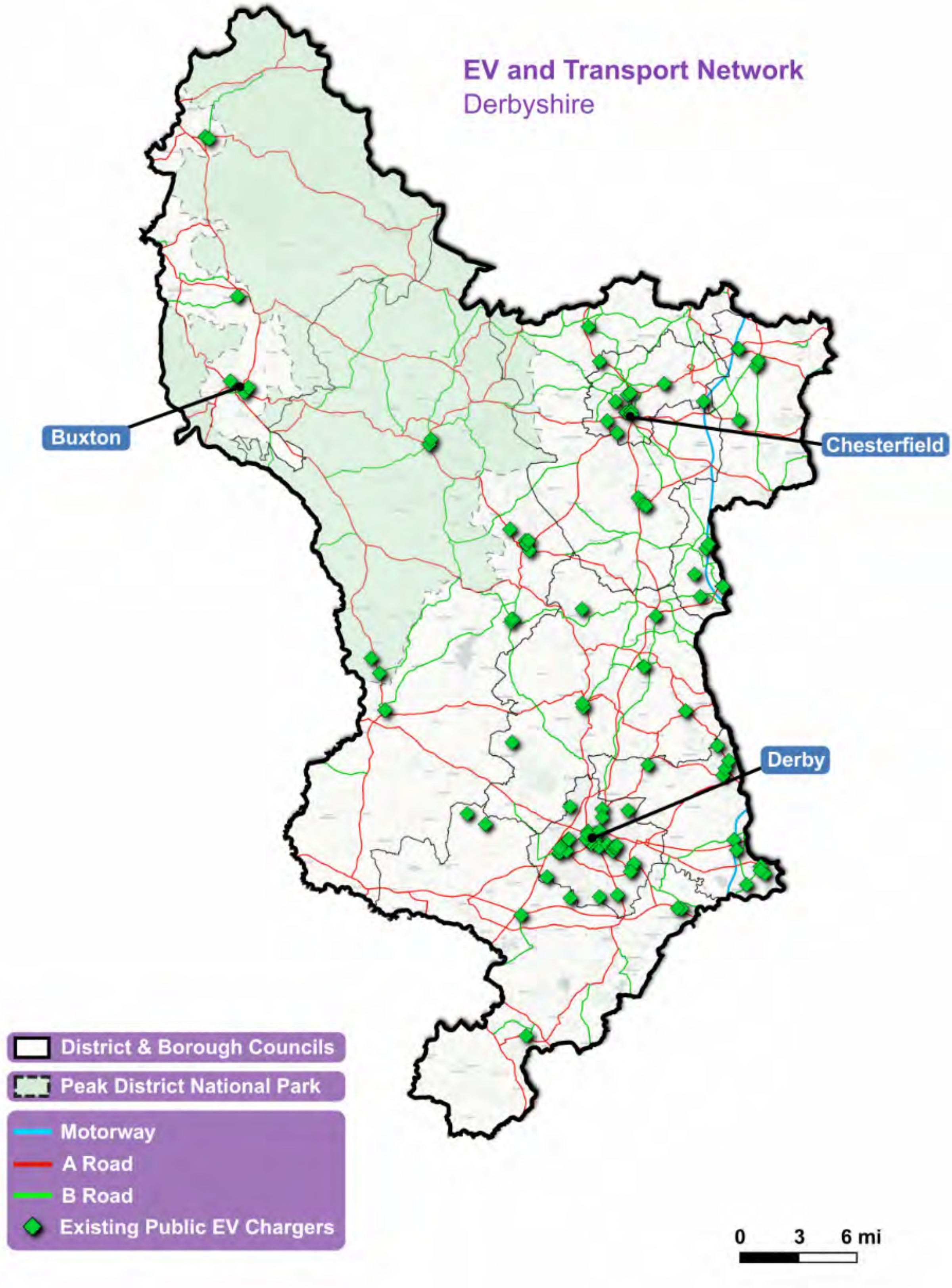

Figure 6.24 – Public EV Charging Infrastructure and Transport Network in Derbyshire

7. A Low Carbon Economy

Renewable and low carbon energy development has the ability to generate significant socio-economic benefits at national, regional, and local scales. As the UK transitions to a low carbon economy, there are a multitude of opportunities for economic, social, and environmental impacts which may be realised through low carbon energy development.

This chapter sets out the economic and non-economic impacts which may be realised through the levels of deployment set out in Chapter 7. Table 7.1 provides an overview of the potential benefits associated with the low carbon economy and energy sector, demonstrating the transformative changes that support for, and investment in, the evolving energy sector may offer for Derbyshire.

This chapter utilises quantitative measures where possible, such as energy costs, to provide estimates for the impacts of energy development in Derbyshire. In some cases, qualitative measures are used to demonstrate softer benefits of low carbon development, such as social impact, supported by case studies.

Low Carbon Economy – Economics and Impact	
Economic	**Description**
Capital Investment	Initial investment in the development and commissioning of energy infrastructure.
Operational Investment	Investment in the operation of energy schemes and deployment programmes.
Cost Savings	Cost savings through energy demand reduction, lower cost generation of energy, and more efficient supply of energy.
Job Creation	Creation of jobs to support energy demand reduction, generation, storage, and transport projects and technologies.
Social	**Description**
Skills Development	Development of low carbon and energy sector skills within local and regional skills base.
Behaviour Change	Awareness and engagement with climate change, net zero carbon leading to greater support for net zero trajectories and change.
Health & Wellbeing	Health benefits resulting from pollution reduction and fuel poverty reduction.
Environmental	**Description**
Pollution	Reduction in pollution resulting from energy generation from utility-scale and local energy generation, as well as low carbon transport development.
Carbon Emissions	Preventing carbon and other climate forcing gas emissions through low carbon energy generation and demand reduction.

Table 7.1 - The impacts of energy development

7.1. National Low Carbon Economy

In 2020, the UK's low carbon economy was worth £41.2bn, comprising 75,000 businesses and employing 207,800 full time staff. This includes businesses involved in the manufacturing of energy technologies, energy services (e.g., energy supply) and construction industries (LCREE, 2020). As the UK continues towards net zero, these figures will increase, and the green economy will form one of the largest sectors and employers within the UK.

As noted in the UK's Net Zero Strategy (2021), the UK's net zero aligned sectors could contribute up to £60bn to gross value added (GVA) by 2050. Furthermore, supporting and developing the UK low carbon economy may lead to both international opportunities – such as low carbon exports of £7bn by 2050 – and national benefits – such as improvements in living standards, skills development, and reinvigorating regional development and economic growth.

Outside of economic benefits, the transition to a low carbon economy has been associated with a number of broader beneficial social and environmental impacts in the UK. This includes energy security, poverty alleviation, public health, protecting biodiversity, inclusion and community resilience, congestion, and many other wider benefits (Gouldson et al., 2018).

7.2. Regional Economy

Derbyshire is home to 1,063,997 people and 29,700 businesses, contributing £15.4bn to the UK's annual economic output. The major employers in Derbyshire are the manufacturing, health, retail and construction sectors and the region has a relatively high employment rate compared to the UK average (Derbyshire Observatory, 2020). In 2022, Derbyshire County Council is developing a strategy to deliver transformative change to the local economy, including an economic recovery strategy following the COVID-19 pandemic and associated energy and transport strategies to support the development of the regional green economy.

This section provides a specific overview of how development in the energy and transport sectors can contribute to Derbyshire's future low carbon economy and outlines the potential investment required to achieve this.

7.2.1 The Costs of Energy Development

The investment requirements for each technology option are set out in Table 7.2, providing a high-level guide of the potential investment need for the deployment extents identified within this report. Details on the calculations within this section can be found in Appendix A.

Where possible, levelised cost of energy (LCOE) has been used, which is the discounted lifetime cost of building and operating an energy asset, expressed as a cost per unit of electricity generated (£/MWh). It covers all relevant costs faced by the generator, including pre-development, capital, operating, fuel, and financing costs. Data has been sourced from BEIS (2020), Mott MacDonald (2018) and IEA (2022) to provide comparable cost data. It is important to note that, whilst lifetime energy costs are accounted for in the analysis, the estimations do not account for future cost drivers. These may include cost reductions due to technology improvements (e.g., energy storage) or changes in costs due to supply chain issues or geopolitical changes (e.g., COVID-19).

In terms of LCOE, lower costs are typically associated with proven technologies and those at scale. This is notable for wind and ground-mounted solar PV, where a significant and investable opportunity is present in the region. Comparatively high costs are expected per MWh for hydropower due to the small scales of development in Derbyshire.

Opportunities for transformative change - including large scale roll out of rooftop solar PV, heat pumps, energy efficiency, and low carbon mobility – are identifiable by the high associated potential costs. Due to the individual and distributed nature of these changes, the investment needs are currently quite high. Supportive policy, mechanisms and delivery infrastructure for these technologies would help reduce the associated costs per MWh / installation.

Reductions in costs are expected for technologies which are emerging (e.g., energy storage) and subject to planned roll-outs and UK government support (e.g., heat pumps). Due to the cost variability of energy efficiency measures, mean cost estimations do not provide a clear picture of total investment needs, which may be higher or lower depending on the type of measures implemented and the specific targeting on energy efficiency programmes.

Cost of Energy Development in Derbyshire			
Electricity Generation	**Deployment Potential (MW)**	**LCOE (£ / MWh)**	**Total Cost (£)**
Wind	126	£46	£10,154,592
Hydropower	< 2	£88	£1,233,408
Solar PV (Ground-Mount)	327	£44	£13,864,277
Solar PV (Rooftop)	913	£114	£100,293,415
Solar Thermal	69,160	£27	£29,648,373
Biomass	7,413	£91	£93,813,416
Heat Pump	42,134	£116	£117,741,494
Anaerobic Digestion	< 50	£142	£38,934,696
Energy from Waste	< 20	£101	£6,334,882
Other Technologies	**No. Installations**	**£ / Installation**	**Total Cost (£)**
Energy Efficiency	292,574	£8,110	£2,372,775,140
Electric Vehicles	509,579	£25,000	£12,739,475,000
EV Chargers	333,103	£6,000	£1,998,618,000
	Deployment Potential (MW)	**£ / MW**	**Total Cost (£)**
Electrical Storage	167	£267,000	£44,589,000

Table 7.2 – Cost of Energy Development in Derbyshire [9, 10]

7.2.2 The Impacts of Energy Development

Supporting and investing in the energy sector and green economy can deliver meaningful and wide ranging economic, social, and environmental benefits within Derbyshire.

Job creation is a key economic benefit outside of direct investment in the energy sector. The job creation potential of each technology has been limited to installation and operation phases where possible, due to the fact that many technologies and supporting services are likely to be manufactured and procured internationally or from elsewhere in the UK. It is not possible within the scope of this study to project the potential regional job creation potential of deployment.

Table 7.3 below demonstrates similar trends to those seen for investment requirements:

- Large scales of development create a lower number of jobs due to scale-efficiency associated with larger developments. Furthermore, the regional nature of such projects mean that many jobs are created in other parts of the UK.
- Individual and specific improvements - including rooftop solar PV, energy efficiency and heat technologies – require the greatest labour input and therefore have the greatest job creation potential.
- This potential is also tied to the scale and speed of transition, as retrofitting, domestic and commercial heat decarbonisation, and low carbon mobility are key targets for the UK. Increasing labour and skills underpinning these areas will be critical to successful implementation.

Energy development can confer a number of social and environmental impacts across Derbyshire. These may include:

- **Skills development:** In tandem with job creation, the creation of local skills through training programmes, and green business growth resulting from low carbon opportunities could lead to Derbyshire becoming a hub for low carbon development. This is particularly true for innovative technologies (e.g., grid energy storage) and large scale roll-outs (e.g., retrofit, heat decarbonisation).
- **Behaviour change**: most often resulting from local action (domestic energy development, community energy) and supported by education programmes in the public and private sectors. This can lead to increased uptake and is a major underpinning of consumer transformation and leading the way future energy scenarios.
- **Consumer Bill Reduction**: leading to reduced energy costs for people and businesses in Derbyshire and addressing the growth in fuel poverty and the cost-of-living crisis.
- **Health and Wellbeing:** Provided through local air quality improvements, reducing pollution from utility, commercial and domestic scale electrical and heat

[9] Table 7.2 uses deployment potential figures as detailed in Chapter 7 where applicable. Where a deployment extent has not been calculated, highest future energy system projections (energy storage, heat pumps, EVs) have been used in the first instance, and assumed deployment based on historical trends in the final instance.

[10] Sourced from BEIS, 2020; BEIS, 2018; DECC, 2015, Renewable Energy Hub UK, 2022

generation, reducing congestion and internal combustion pollution. Health and wellbeing can also be supported by improvements such as public transport electrification and service quality, cycle infrastructure, and promoting walking and other healthy activities.

Low Carbon Economy – Derbyshire Impact Matrix		
Economic Impacts		
	Total Investment Requirement(£m) (as of 2022)	**Lifetime Job Creation**
Wind	10	189
Hydropower	1	12
Solar PV (Ground-Mount)	14	2,126
Solar PV (Rooftop)	100	12,326
Electrical Storage	45	-
Solar Thermal	30	5,835
Biomass	94	1,205
Heat Pump	118	2,694
Anaerobic Digestion	39	112
Energy from Waste	6	143
Energy Efficiency	2,373	17,554
Electric Vehicles	12,739	1,780
EV Chargers	1,999	

Low Carbon Economy – Derbyshire Impact Matrix				
Social Impacts				
	Skills Development	**Behaviour Change**	**Consumer Bill Reduction**	**Health & Wellbeing**
Wind	√			
Hydropower	√			
Solar PV (Ground-Mount)	√			
Solar PV (Rooftop)	√	√	√	
Electrical Storage	√	√	√	
Solar Thermal	√	√	√	√

Low Carbon Economy – Derbyshire Impact Matrix				
Social Impacts				
	Skills Development	Behaviour Change	Consumer Bill Reduction	Health & Wellbeing
Biomass	√	√	√	
Heat Pump	√	√	√	
Anaerobic Digestion	√			
Energy from Waste	√			
Energy Efficiency	√	√	√	√
Electric Vehicles	√	√	√	√
Environmental Impacts				
	Pollution Reduction		Lifetime Carbon Emissions Reduction ($MtCO_2e$)	
Wind	Moderate		46	
Hydropower	Moderate		1	
Solar PV (Ground-Mount)	Moderate		120	
Solar PV (Rooftop)	Moderate		336	
Electrical Storage	Moderate		-	
Solar Thermal	High		82	
Biomass	Low		131	
Heat Pump	High		746	
Anaerobic Digestion	Moderate		18	
Energy from Waste	Low		7	
Energy Efficiency	High		219	
Electric Vehicles	High		1,099	

Table 7.3 – Derbyshire Low Carbon Economy Impact Matrix

Further details of the associated social and financial benefits provided by low carbon energy schemes are outlined in the below case studies, focusing on community energy and district heat decarbonisation.

Lastly, energy development offers local environmental benefits via pollution reduction, as set out above, and international climate change mitigation through reduced carbon emissions. The greatest impactors on local pollution in Derbyshire are expected to be the decarbonisation of transport and homes, including efficiency improvements and low carbon heating system implementation. This is reflected in terms of carbon emissions where low carbon mobility and the decarbonisation of heat are expected to offer the greatest opportunities to reduce Derbyshire and the UK's carbon footprint.

‘Archie’ - Torrs Hydro, New Mills

The Torrs Hydro scheme, located in New Mills, Derbyshire, consists of a reverse Archimedes screw hydro turbine with a maximum power output of 63 kW. Sitting at the convergence of the Sett and Goyt Rivers, the turbine, nicknamed ‘Archie’, has provided over 1.4 GWh of clean community-owned electricity to the local Co-op supermarket since its installation in 2008.

The turbine is managed by Torrs Hydro New Mills Ltd., a Community Benefit Society set up by a team of passionate local volunteers driven to help combat climate change through collective community ownership.

In 2020, the scheme generated around £24,000 through selling excess electricity to the grid and Renewable Obligation Certificate subsidies for the clean energy that it generates. Since its installation, it has offset around 304 tonnes of CO_2e emissions which would have been generated by the grid otherwise. The Torrs Hydro Community Fund supports local community projects and hosts regular educational visits and tours for local people and schools who wish to learn more about renewable energy technologies and the role of communities in helping fight climate change.

Leeds PIPES

The Leeds PIPES District Heating Network provides a source of low carbon heating and hot water to around 2,000 properties, businesses, and public buildings throughout the inner city. Funded by European, national, and regional bodies, as well as the city council itself, the £40 million two-phase programme contributes to the city’s objective to become carbon neutral by 2030.

The two-phase programme has involved the replacement of gas boilers with district heat network heat exchangers, interconnected by over 26km of piping to transport the low-carbon heating from the centralised heating source to the buildings. The heat itself is generated by the combustion of non-recyclable household waste at Leeds Recycling and Energy Recovery Facility, reducing landfill and reusing heat.

Over 400 jobs were created through the project, and the 33 MW heat network is able to generate up to 175 GWh of low carbon heating each year and offset over 16,000 tonnes of carbon emissions. Since it replaces gas boilers, the project also improves household and regional air quality and health through the reduced risk of carbon monoxide poisoning. An educational programme also allows local schools to visit the project to learn about climate change and renewable technologies.

8. Policy Recommendations

The local authorities in Derbyshire should continue to produce and adhere to Net Zero and Climate Action Plans to meet their carbon emissions targets and trajectories (LGA, 2022). This should extend beyond the current climate change strategy to include emerging strategies (e.g., Natural Capital (2022), Good Growth (2022), and LEVI (2019 – 2029) strategies) and focus on the production of a deliverable action plan to turn intentions into reality.

The recommendations within this chapter have taken into account UK Government guidance, precedents within the UK, emerging sectoral trends, and the spatial appraisal detailed in Chapter 6.

8.1. Decarbonisation

The local authorities in Derbyshire should lead by example. In addition to the above action planning, it should seek to embed climate change mitigation and adaptation, energy, sustainability, and carbon into the whole authority, across staff and systems. This should include incorporating energy and carbon considerations into planning and procurement processes; and developing and implementing an evidence-based approach through quality and in-depth in data collection, potentially through standardised data templates and reporting methodologies for future data collection, analysis mapping and forecasting by district and region (for example, see Appendix D- Replication Toolkit).

Place shaping is one of the most powerful levers available to the local authorities in Derbyshire (LGA, 2022). Decarbonisation should therefore be built into all local planning, Masterplanning and other emerging plans to ensure that energy and carbon are considered and prioritised. In the context of this study, this should include how electrical and heat generation at both large and small-scales can be utilised to deliver low carbon development in Derbyshire.

Furthermore, Local Area Energy Planning (LAEP) should be considered to ensure maximisation of energy demand met and resources used, to enable better planning for local energy development, and to identify and account for the specificity of local areas in spatial energy planning.

As enabling bodies, local authorities in Derbyshire authorities should seek to support low carbon development financially. This could include:

- Direct funding for internal decarbonisation, including energy efficiency in buildings, ULEV deployment, building retrofit, and microgeneration;
- Provision of grant support or low / zero interest loans for regional low carbon development. This may particularly apply to large roll-out programmes such as building retrofit and domestic heat decarbonisation, in line with national agendas. Combining such support with UK government grant and loan facilities may also

enable transformative change, such as supporting heat network development in urban centres in Derbyshire;

- Divestment from fossil fuel interests and investment in regional and national low carbon energy;
- Offsetting carbon emissions through the purchase of carbon credits and investment in decarbonising projects in Derbyshire, nationally and internationally. This may develop and / or support carbon reduction schemes in Derbyshire, such as peatland restoration, low carbon agriculture and other low carbon land uses.

Relevant examples include:

- Portsmouth City Council, which became the first city to introduce on-street residential EV charge points in lamp posts, helping to promote EV uptake and reduce urban air pollution. The project is part funded and supported by the Office for Low Emissions Vehicles (OLEV).
- The Bristol City LEAP, which established a joint venture between the City Council and a strategic partner to deliver more than £1 billion of investment towards Bristol becoming a zero-carbon, smart energy city by 2030.

8.2. Demand Reduction

In the context of the UK Government's stated ambition of 25 million homes to be retrofitted with improved energy efficiency measures by 2050 and the additional efficiency requirements of commercial and industrial sectors, demand reduction should be a priority for all areas of the UK. This ambition is expected to require investment of between £400 – 1,000bn alone in the next 30 years (BEIS, 2022).

8.2.1 New Buildings

The local authorities in Derbyshire should focus on reducing energy demand for all new premises and land uses. This would include ensuring low carbon and energy efficiency are intrinsic elements of any new County and Local Council developments and buildings.

Local planning authorities should adhere to building regulations, and energy efficiency standards within all adopted and emerging policies to meet local, regional, and national decarbonisation ambitions. This may include requiring larger developments to meet ambitious energy consumption and emission targets as an acceptability criterion.

Policy should ensure that planning applications for new buildings must prioritise active and low carbon transport and inter-connectivity. Local transport plans should provide evidence to support and promote transport via low carbon methods in adherence with the NPPF expectations and guidance.

Local authorities in Derbyshire may support the development and implementation of local zero carbon design guides, in tandem or instead of design guides developed using the national design code. This includes considering embodied and operational carbon and energy within future developments, such as in the LETI Climate Emergency Design Guide (2020).

8.2.2 Retrofit Policy

In leading by example, local authorities in Derbyshire should focus on the retrofit of public buildings and housing stock and on meeting national target EPC levels of C, prioritising least efficient buildings and progressing incrementally towards the more efficient.

Local authorities have a duty to deliver minimum energy efficiency standards (MEES, 2018) and act where health hazards exist within public property stock (HHSRS, 2006). The local authorities in Derbyshire should seek to exceed these minimum standards and deliver transformative change via wide ranging internal retrofit programme(s).

Local authorities in Derbyshire should support, and coordinate retrofit programmes in Derbyshire, including outreach to homeowners and businesses, facilitating knowledge transfer (e.g., via knowledge hubs, one-stop-shop approaches, online resources).

Local authorities in Derbyshire should identify relevant low carbon businesses and SMEs in Derbyshire with retrofit capabilities, facilitate skills development (e.g., linkages with local educational institutions and programmes), and mainstream opportunities via procurement processes, such as retrofit frameworks, dynamic purchasing systems (DPS), simplification of procurement for smaller projects and businesses, and supporting supply chain events and networking.

Local authorities in Derbyshire should work with local organisations and businesses to advance retrofit in the private and third sectors. Examples include Hampshire County Council (NEF, 2021), which has worked with the LEP to deliver financing, a knowledge hub and local networking for retrofits across the county, identifying skills gaps in retrofitting and addressing these through specific and dedicated programmes.

One ongoing example of demand reduction is the DE-Carbonise project, which supports SMEs in Derbyshire and Nottinghamshire increase their sustainability and save money by reducing energy costs and carbon emissions. A collaboration between the University of Derby, Derby City and Derbyshire County Council, the project provides expert support and grant funding to implement carbon reduction recommendations.

8.3. Electricity Generation

Energy should be a key concern of every council, with energy strategies forming an integral part of the wider spatial, economic and wellbeing strategies undertaken as part of normal business (Local Partnerships, 2016). This may include direct investment in electricity and heat generation and supply, or influencing development through procurement and local policy.

Local authorities in Derbyshire should focus on technologies which offer the greatest generation potential and which have the greatest unconstrained space for development. In particular, ground-mounted solar PV and small to medium scale wind developments fulfil these criteria. Any development would need to be considered and permitted in line with the NPPF and supporting policy and guidance, particularly in relation to onshore wind which, as of 2022, is constrained by planning policy.

Further focus should be placed on aggregating positive impact from buildings through local energy development, including rooftop solar PV and thermal. These technologies should be considered alongside wider local energy development, including building efficiency improvements and heat generation technologies. Electricity generation should be considered as much as possible in design to contribute to, or entirely meet, local needs (i.e., energy demands) now and in the future.

It is important to consider the cumulative impacts of technology development: whilst transformative change is required to meet carbon and energy ambitions in Derbyshire, this should not be to the detriment of the local environment. All scales of development should pay close attention to landscape sensitivity, loss or degradation of land, capacity and the cumulative impacts of technology development.

Local authorities in Derbyshire should engage with energy system/network operators in their area, to become aware of ongoing activity and innovation projects which may improve low carbon development and uptake in Derbyshire. This may include supporting smart meter roll out, supply and demand balancing through council assets, facilitating network services from other public services (NHS, fire and rescue, education facilities), demand side response, and EV charging network planning.

Local authorities in Derbyshire should investigate opportunities to directly engage with the energy sector, either through co-investment or as an energy user, or both. This could include developing and investing in energy generation projects, securing power purchase agreements with new developments, private-wire supply to council assets, and other energy supply arrangements which may benefit local authorities and developers mutually.

8.4. Heat Generation

Heat and efficiency are inherently local. Local actors are best placed to understand local context, including understanding existing resources, infrastructure, and energy demand. This means local authorities and county councils are well placed to coordinate local action, building on national policies, such as the UK Heat and Buildings Policy to deliver heating projects and programmes.

Local authorities in Derbyshire should play a key role in heat delivery in Derbyshire, including:

- Developing and delivering heat network connections;
- Implementing and enforcing national regulations and policy (e.g., MEES);
- Carrying out key statutory duties such as planning and control for new-build development;
- Supporting low-carbon heating and energy efficiency measures;
- Engaging with businesses and constituents around heat generation and supply.

Taking a systems approach to the interaction between heating, cooling, building energy efficiency and energy networks is necessary to identify least-cost, cross-vector pathways, and create a more efficient energy system. These elements must be considered together to ensure effective and viable heat projects can be identified, implemented, and that customers can benefit from cost savings.

One means of achieving the above systems approach is to utilise heat zoning (ADE, 2020). Heating zoning is the process of defining heat networks development zones where they can provide the lowest cost, low carbon heat to the end-consumer through regulation, mandating powers, and market support. This would require research and application of heat network zoning where heating solutions would be matched with appropriate energy efficiency solutions, to deliver a least-cost, combined heating, and energy efficiency approach to deliver local and national decarbonisation targets. Heat zoning is a requirement of the UK Government by 2025 (BEIS, 2022).

Alongside the heat policies and zoning proposal set out above, local authorities in Derbyshire must combine all heat generation support with new build and retrofit support for building efficiency and heating system improvements. This is a current national and regional policy gap which is hindering the progress of decarbonising heat from the failure to recognise the essential relationship between low carbon heating technologies and energy efficiency in our homes (BEIS, 2022).

8.5. Low Carbon Transport

Local authorities can play a role in influencing and shaping low carbon transport through low carbon mobility strategies, action plans, support programmes and direct investment in public transport practices and vehicle fleets. Transport typically covers a large proportion of an authority's carbon emissions and is a key contributor to air pollution, particularly in urban areas.

Local authorities in Derbyshire should identify and implement opportunities for internal low carbon transport improvements. This may include investment in low carbon vehicles within council owned vehicle fleets, decarbonisation of council owned public transport, promotion of low carbon alternatives for staff travel (e.g., grey fleets, cycling and walking), and assessment of and influencing wider emission scopes such as staff commuting.

Local authorities in Derbyshire should ensure that infrastructure planning in Derbyshire prioritises low carbon travel options. This may include:

- Local planning and transport planning which encourages zero carbon transport such as walking, cycling, as well as low carbon alternatives, such as public transport and ULEVs.
- New development planning and Masterplanning which considers low carbon access, including provision of walking infrastructure, cycle paths and lanes, public transport and charging infrastructure.
- Adopting and implementing Planning policies which limit car use (e.g., car parking limitation or car-free developments) only where the circumstances for doing so can be justified against paragraphs 107-108 NPPF or as subsequently modified. Councils can also consider the case for limiting or discouraging specific high emissions vehicles from certain areas through the adoption of programmes such as localised Clean Air Zones (CAZ) or Air Quality Management Zones (AQMA) under the relevant legislation.
- Future local planning and infrastructure which supports the provision of ULEVs and reduces reliance on private vehicles where possible.
- Inclusion of policy positions that require major new developments and regeneration areas to understand EVs in planning appraisals , including charge numbers, types, costs, and network impacts.

Local authorities in Derbyshire should set out and implement options for public transport fleet decarbonisation. This may include ultra-low emissions buses for subsidised services where councils have an element of control (e.g., Ultra-low Emissions Bus Scheme), quality contracts with service providers to specify low carbon requirements, or provision of capital grants to support the low carbon transition for service providers.

Local authorities in Derbyshire should investigate and apply traffic regulations to reduce pollution and incentivise low carbon transport in line with NPPF 105 - 108 and subsequent modifications. This may include targeting poor environmental condition areas; the application of low emissions vehicle zones; the implementation of AQMA or CAZ; lowering speed limits in urban areas; introducing parking charges including a workplace parking levy; restricting traffic in certain areas or at certain times (Traffic Regulation Orders); taxi licensing only for electric taxis and private hire vehicles; and re-regulating buses.

Implementation should be linked to, and supported by, local design guides, ensuring low carbon mobility considers population densities, layouts and forms of development, in line with local plan policy(s). Local authorities in Derbyshire should implement and promote policies which prioritise walking and cycling, working with transport and highways authorities as applicable to provide appropriate infrastructure, and ensure that network upgrades and repairs consider and prioritise low carbon transport and cycle lane provision where needed.

8.6. Conclusions

This section has identified and described a number of policy and planning tools which may be applicable to Derbyshire and may be implemented by Derbyshire County Council and local authorities in Derbyshire

The purpose of the information presented is to provide a policy evidence base to build on the spatial and technical evidence base set out in Chapters 4 - 7. The policy recommendations set out in Chapter 8 are purely for demonstration and guidance purposes. As an evidence base, this report does not seek to define future strategies nor recommend policy wording or specific guidance on behalf of Derbyshire County Council and local authorities in Derbyshire.

As detailed in this report, Derbyshire is making progress towards regional and local climate targets. The information and tools within this report will underpin this continued effort and support the development of future renewable and low carbon projects across Derbyshire in a way which maximises growth and wider benefits in Derbyshire, whilst retaining the regions character and protecting sensitive landscapes and areas within the region.

Please see the supporting appendices and spatial data for further information about this study.

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