Appendix A

Methodology

1. Introduction

This appendix provides a high-level description of the approach and methodologies to be used in the spatial energy assessment in Derbyshire and the Peak District National Park (‘the study area’). It sets out the focus of the study, the approach to identifying areas of opportunity, and relevance to future development in the study area.

1.1 Approach

The spatial study aims to provide Derbyshire local authorities, including the Peak District National Park Authority, with an evidence base to inform and influence local plan development and the development of planning guidance within the study areas. This methodology is based on the Department for Energy and Climate Change (DECC)[1] best practice guidance relating to low carbon energy capacity assessments:.

The process undertaken is set out below:

1. Characterise the study area’s existing and future energy system and level of development.
2. Assess naturally available energy resources.
3. Identify constraints and limitations within the study area in relation to low carbon development.
4. Spatially assess opportunities for low carbon development in the study area.
5. Assess economic viability and potential impacts of development.
6. Assess deployment constraints.
7. Make links to regional and local policy and ambitions.

The intent of the described methodology below is to provide a robust and reliable evidence base which underpins future local development planning and decision making and ensures consistency in approach across the geographic county and wider East Midlands area.

[1]DECC (2010) Renewable and Low-carbon Energy Capacity Methodology

2. Assessing Constraints

Areas of opportunity are first classified by constraints, defining the limitations of development in the study area and the acceptable technologies within and adjacent to constrained sites.

2.1 Environmental

Table 2.1 and Table 2.2 provide an overview of environmental and land use constraints considered within this study.

Natural Heritage	
Designation	**Level of Importance**
Ramsar site	International
Special Area of Conservation (existing and candidate)	International
Special Protection Area (existing and candidate)	International
Ancient Woodland	National
Environmentally Sensitive Area	National
National Nature Reserve	National
Site of Special Scientific Interest	National
Local Nature Reserve	Local
Local Wildlife Sites	Local
Natural Capital study sensitivities	Local

Table 2.1 - List of Environmental Constraints

Land Use	
Designation	**Level of Importance**
Landfill Sites	Local
Quarry Sites	Local
Built Environment	Local

Table 2.2 - List of Land Use Constraints

2.1 Landscape

Table 2.3 provides an overview of the landscape designations considered within this study.

Landscape	
Designation	**Level of Importance**
National Park	National
National Forest	National
Community Forest	National
Green Belt	Local
Tranquillity Mapping	Local
Sensitive Viewpoints	Local

Table 2.3 - List of Landscape Constraints

Further to the above designation constraints, landscape character and their locations within the study area are set out in Table 2.4. The assessment of acceptability against landscape character is a material consideration, specific to development scale and typology. A desk-based assessment of landscape character against energy technologies and scales has been conducted to provide a specific sensitivity analysis, informing areas of opportunity within the study.

The Landscape Character of the study area is presented in two studies:

- The Landscape Character of Derbyshire, 4th edition, (2014)
- Peak District National Park Landscape Strategy and Action Plan 2009 – 2019, (2009)

The Landscape Character of Derbyshire provides descriptions of the existing character of the County in Part 1 of the study, providing details of key characteristics which should be considered when planning and siting new development. There is no specific reference to energy infrastructure.

Part 4 of the study provides guidance on using landscape character as a spatial framework and identifies Areas of Multiple Environmental Sensitivity (AMES) and Tranquillity Mapping.

The Peak District National Park Landscape Strategy and Action Plan contains the Landscape Character Assessment, Strategy and Guidelines for the Peak District. This includes guidance by landscape character area on energy and infrastructure. Although prepared in 2009 to cover the period up to 2019, this guidance still remains relevant in 2022, primarily as it recognises the medium-to-high sensitivity of the landscape throughout the Park to larger scale development, and this position of relative development constraint has meant there have generally not been material changes to the receiving landscape which require the guidance to be updated.

The extent to which landscape character needs to be considered depends on the scale of development, with landscape character defined at larger scale (Landscape Character Areas) or at a smaller scales (Landscape Character Types). Further, it is worth noting that development impacts may extend beyond one landscape character area into other adjacent areas.

Landscape Character Areas
Derbyshire
Open Moors
Moorland Fringe
Enclosed Moorland
Settled Valley Pastures
Riverside Meadows
Plateau Pastures
Upland Limestone Pastures
Limestone Slopes
Limestone Dales
Enclosed Moors and Heaths
Wooded Slopes and Valleys
Wooded Farmlands
Gritstone Heaths and Commons
Settled Farmlands
Wooded Hills and Valleys
Estate Farmlands
Coalfield Village Farmlands
Coalfield Estatelands
Plateau Estate Farmlands
Limestone Farmlands
Limestone Gorges

Settled Plateau Farmlands
Sandstone Slopes and Heaths
Lowland Village Farmlands
Wet Pasture Meadows
Wooded Estatelands
Village Estate Farmlands
Peak District National Park
Densely Enclosed Gritstone Upland
Enclosed Gritstone Upland
Estatelands
Gritstone Village Farmlands
Limestone Dales
Limestone Hills & Slopes
Limestone Plateau Pastures
Limestone Village Farmlands
Moorland Hills & Ridges
Moorland Slopes & Cloughs
Open Moors
Reservoir Valleys with Woodland
Riverside Meadows
Slopes & Valleys with Woodland
Upland Pastures
Upper Valley Pastures
Valley Farmlands with Villages
Valley Pastures with Industry
Village Farmlands on Shale Ridges

Table 2.4 - List of Landscape Character Types in DCC and PDNPA

2.3 Cultural

Table 5 provides an overview of cultural constraints considered within this study.

Natural Heritage	
Designation	**Level of Importance**
World Heritage Site	International
Conservation Area	National
Historic Battlefield (Registered Battlefield)	National
Listed Building	National
Scheduled Monument	National
Archaeological Sites	Local
Historic Environment Record	Local
Registered Parks & Gardens	Local

Table 2.5 - List of Cultural Constraints

2.4 Technical

Electrical grid capacity is critical in defining the available headroom for future low carbon generation. Table 6 provides an overview of the relevant variables considered for electrical grid constraints.

Substation Headroom	Available capacity at nearest major substation	>25% (Green) 10 – 25% (Amber) <10% (Red)	DNO
Network Extent	Proximity to HV and LV electricity network to reduce network expansion costs.	<5 MW (11 kV) 6 – 20 MW (33kV) >20 MW (132 kV)	DNO

Table 2.6 - Electricity Network Capacity Constraints

Locations are assessed on the basis of available grid headroom at the nearest primary grid supply point (GSP). Headroom is the amount of electrical load available for the export of energy. Where headroom is not available, infrastructure improvement or reinforcement is required.

The extent of the gas network has an impact on the viability of heating technologies, presenting an opportunity rather than a constraint in terms of low carbon development. Off-gas-grid properties and land are considered as having higher development potential for low carbon heating due to an expected higher price of fuel in comparison to gas supplied properties[2].

2.5 Cumulative Landscape Impacts

The cumulative landscape impacts are the effects of a proposed development on the fabric, character, and quality of the landscape, when considered in combination with other energy development. It is concerned with the degree to which a proposed renewable energy development will contribute to impacts from other existing, consented, or proposed development to become a significant or defining characteristic of the landscape.

The cumulative impacts on nature and landscapes need to be carefully considered and the guidance summarised here provides advice on assessing cumulative landscape and visual impacts. This report draws on best practice cumulative impact guidance, including UK Government[3] and NatureScot[4] guidance.

Cumulative impact is relevant to wind energy, ground-mounted solar PV, and other large generation types (e.g., energy from waste (EfW), large biomass). Cumulative assessment has been limited to these technology types.

Within this study, the below process has been used to define areas of sensitivity and assess cumulative impact:

1. Define the study area and characterise landscape and visual baseline and scope of energy types to be included in the strategic study (see Section 4)
2. Assess landscape sensitivity based on landscape character types (LCTs) and landscape character areas (LCAs). This assessment considers landscape character sensitivity, visual sensitivity, and landscape value.
3. Assess the capacity of the landscape to acceptably accommodate energy development of different types and scales based on the assessment of sensitivity and value of the LCAs and LCTs. This is an assessment of the underlying landscape without or before taking the effects of existing energy infrastructure into account.
4. Record the current type and extent of existing and consented energy development in the study area and the surrounding local authorities.

[2] National Grid (2021) The Non-gas Map
[3] UK Government (2015) Planning for renewable and low carbon energy
[4] NatureScot (2021) Assessing the cumulative landscape and visual impact of onshore wind energy developments

5. Determine the extent to which cumulative consented development has occupied the underlying capacity of the landscape to accommodate energy development.
6. Further to the assessment of landscape capacity and cumulative development, identify areas in which:
    - there is no underlying landscape capacity for energy development;
    - consented cumulative development limits landscape capacity for further energy development.
    - there is remaining landscape capacity for further energy development which should be quantified

3. Technical Resource Assessment

This section provides details about each technological resource assessment across electricity and heat, including the approach, variables and assumptions and data sources.

3.1 Wind

Wind energy resource assessment and opportunity analysis was conducted in line with the below data and variables.

Turbine Height	Indicative turbine heights as a means for differentiating development zones	<15m (Micro) 15 – 50m (small) 51 -80m (Medium) 81 – 120m (Large) >120m (Very large)	Defined against current and expected turbine development types.
Number of Turbines	Number of turbines within a specific development	Single Turbine (1) Small wind farm (>5) Commercial Wind farm (>10)	Defined against current and expected turbine development types.
Wind Speed	Estimated wind speeds at varying heights to provide turbine performance constraints	Metres per second (m/s)	NOABL

Table 3.1 - Wind Energy Technical Analysis

Wind Constraints

Environmental
A presumption against development being acceptable within some designations; while scale limitations apply within international and nationally recognised landscapes and designations, as identified in tables 1, 3 and 5.

Settlements
Buffer applied to all built up areas (600m) for Medium, Large and Very Large

Buffers for individual residential properties based on height of wind turbine as below:

- Medium, Large, Very large – 300m
- Small – 150m
- Micro – 50m

(Based on highly likely unacceptable effects on residential amenity from visual impact or noise impact. Detailed assessment would be required to overcome a presumption against development (DECC, 2010))

Infrastructure
Buffer (tip height + 10%) applied to key infrastructure for safety, amenity, and feasibility reasoning, including roads, railways, waterways, MOD sites.

DECC (2010) guidance proposes a 5km buffer around all airport infrastructure. Whilst airports are not a constant constraint, a buffer is used to define levels of unacceptable (<2km) and potentially acceptable (<5km - micro, small) development.

Peak District National Park
Within the PDNP area turbines of <15m (micro) are the only potentially acceptable scale of development.

Policy Support
The applied methodology does not consider the impacts of current or emerging national planning policy regarding wind turbines in 2022. Policy support is subject to change and therefore cannot be considered a long-term constraining factor.

Table 3.2 - Wind Energy Constraints

3.2 Hydropower

Hydroelectric development is naturally constrained by the availability and suitability of watercourses for development.

Hydropower			
Parameter	**Description**	**Value**	**Source**
Catchment Areas	Identify suitable catchment areas and watercourses for development	Spatial	Environment Agency DCC
Scale of development	Typology of scale	<5kW (Pico) 5 - 25kW (Small) 26 – 100 kW (Medium) >100kW (Large)	Defined against current and expected turbine development types.
Head Height	Identify locations with suitable head height for hydro	<1.5m (Pico – Small) 1.6 - 10m (Medium) >10m (Large)	Historic England
Existing Sites	Identify locations where hydro may be appropriate such as mill buildings	Spatial	Historic England

Table 3.3 - Hydropower Technical Analysis

Hydropower Constraints
Environmental A presumption against development being acceptable within some designations; while scale limitations apply within International and nationally recognised landscapes and designations, as identified in tables 1, 3 and 5. Ecological Status and waterbody classification (Environment Agency) is used to discount identified catchments which are not suitable for hydropower development. **Existing Hydro** Mapping of existing, consented and planned hydroelectric schemes, including scale and type to understand watercourses with low likelihood for further development. This assessment is due to both technical generation limits, regulatory limitations and cumulative impacts of proximal schemes. **Infrastructure** Buffer applied to key infrastructure for safety, amenity, and feasibility reasoning, including roads, railways, MOD sites. **Peak District National Park** Within the PDNP small scale hydro may be acceptable dependent on the supporting infrastructure required for development. Within this study, hydro has been considered as feasible within the PDNP.

Table 3.4 - Hydropower Constraints

3.3 Solar PV (Ground-mounted)

Ground mounted Solar PV energy resource assessment and opportunity analysis was conducted in line with the below data and variables.

Solar PV (Ground-Mounted)			
Parameter	**Description**	**Value**	**Source**
Development Footprint	Indicative footprint of solar PV panels	>2ha (<1MW) 3ha – 10ha (1 - 5MW) 11 – 40ha (6 - 20MW) 41 - 100ha (20 - 50MW) >100ha (50MW)	Defined against existing and expected scale of development
Solar Capacity	Average annual irradiation values to calculate generation capacities	Solar GHI	Met Office Energydata

Table 3.5 - Solar PV (Ground-mounted) Technical Analysis

Solar PV (Ground-Mounted) Constraints
Environmental A presumption against development being acceptable within some designations; while scale limitations apply within International and nationally recognised landscapes and designations, as identified in tables 1, 3 and 5.
Agriculture Low likelihood of development being acceptable on category 1, 2 and 3a agricultural land, with a preference for brownfield sites, contaminated land, industrial land, or agricultural land classification 3b, 4 or 5 (BRE 2014)[5]
Infrastructure Buffer applied to key infrastructure for safety, amenity, and feasibility reasoning, including roads, railways, waterways, built-up areas, MOD sites.
Peak District National Park Within the PDNP area ground-mounted solar PV is not considered acceptable except for at smaller scales.

Table 3.6 - Solar PV (Ground-mounted) Constraints

[5] BRE (2014) Planning guidance for the development of large scale ground-mounted solar PV systems

3.4 Bioenergy

Bioenergy encompasses all scales of biomass development (domestic, commercial, industrial) as well as energy from waste (EfW).

Biomass			
Parameter	**Description**	**Value**	**Source**
Existing Building Stock	No. suitable buildings	No. Properties	ONS data English housing Survey (EHS)
New Development	No. suitable buildings	No. Properties	RSS new housing provisions
System Capacity	Average Value	Domestic – 5kW	-
		Commercial – 100kW	-
Local Feed Stock	Proximity to managed forestry / energy crops	Grade 3 / 4 agricultural land types Managed woodland (FCS) Managed woodland (other)	Forestry Commission Natural England

Table 3.7 - Biomass Technical Analysis

Biomass Constraints

Constraints accounted for in the above values, including conservation areas, listed buildings and other permitted development limiting constraints.

Air Quality Management Areas (AQMA) and smoke control zones will limit the ability to install domestic and commercial systems.

Feed stock

Feed stock constraints relating to agricultural quality of land, woodland type (ancient, semi-ancient) and environmental designations on or around potential feed stock production locations.

Table 3.8 - Biomass Constraints

Similar to biomass, anaerobic digestion requires feed stock to run, although it is typically wet feed stock. Both biogas yield and electricity generation are estimated for anaerobic digestion.

Existing Feed stock	Amount of feed stock available	Livestock numbers Manure factor Food Waste volume	ADAS Manure Management Database Defra Agricultural and horticultural survey – England WRAP
Biogas Yield	Amount of biogas generated by feed stock (m^3/tonne)	Cattle: 25 m3/t Pigs: 26 m3/t Food & drinks: 46 m3/t	UK National Non-Food Crops centre (NNFCC)
Feed stock Requirement	Required amount of biogas per MW capacity	37,000 tonnes per MW per year	DECC Benchmark

Table 3.9 - Anaerobic Digestion Technical Analysis

Anaerobic Digestion Constraints

Environmental / Cultural

A presumption against development being acceptable within some designations; while scale limitations apply within International and nationally recognised landscapes and designations, as identified in tables 1, 3 and 5.

Proximity & Access

Due to the need for local feed stock or feed stock delivery, AD is considered acceptable within 1km of a feed stock source (e.g., farm) or 200m from a paved road and within the stated spatial constraints.

Feed stock

Feed stock constraints relating to manure availability and food and drink waste. This study looks at locally available feed stock sources only.

Peak District National Park

Anaerobic digestion is considered acceptable in the PDNP providing it only uses products from the farm it serves and is positioned sensitively within the landscape.

Table 3.10 – Anaerobic Digestion Constraints

Energy from waste requires a suitable waste source, a rationale for waste burning and suitable headroom within the local electricity network.

Energy from Waste			
Parameter	**Description**	**Value**	**Source**
Municipal Solid Waste	Availability of municipal waste	Landfill proximity	DCC
C&I Waste	Availability of C&I waste	C&I waste proximity Specific industries and industrial park proximity	Review of study area OS Data
Network Proximity	Proximity to electricity network for export	Distance from nearest suitable connection <5 MW (11 kV) 6 – 20 MW (33kV) >20 MW (132 kV)	DNO

Table 3.11 – Energy from Waste Technical Analysis

Energy from Waste Constraints

Environmental / Cultural
Due to the industrial nature of EfW plants, it is not expected that such a development would be acceptable within a designated environmentally sensitive location or designated culturally sensitive location.

Air Quality
Air quality limitations and regulations are expected to limit the development of EfW facilities.

Visual Impact
Scale and emissions from EfW are expected to limit the development area for EfW facilities.

Feed stock
Proximity to suitable solid waste, Commercial & Industrial (C&I) waste sites, sewage plants and transport infrastructure for feed stock delivery.

Peak District National Park
Within the PDNP area energy from waste is not considered acceptable.

Table 3.12 – Energy from Waste Constraints

3.5 Rooftop Solar

Solar PV and thermal assessments are based on DECC (2010) guidance, which sets out average building capacities and extent of deployment. For commercial and industrial assessments, a sample of 30 properties were taken across the study area to understand roof-size and therefore average solar PV capacity.

Rooftop Solar			
Parameter	**Description**	**Value**	**Source**
Existing Roof space	No. of roofs suitable for solar	25% domestic properties 40% commercial properties 80%industrial properties	CLG Statistics ONS data English housing Survey (EHS)
New Development	No. suitable roofs for solar	50% new build properties	RSS new housing provisions
System Capacity	Average Value	Domestic – 2.5kW Commercial – 5kW Industrial – regional average	- -

Table 3.13 - Rooftop Solar Technical Analysis

Rooftop Solar Constraints
Constraints accounted for in the above values, including conservation areas, listed buildings and other permitted development limiting constraints.

Table 3.14 - Rooftop Solar Constraints

3.6 Heat Pumps

Heat pump assessment is based on the below parameters, including air-source (ASHP), ground-source (GSHP), and water-source (WSHP) variants.

Heat Pumps			
Parameter	**Description**	**Value**	**Source**
Existing Building Stock	No. suitable buildings	100% off-grid Domestic 75% Detached and semi-detached domestic 50% terraced 25% flats	CLG Statistics ONS data English housing Survey (EHS)
New Development	No. suitable buildings	100% all new build properties	RSS new housing provisions
System Capacity	Average Value	Domestic – 5kW Commercial – 100kW	- -
System Performance	Coefficient of Performance	2.5	-

Table 3.15 - Heat Pump Technical Analysis

Heat Pump Constraints
Constraints accounted for in the above values, including conservation areas, listed buildings and other permitted development limiting constraints. **Environmental** Flooding Zones are a potential constraint to deeper geothermal system and any high-risk zones are not considered on this basis. Water source constraints, including ecological status and protection designations may mean water-source heat options unlikely to be considered acceptable.

Table 3.16 - Heat Pump Constraints

Each variant has different levels of applicability and performance in relation to electricity demand and heat generation. These factors are not considered within this study, as the focus here is on the spatial deployment of heat pump technologies rather than exact performance and impact valuation. Average coefficient of performance values are detailed in Table 3.16.

3.7 District Heat Networks

District heat network (DHN) viability is dependent on the density of heat demand, either in terms of density of properties or the presence of anchor load(s), as well as suitable heat sources. Analysis refers to the development of heat network zoning as an emerging policy and planning tool[6].

District Heat Networks (DHN)			
Parameter	**Description**	**Value**	**Source**
Heat Demand Density	Dwellings per ha	50	OS Data
Heat Demand Density	Demand value	kWh / m^2	UK Heat Map
Public Sector Estate	DCC and PDNP estate	Spatial	DCC / PDNP Data
New Developments	New development locations with heat network applicability	High density (50 dwellings/ha) in study area.	RSS new housing provisions
Anchor Load	High head demand buildings	Hospitals Industrial properties Schools & Universities Swimming Pools Care Homes Hotels Prisons	OS Data
Off-gas-grid locations	Areas off gas grid with higher suitability for DHN	On / Off	National Grid Non-Gas Map 2021[7].
Thermal availability	Ground Temperatures	Shallow Deep Geothermal	British Geological Society (BGS)

[6] BEIS (2021) Heat network zoning
[7] National Grid (2021) The Non-gas Map

District Heat Networks (DHN)			
Parameter	**Description**	**Value**	**Source**
Minewater Source	Location of Mines	Presence of accessible mine	Coal Authority
Water Source	Nearby water source for heat	Rivers, marine, lakes, and canals within 50m	Environment Authority
Greenspace	Available green space for development	Greenspace within 50m	OS Greenspace

Table 3.17 - DHN Technical Analysis

District Heat Networks (DHN) Constraints
Environmental Flooding Zones are a potential constraint to deeper geothermal system and any high-risk zones are not considered on this basis. Water source constraints, including ecological status and protection designations may mean water-source heat options unlikely to be considered acceptable. **Cultural Heritage** Heat networks are unlikely to be acceptable in conservation zones, world heritage sites and in locations with a high number of listed buildings. This is also true of archaeological sites and scheduled monuments.

Table 3.18 - DHN Constraints

3.8 Low Carbon Mobility

Low carbon mobility assessment uses data relating to existing and planned infrastructure relevant to transport and the development of low carbon solutions.

Low Carbon Mobility			
Parameter	**Description**	**Value**	**Source**
Existing EV Charger	Locations of EV chargers	Location	Department for Transport (DfT) Commercial services (e.g., Zap Map)
Transport Routes	Road Network	Existence and usage of road network	OS Data
Petrol Stations	Locations of petrol stations	Location	OS Data
Retail	Locations of supermarkets and retail parks	Location	OS Data

Table 3.19 - Low Carbon Mobility Technical Analysis

Constraints relating to low carbon mobility would be proposed based on identified locations where charger placement is recommended, such as zones with few chargers at present, high traffic routes and key customer destinations.

4. Energy System

The energy system is appraised in terms of:

- Network opportunities (i.e., electricity and gas grid availability);
- Current demand, as a means of identifying areas and sectors where low carbon generation or services may be applicable;
- The future energy system, including planned energy network development, expected energy use and demand trends, and expected regional development (e.g., industry, settlement growth, etc.)

4.1 Energy System

The energy system within the study area is assessed using Distributed Network Operators'[8] (DNO) data to understand current and future grid availability and spatial constraints on the system, as well as existing and planned generation and demand sources.

Energy Network			
Parameter	**Description**	**Value**	**Source**
Substation Capacity	2021/22 substation capacity for generation connection	Headroom calculation	DNO
Grid location	Location of High voltage (HV) and low voltage (LV) grid	Spatial	DNO
Planned Upgrades	Expected improvements to energy network in next 10 years	Narrative	DNO
Existing HV connected	Overview of HV connected energy projects (renewable and fossil fuelled)	Spatial	UK Government
Planned HV connected	Overview of planned energy projects (renewable and fossil fuelled)	Spatial	RSS / REPD
High Demand Sources	Overview of high demand sources in DCC / PDNP such as energy-intensive industry	Spatial	OS Data Review of study area

Table 4.1 - Energy System Constraints

[8] Electricity North West (ENW), Northern Powergrid (NPG), Western Power Distribution (WPD)

4.2 Energy Demand

Local authority and district-wide energy use data (electricity, heat, fuel) and carbon emissions by sector.

Energy Demand			
Parameter	**Description**	**Value**	**Source**
Sub-national fuel use	Type and amount of fuel used at LA and district level	GigaWatt Hours (GWh)	Sub-national Consumption Statistics
Sector fuel use	Sector split of fuel use	GigaWatt Hours (GWh)	Sub-national Consumption Statistics
Fuel use trends	Trends in fuel use by sector	GigaWatt Hours (GWh)	Sub-national Consumption Statistics
CO2 emissions	Overview and trends in CO2 emissions by sector	tCO_2e	UK local authority and regional carbon dioxide emissions national statistics

Table 4.2 - Energy Demand Technical Analysis

4.3 Future Energy System

Future energy system changes are provided on a narrative basis, examining how the energy network will change (upgrades, innovation), how new sources of demand affect energy use (new industry, settlements, EV use), and how new low carbon technologies affect demand (e.g., small-scale solar PV, heat pump roll-out). The future energy system will focus on 2035 and beyond.

A set of assumptions are developed based on similar studies and academic evidence to set out simple energy system projections for the study areas, specifically:

- Domestic Energy Demand (including demand trends and growth in housing)
- Non-domestic Energy Demand (including demand trends and growth in non-domestic properties)
- Industrial Energy Demand
- Generation capacity (both fossil and non-fossil fuel)
- Percentage of renewable energy capacity
- EV demand

Future Energy Use			
Parameter	**Description**	**Value**	**Source**
Future energy network	Changes to energy network capability and use	Narrative	FDES
Future regional development	Planned local development, including new homes, industry, etc.	Narrative	FDES
Generation technologies	Planned generation sites and overview of energy generation trends	Narrative	FDES
Technology trends	Impacts of energy efficiency, battery technologies, EV and low carbon heat on regional generation and demand.	Narrative	FDES

Table 26 - Future Energy Use Analysis

4.2 Deployment Extent Calculations

Within this study, estimated deployment extents have been calculated for several technologies. Calculations for property based technologies - namely, rooftop solar PV and thermal, biomass and heat pumps - are detailed within the relevant sections within this methodology.

Specific calculation methodologies have been used to understand deployment extents both ground-mounted solar PV and wind energy, detailed below.

Available land area = less constrained land identified within this study

Wind Energy Deployment Calculations

The below calculations were used to assess deployment potential for wind, both as a capacity value and number of turbines.

*MW capacity = MW / km² * Available land area * Reduction factor (5%)*

Number of turbines = MW Capacity / Typical turbine capacity

*MWh Generation = MW * Load Factor (20%) * annual hours (8760)*

Land area for larger scales of generation is preferred in the first instance, maximising efficiency of generation across the land area identified.

A 5% reduction factor has been used to account for expected levels of development in line with historical development trends in Derbyshire, expected future levels of development (Distributed Future Energy Scenarios), and technical and planning considerations for wind development (e.g., wind turbine density, visual impact, etc.).

Key Variables

- Small scale wind - 15m height to tip (HTT) - 1.35 MW / km² - 0.055 MW per turbine
- Medium scale wind - 50m height to tip (HTT) - 4.5 MW / km² - 0.75 MW per turbine
- Large scale wind - 100m height to tip (HTT) - 9 MW / km² - 2.5 MW per turbine

Solar PV Energy Deployment Calculations

The below calculations were used to assess deployment potential for ground-mounted solar PV as a capacity number.

*Mwh annual generation = kWh / m² (2.185) * Available land area * Reduction factor (5%)*

MWp = MWh / Load Factor (11%) / annual hours (8760)

A 5% reduction factor has been used to account for expected levels of development in line with historical development trends in Derbyshire, expected future levels of development (Distributed Future Energy Scenarios), and technical and planning considerations for wind development (e.g., wind turbine density, visual impact, etc.).

No detailed assessment of variance in ground-mounted solar PV scales was conducted within deployment calculations..

4.3 Low Carbon Impacts

Financial appraisals are conducted using the understood development extent, Levelised Cost of Energy (LCOE), and formula as detailed below. LCOE 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.

Where installation numbers are used (i.e., where LCOE is unavailable), installation costs are used in line with the formula below.

LCOE Calculation Formula

*Development potential (MW) * Load Factor * Hours in Year (8760) = Generation Capacity (MWh)*

*Generation Capacity (MWh) * LCOE (£ / MWh) = Lifetime project costs*

Installation Calculation Formula

*Potential Number of Installation * Installation Cost (£) = Lifetime project costs*

*Development potential (MW) * Cost per MW (£) = Lifetime project costs*