Herefordshire Renewable Energy Survey December 2023

Wind and solar potential

Herefordshire Council

Final report

Prepared by Prepared by LUC and Geospatial Insight

December 2023

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Foreword

Introduction from the Council

Introduction and use of this report

This report, commissioned by Herefordshire Council in 2023, provides an overview of the technical potential for wind, ground-mounted solar PV and rooftop solar PV opportunities within Herefordshire. It presents the data that will be used within the Herefordshire interactive renewables online map.

The report and map have been created to support the Council in achieving its goal to become a Net Zero County by 2030.

Technical potential is created by two factors:

- The presence of suitable natural resources – in this case wind speed and sun exposure; and
- The absence of constraints – areas where the physical, natural and heritage features prevent or limit the deployment of wind or solar technologies.

An area that has suitable natural resources, and is unconstrained, is an area of technical potential for development. However, in practice much of the area with technical potential would not be suitable for development due to:

- Factors that could only be considered on a case-by-case basis through the planning system;
- Building or land owners not exploring development at a particular site;
- Practical and technical difficulties present at a particular site;
- Limitations on the generation potential due to constraints on the electricity distribution network (grid); and

- Limited generation potential that reduces the financial viability of a specific development.

The area of technical potential is quantified in terms of the number of generators and the overall generation potential. It is important to recognise that in practice this potential is severely restricted by a range of factors and that the maximum technical potential would never be reached. For both wind and ground-mounted solar, it is likely that only a small proportion of the technical potential would ever be considered, and an even smaller proportion determined to be acceptable in planning terms.

Context for assessing technical potential

A significant increase in the amount of renewable electricity generation is required for the UK to achieve its legally binding targets for greenhouse gas emissions reduction. This will require new renewable generation to be sited in areas where there is technical potential and where the development can demonstrate compliance with local planning policies and environmental considerations. This report and the maps contained within it only consider the technical potential for wind and solar PV. Compliance with planning policies is not considered further, although a number of potential planning constraints to development have been identified.

It is not appropriate to consider the planning suitability within the assessment of technical potential, as this is effectively delivered through national and local planning policies.

Planning considerations

It is important to recognise that the maps within this report do not:

- Indicate that any areas have been identified as suitable for development;
- Identify areas where development would be preferred;
- Show any areas that are currently being considered for development; or
- Determine where renewable developments will and will not be permitted.

Rather, the maps identify which areas have constraints present. In all instances, any potential development proposal would need to demonstrate compliance with national and local planning policies, including ensuring that any protected or designated areas are fully considered within the scheme.

Some constraints would effectively prevent development and others may have implications in relation to the scale, design and location of renewable developments, or the need for effective mitigation to reduce adverse impacts. Much of the area with technical potential is unlikely to be acceptable in planning terms.

The high-level mapping has been undertaken based on a number of assumptions and boundaries. For any development, detailed site-specific survey and assessment would be required. The information presented on the maps should not be considered definitive and cannot be used as the sole basis for development.

As well as detailed site survey, environmental and landscape impact surveys would be required for most developments. Information on protected species has not been used as a constraint and detailed survey work would be required for all development applications.

Herefordshire Council

December 2023

Chapter 1
Introduction

1.1 Herefordshire Council commissioned LUC to produce an up to date assessment of the technical potential for wind and solar development in Herefordshire (see Figure 1.1). The results of the assessment will be used to inform investment in renewables in the County to help the Council meet their net zero carbon target by 2030.

1.2 The Council intends to use the outputs (this report and supporting data) to develop an interactive webmap that is viewable online and provides access to the results for a range of stakeholders. Additional data, such as district network operator data, will be overlaid to provide an insight into grid capacity on a semi-live basis.

1.3 This 'Energy Map' and associated resources will be made available on the Council website to support stakeholders considering energy options and 'matchmaking; between potential energy demand and supply providers.

1.4 This report outlines the methodology used to produce the strategic maps, and identifies where further site-specific work will be required in order to determine the feasibility of individual sites for wind, ground-mounted and rooftop solar energy developments. It also estimates the generation potential of wind and solar within Herefordshire.

1.5 The remainder of this report is structured as follows:

- Chapter 2 outlines the methodology used to undertake the mapping analysis.
- Chapter 3 outlines the findings of the analysis.
- Chapter 4 sets out how the Council can take the findings of this study forward.

- Appendix A sets out the assumptions used in the assessment of wind and ground-mounted solar energy development potential.
- Appendix B presents the wind assessment constraints maps.
- Appendix C presents the ground-mounted solar assessment constraints maps.
- Appendix D presents the secondary constraints and opportunities maps.

Figure 1.1

Chapter 2
Method

2.1 This chapter outlines the assumptions used to identify land with technical potential for wind and solar energy developments. It also sets out the approach to calculating generation potential and the limitations of the study.

2.2 The ‘technical potential’ is the total amount of renewable energy that could be delivered in the area based on assumptions regarding the amount of natural resource and space available once land use constraints are removed. This differs to the ‘deployable potential’, which estimates what could realistically be delivered when also taking into consideration factors such as planning issues, economic viability, availability of grid connections and landscape sensitivity.

2.3 This study additionally presents secondary constraints and opportunities for wind and ground-mounted solar developments. These have the potential to impact how appropriate identified technical potential land may be for development. However, to determine the full deployable potential of renewables within Herefordshire would require further study beyond the scope of this high-level assessment.

Wind

Description of technology

2.4 Onshore wind power is an established and proven technology with thousands of installations currently deployed across many countries throughout the world. The UK has considerable wind energy resource.

2.5 Turbine sizes do not fall intrinsically into clear and unchanging categories. At the largest scale, turbine dimensions and capacities are evolving quite rapidly. The deployment of turbines at particular 'typical' scales in the past has also been influenced by changing factors which include the availability of subsidies of different kinds. As defined scales need to be applied for the purpose of the resource assessment, the assessment has used five size categories based on consideration of current and historically 'typical' turbine models:

- Very large (150-220m tip height)
- Large (100-150m tip height)
- Medium (60-100m tip height)
- Small (25-60m tip height)
- Very small (<25m tip height)

2.6 An assessment of technical potential for very small wind (<25m height) was not undertaken as it is not possible to define areas of suitability for these using the same assessment criteria. Notional turbine sizes for the purposes of the present resource assessment are approximately intermediate within each class size (Table 2.1).

Table 2.1: Notional turbines used for this resource assessment

Scale	Typical Turbine Installed Capacity	Typical Turbine Height (maximum to blade tip)
Very large	4MW	185m
Large	2.5MW	125m
Medium	500kW	80m
Small	50kW	45m

2.7 Most turbines above the smallest scales have a direct connection into the electricity distribution network, at a point in the 'national grid' structure that can accommodate their output. Smaller turbines may provide electricity for single premises via a 'private wire' (e.g. a farm or occasionally a large energy user such as a factory), or be connected to the grid directly for export into the national system. Typically, turbines will be developed in larger groups (wind farms) only at the larger scales. The amount of energy that turbines generate will depend primarily on wind speed, but will be limited by the maximum output of the individual turbine (expressed as 'installed capacity' in Table 2.1).

2.8 A review of wind turbine applications across the UK found that tip heights range from less than 20m up to around 220m, with larger turbine models particularly in demand from developers following the reduction in financial support from Government. The majority of operational and planned turbines range between 80m and 220m, with most at the larger end of the scale.

2.9 The National Planning Policy Framework, which sets out the government's planning policies for England, states that wind turbines will only be considered acceptable within "an area identified as suitable for wind energy development in the development plan or a supplementary planning document; and, following consultation, it can be demonstrated that the planning impacts identified by the affected local community have been fully addressed and the proposal has their backing following consultation, it can be demonstrated that the planning impacts identified by the affected local community have been appropriately addressed and the proposal has community support" **[See reference 1]**. Moreover, the adopted Herefordshire Local Plan Core Strategy Policy SD2 – Renewable and low carbon energy generation, also includes wording in line with the NPPF **[See reference 2]**.

2.10 As of the second quarter of 2023, the UK had 15,283MW of installed onshore wind capacity, providing 15,407GWh electricity during the first half of the year **[See reference 3]**. Since the removal of financial support and restrictive policy requirements in the 2015 Written Ministerial Statement and subsequently incorporated in the NPPF referred to above, onshore wind development activity has overwhelmingly moved away from England towards Scotland and Wales, with a particular focus on sites with high wind speeds and

the ability to accommodate large numbers of tall turbines. Very few onshore wind energy projects have been approved and built within England since 2015.

Existing development within Herefordshire

2.11 According to the most recent Department for Business, Energy and Industrial Strategy (BEIS) Renewable Energy Planning Database extract **[See reference 4]**, there are no consented or operational wind developments within Herefordshire. However, this database only includes projects over 150kW, and until 2021 included only projects over 1MW. The Council are aware of existing operational wind turbines within Herefordshire that are not included within this database.

2.12 In addition, the Renewable Energy Planning Database identifies that the 9.2MW Reeves Hill Wind Farm was submitted in 2008 but this permission has since expired with no development having taken place. Moreover, there may also be previously permitted development sites that have now lapsed. Herefordshire Council's website can be checked for lapsed sites.

Assumptions used to identify land with technical potential

2.13 The assessment of technical potential for very large, large, medium and small turbines was undertaken using Geographic information Systems (GIS) involving spatial mapping of key constraints and opportunities. The assessment identified areas with suitable wind speeds. A reasonable but relatively low wind speed is considered to be technically suitable for wind development, however it is noted that only the highest wind speeds are potentially economically viable at the present time. The assessment then calculated the number of turbines that could theoretically be deployed within these areas. A series of constraints relating to physical features and environmental and heritage protection were

then removed. The remaining areas have ‘technical potential’ for wind energy development.

2.14 The key constraints considered are set out in detail in Appendix A.

2.15 Unconstrained areas of land were excluded if they were below a minimum developable size of 40m width and an area that varied per turbine size:

- Very large: 0.8ha
- Large: 0.6ha
- Medium: 0.4ha
- Small: 0.2ha

Calculation of generation potential within Herefordshire

2.16 The analysis examined the potential for very large, large, medium and small turbines. Where potential exists for more than one size of turbine, it was assumed that the larger turbines would take precedence as, to ensure viability, developers usually seek to install the largest capacity turbines possible.

2.17 The calculation of potential wind capacity involved applying an assumption concerning development density. In practice, turbines are spaced within developments based on varying multiples of the rotor diameter length. Although turbine separation distances vary, a 5 x 3 rotor diameter oval spacing **[See reference** 5**]**, with the major axis of the oval oriented towards the prevailing wind direction, taken to be south-west as the ‘default’ assumption in the UK, was considered a reasonable general assumption to use at the present time in this respect. In practice, site-specific factors such as prevailing wind direction and turbulence are taken into account by developers, in discussion with turbine manufacturers. Bearing in mind the strategic nature of the present study, the

density calculation did not take into account the site shape, and a standardised density was used instead as set out below:

- Very large: 4 turbines per km^2
- Large: 8 turbines per km^2
- Medium: 22 turbines per km^2
- Small: 167 turbines per km^2

2.18 The calculation of potential energy yield requires the application of a 'capacity factor' i.e. the average proportion of maximum turbine capacity that would be achieved in practice over a given period. Capacity factors vary in practice in accordance with wind speed, terrain and turbine scale. It was not possible to find suitable local historic data on capacity factors, and so a single capacity factor of 17.1% was used for all turbine scales, based on the available regional data **[See reference 6]**. It is noted that further study and specialist input would be required to determine the capacity factor of specific sites and proposed turbine heights and models.

2.19 In addition, the potential carbon savings as a result of generation via the identified wind potential was calculated. This assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that provided by the national grid. The national grid emission factor used within this assessment was 0.183kgCO_2e/kWh **[See reference 7]**. This is an estimated annual average carbon intensity of electricity (five year forecast from 2022). This was chosen to reflect the potential carbon that could be offset by future wind developments built following this study, when the national grid has further de-carbonised, as opposed to using the static current grid emission factor.

Ground-mounted solar PV

Description of technology

2.20 In addition to PV modules integrated on built development, there are a large number of ground-mounted solar PV arrays or solar farms within the UK. These consist of groups of panels (generally arranged in linear rows) mounted on a frame. Due to ground clearance and spacing between rows (and between rows and field boundary features) solar arrays do not cover a whole field and allow vegetation to continue to grow between and even underneath the panels.

2.21 Ground-mounted solar project sizes vary greatly across the UK although developers in a post-subsidy environment are increasingly focusing on large-scale development, with the largest currently consented scheme in England (Cleve Hill in Kent) being over 350MW **[See reference** 8**]**. There is no one established standard for land take per MW of installed capacity, although land requirements for solar are comparatively high compared to wind. For the present assessment, an approximate requirement of 1.2 hectares per MW has been applied based on past and recent development experience.

2.22 As of the second quarter of 2023, the UK had 15,345MW of installed solar PV, providing 7,333GWh electricity during the first half of the year **[See reference** 9**]**. The lower energy generation relative to wind – see paragraph 2.10 – despite the similar installed capacity is due to the lower capacity factors of solar PV generation – see paragraph 2.28. These figures include all forms of solar PV – although according to the most recent available data, ground-mounted schemes account for 51.9% of overall solar capacity **[See reference** 10**]**. Falling capital costs mean solar PV is increasingly viable in a post-subsidy context, although as outlined above, at present developers are generally focusing on large developments in order to achieve economies of scale. Grid connection costs can also critically affect viability.

Existing development within Herefordshire

2.23 The data available from BEIS **[See reference** 11**]** identifies there is 135MW of ground-mounted solar PV currently consented or installed in Herefordshire.

Assumptions used to identify land with technical potential

2.24 A GIS assessment of technically suitable land for solar development was undertaken using a similar approach to that undertaken for wind development.

2.25 Using modern solar panel technology, the vast majority of land within England is deemed suitable for solar panel development in terms of solar irradiance. This was mapped in Figure C.1 in Appendix C for information only to indicate where the more productive sites may be located. Any land unsuitable due to slope and aspect, which limit the total hours of direct daily sunlight within a location was removed. A series of primary constraints relating to physical features and environmental/heritage protection were then removed. The remaining areas have 'technical potential' for ground-mounted solar energy development.

2.26 The key constraints and opportunities considered are set out in Appendix A.

Calculation of generation potential within Herefordshire

2.27 Solar development is more 'modular' than wind (development size is dictated by the number of panels, which themselves do not differ greatly in size)

and constraints are not affected by project scale in the way that they are for wind. Therefore, the identification of available land for ground-mounted solar has not been broken down into discrete project sizes but rather any land technically suitable for development has been identified.

2.28 The calculation of potential solar capacity involved applying an assumption concerning development density. The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) **[See reference** 12**]** states that, along with associated infrastructure, generally a solar farm requires between 2 to 4 acres for each MW of output. This equates to 0.8-1.6ha per MW. For this study, the average of 1.2ha per MW was used.

2.29 It is noted that on sites where solar farms are co-located with wind turbines, the value of MW per ha may increase as infrastructure may be able to be shared between the technologies. Further site specific study would be required to consider this scenario.

2.30 The calculation of potential energy yield requires the application of a 'capacity factor' i.e. the average proportion of maximum turbine capacity that would be achieved in practice over a given period. Capacity factors vary in practice in accordance with irradiance, orientation and location. It was not possible to find suitable local historic data on capacity factors, and so a single capacity factor of 9.9% was used, based on the available regional data **[See reference** 13**]**. It is noted that further study and specialist input would be required to determine the capacity factor of specific sites and proposed solar farm designs.

2.31 In addition, the potential carbon savings as a result of generation via the identified solar potential was calculated. This assumed that the electricity generated from the identified solar potential would result in negligible carbon emissions and would replace that provided by the national grid. The national grid emission factor used within this assessment was 0.183kgCO_2e/kWh **[See reference** 14**]**. This is an estimated annual average carbon intensity of electricity (five year forecast from 2022). This was chosen to reflect the potential carbon that could be offset by future ground mounted developments built

following this study, when the national grid has further de-carbonised, as opposed to using the static current grid emission factor.

2.32 Unconstrained areas of land were mapped and the generation potential and potential carbon savings calculated. In addition, calculations were presented for identified technical potential land parcels within a minimum development size of 0.6ha, to represent a typical 0.5MW installation.

Secondary constraints and opportunities for wind and ground-mounted solar

2.33 Following the assessment of technical potential (which only considered primary or 'show stopper' constraints) all unconstrained land was reviewed to take account of secondary constraints and opportunities – i.e. to show which areas may have greater potential for development. This secondary assessment was undertaken for wind and ground-mounted solar technologies only. As noted in paragraph 2.49, further study would be required to review potential additional constraints to roof-mounted solar development.

2.34 In the analysis of secondary constraints, areas were evaluated based on their proximity to features that might influence their developability. For example, an arbitrary radius of 1km was applied around the National Landscapes (formerly Areas of Outstanding Natural Beauty – AONB) **[See reference** 15**]** to highlight potential issues relating to the setting of the National Landscape. This buffer is arbitrary and further site-based assessments would be needed to verify if this buffer is appropriate in reality. For the purpose of a strategic assessment however, this was deemed to be a proportionate and pragmatic approach. The buffers applied vary for the features considered, as set out in Appendix A.

2.35 As Herefordshire is located adjacent to the Welsh border, and these arbitrary radiuses surrounding constraints and opportunities could extend beyond the County, both English and Welsh datasets were considered.

2.36 The results of the secondary constraint and opportunity analysis are intended to be presented on the online webmap, alongside the technical potential results. Supporting policy text within the Local Plan could then be added to direct people to use this webmap as a tool to begin site searching. However, further site based feasibility studies, beyond the scope of this study, would be required to determine the actual suitability of locations for wind and ground mounted solar development.

Roof-mounted solar PV

Description of technology

2.37 Rooftop solar PV is a well-established technology in the UK, with uptake having been significantly boosted through the Feed-in Tariff (FiT) scheme from 2010 until its closure in 2019. Installations are largely confined to south-west to south-east facing roofs, pitched between 20-60º, and which have minimal shading. These may be installed upon existing roofs or can be roof-integrated. Roof-integrated systems, such as PV tiles, shingles and semi-transparent PV panels, form part of the roof itself and can offset some of the cost of conventional roofing materials.

2.38 On flat roofs, commonly found on flats and on domestic properties, the orientation of the roof is less critical to the viability of solar technologies. However, on these roofs, the panels will instead need to be pitched on tilted frames and spaced appropriately to limit self-shading.

2.39 On pitched roofs, approximately 7.5m^2 of roof space per kW of high efficiency (e.g. monocrystalline silicon) solar PV panel is required. This takes

into consideration of an internal roof buffer. See paragraph 2.60 for further details.

2.40 These PV systems can also be connected to export power to the grid at times when there is insufficient energy use or storage capabilities within the property.

2.41 Standard installations of solar panels are considered to be 'permitted development' **[See reference** 16**]** and therefore do not normally require planning consent. However, installations on listed buildings, or on buildings in designated areas (e.g. on the site of a scheduled monument or in a conservation area) are restricted in certain situations and may require planning consent.

Existing development within Herefordshire

2.42 Herefordshire saw 45,247kW of solar PV capacity installed between April 2010 (launch of the FiT) and March 2019 (when it closed), with 4,555 installations deployed on domestic properties and 532 installations on non-domestic properties **[See reference** 17**]**. The data available from BEIS **[See reference** 18**]** identifies there is 1.77MW of roof-mounted solar PV currently consented or under construction in Herefordshire.

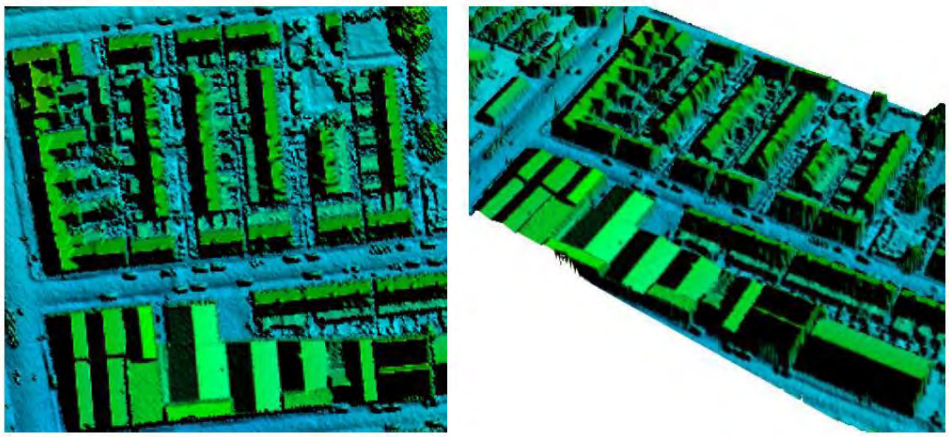
Assumptions used to identify land with technical potential

2.43 Geospatial Insight undertook the assessment of roof-mounted solar resource potential.

2.44 To establish individual property level solar suitability and potential, Geospatial Insight utilised a Digital Surface Model (DSM) alongside a building footprint dataset collated and conflated by Geospatial Insight from multiple

Open Data sources. The DSM is a high-resolution surface model produced using airborne LiDAR or photogrammetric stereo aerial photography. The DSM provides a digital model or 3D representation of a terrain's surface and all above ground features, including buildings and trees (see Figure 2.1).

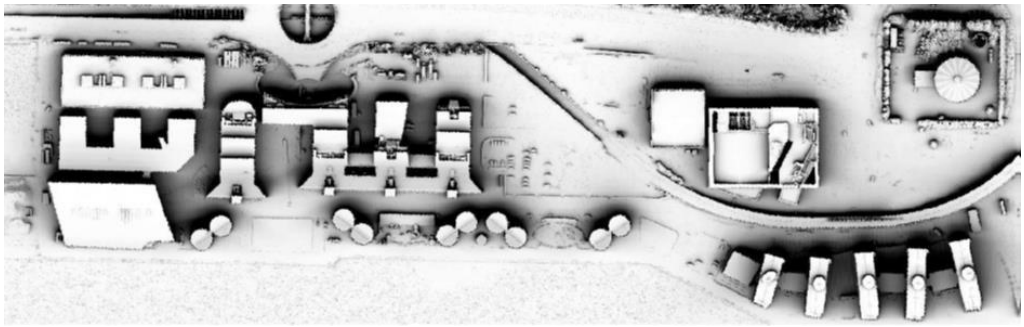
Figure 2.1: Example of DSM



2.45 Automated interrogation of the DSM data within each building footprint (representative of the roof area) was undertaken to determine which roofs are potentially suitable for solar by identifying the roof pitch, aspect, and useable area. Geospatial Insight used 'standard' values, where flat roofs and roofs with a pitch of between 5° and 50°, and within a 90° to 270° aspect (through south) were deemed suitable. Roofs outside of these values were deemed unsuitable, but the building footprints are still retained in the output database.

2.46 The DSM data was additionally modelled in PV.GIS, a solar irradiance calculation tool that uses the pitch, aspect, and location of a surface to estimate average annual irradiance exposure based on real world historic values (see Figure 2.2, where 'white' areas have the highest irradiance).

Figure 2.2: Example of irradiance



2.47 Using roof pitch, aspect, area, and irradiance details Geospatial Insight further established the potential array size, install costs, onsite energy savings, export revenue, and CO_2 savings for each building over both a 1-year period and a 20 year 'lifetime'.

2.48 The results are drawn from national analysis completed by Geospatial Insight, which uses a different CO_2 factor than the wind and ground-mounted solar assessments. The processing parameters are detailed below:

- Export Rate Inflation (RPI): 3.1% Per Annum
- Energy Price Inflation: 3% Per Annum
- Drop in System Performance: 1% Per Annum
- System Size: 250W
- Imported Electricity Cost: 28.0 Pence Per kWh (estimated for 2022) **[See reference** 19**]**
- Percentage of Self Consumption: 50%
- Percentage of Export: 50%
- System Efficiency: 20%
- Life Span: 20 Years
- Exported Electricity Rate: 3.5 Pence Per kWh **[See reference** 20**]**

- CO_2 Factor: 0.19338 kg CO_2e Per kWh for UK electricity (June 2022) **[See reference 21]**

2.49 Using Historic England and Herefordshire Council's data, conservation areas, scheduled monuments and listed buildings **[See reference 22]** were considered as secondary constraints to solar rooftop development. This is because installations on listed buildings, or on buildings in designated areas (e.g. on the site of a scheduled monument or in a conservation area) are restricted in certain situations and may require planning consent (see paragraph 2.41). As such, developments in such locations may be more difficult to deploy.

2.50 It is noted that further study would be required to consider other constraints to rooftop solar development, such as:

- Roof surface material/construction;
- Roof structure and loading capacity;
- Protected species – bat roosts;
- Protected species – bird nests; and
- Grid connection (for larger developments).

Calculation of generation potential within Herefordshire

2.51 The analysis within this report included the following rooftop solar deployment scenarios:

- All buildings;
- All residential properties only (as defined in Ordnance Survey Addressbase data); and
- All large industrial buildings only (with a minimum system size threshold of 50kWp).

2.52 Within the scenarios, the following sub-divisions of results were also included: 100% deployment; 10% deployment; and unconstrained deployment, which excludes properties affected by secondary heritage constraints (listed buildings 5m buffer footprints and buildings within conservation areas or scheduled monuments).

2.53 This report also includes recommendations on additional analysis and potential application of the rooftop solar results that the Council could apply.

Limitations

2.54 The paragraphs below outline the limitations of the work undertaken, which need to be considered when interpreting the results and maps produced by this work. These limitations are deemed to be proportionate given the strategic nature of this study.

Point and line data

2.55 As noted in Appendix A, some of the datasets used as part of this work were only available in point or line format e.g. listed building points and road lines. As a result, buffers were applied to these features to estimate their 'footprint', e.g. listed building footprints and road widths, based on the professional knowledge and experience of LUC. Further site-specific work would be required to determine the exact sizes of such features and how this may impact the potential to deliver wind and ground-mounted solar energy developments.

2.56 With regards to the assessment of rooftop solar potential, it is noted that the residential properties and listed building point data may not align perfectly with the solar rooftop results. As such, further site-specific work would be required to determine the exact location and sizes of such features and their relationship with the identified rooftop solar potential.

Buffer distances

2.57 The safety buffer distances surrounding features used as part of the primary constraints to wind and ground-mounted solar developments were informed by standard industry practice, as outlined in Appendix A.

2.58 However, as stated in paragraph 2.34 above, arbitrary radii around secondary features that may influence developability were mapped. Site-specific studies would be required to determine the suitability of land for wind and solar energy development in proximity to these features. For example, some biodiversity designations may not be sensitive to wind developments within 1km, whereas some may be sensitive to wind developments over greater distances.

Study scale

2.59 This work has been undertaken at the geographical county-wide scale and identifies the strategic potential for wind and solar energy developments. There are numerous smaller-scale factors that would require further site-specific assessment in order to determine the suitability of individual sites for wind and solar energy developments.

Rooftop solar assessment

2.60 As noted in paragraph 2.39, the suitable rooftop area to potential solar capacity ratio takes into consideration an internal roof buffer. However, as 1m LiDAR data is used by Geospatial Insight to produce their rooftop solar potential database, and obstruction vertically less than 150mm and horizontally less than 1m cannot be considered. For example, a tall chimney or wide dormer would be considered, but a stench pipe or skylight would not.

2.61 As noted in paragraph 2.48, Geospatial Insight's rooftop solar potential database considers modules with a 250W power output as standard. As technology improves, it is planned that future developments of their database will consider modules with a power output of 400W as standard. This will impact the suitable rooftop area to potential solar capacity ratio. Additional work could therefore be commissioned in the future to assess rooftop solar potential within Herefordshire considering modules with higher power outputs as technology improves.

Grid data

2.62 The only electricity transmission line data available to use for this study was from open sources: National Grid and Ordnance Survey. These were considered as technical constraints to wind with regards to turbine placement in proximity to overhead lines. As noted in Appendix A, further study would be required to consider transmission lines operated by the local District Network Operator (DNO) Western Power Distribution (WPD). (It is noted that WPD is now part of the National Grid Group, however the DNO-level data is not included within the open national-scale National Grid data available).

2.63 The only substation data available to use for this study with regards to secondary opportunities for wind and solar developments was also from the open national-scale National Grid data. As such, only two National Grid substations within 1km of Herefordshire were considered as secondary constraints (see Figure D.9). There are many additional substations within and surrounding Herefordshire that could present secondary opportunities for wind and solar developments. As noted in Appendix A, further study would be required to include additional substations operated by the local DNO. In addition, if this data is made available to the Council, the Council's online webmap could overlay these on the results of this study.

Chapter 3
Results

Wind potential

3.1 Figure 3.1 and Table 3.1 below provide a summary of the technical potential for wind energy within Herefordshire. The assessment results indicate that there is technical potential to deliver up to 5,843MW of wind energy capacity in Herefordshire; with the greatest potential for small turbines as these can be located in more areas. This capacity equates to 75,687 turbines and could deliver carbon savings of up to 1,606 kilotonnes of CO_2 per year. These statistics present technical potential inclusive of any existing wind development within the County, as no data could be sourced to exclude existing developments from the assessment (see paragraph 2.11). It is noted that in practice, all of this technical potential would not be developed within the County.

3.2 In addition, the map in Figure 3.2 presents areas which have been identified via the GIS analysis to have technical potential for wind development at each turbine scale considered.

3.3 To illustrate the GIS tool parameters, a series of opportunity and constraints maps were produced and are available in Appendix B. Figure B.1 in Appendix B shows the wind speed within Herefordshire at 50m above ground level (agl). This shows that the highest winds speeds are predominantly located south-west and north of the County. Other mapped constraints that have influenced the assessment outcomes are included in Appendix B (Figure B.2 to Figure B.8).

Figure 3.1: Onshore wind potential capacity and carbon savings [See reference **23**] **within Herefordshire**

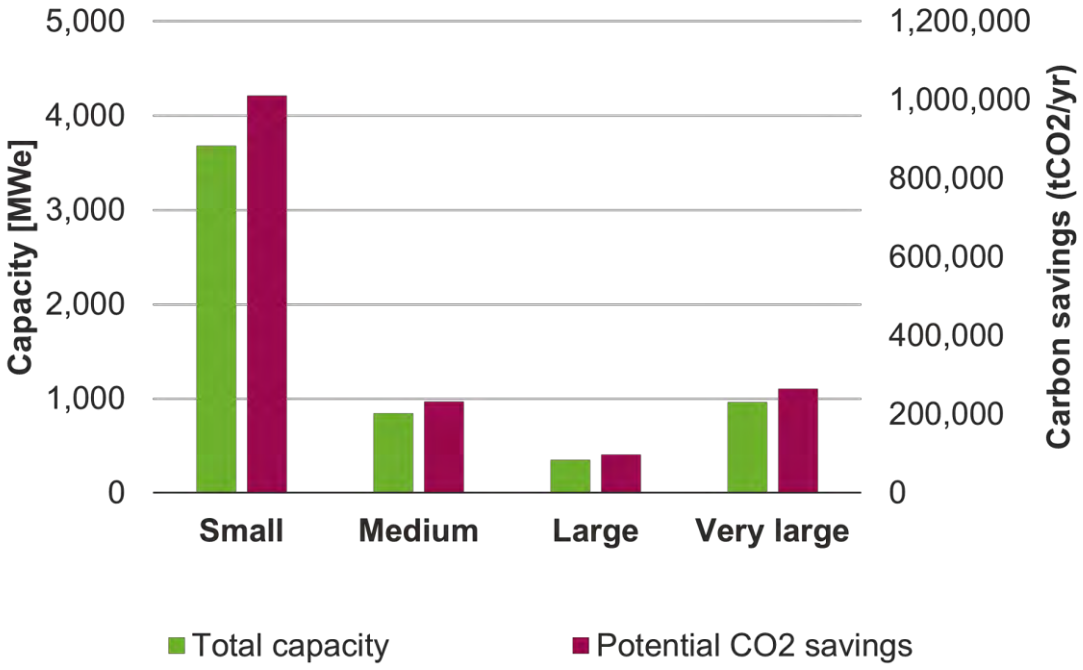


Table 3.1: Onshore wind potential capacity, output, carbon savings [See reference **24**] **and coverage within Herefordshire**

Scale (100% of tech. resource)	Estimated Total Capacity	Electricity Output	Potential CO_2 Savings	Estimated Number of Turbines	Area (ha)	Percent of County
Small	3,681MW	5,528GWh/year	1,012kilo tonnes/year	73,613	59,553ha	27.3%
Medium	846MW	1,270GWh/year	232kilo tonnes/year	1,692	15,474ha	7.1%
Large	354MW	531GWh/year	97kilo tonnes/year	142	7,785ha	3.6%
Very large	963MW	1,446GWh/year	265kilo tonnes/year	241	6,016ha	2.8%
Total	**5,843MW**	**8,776GWh/year**	**1,606kilo tonnes/year**	**75,687**	**88,828ha**	**40.8%**

Figure 3.2

3.4 An assessment of this nature will necessarily have certain limitations. In addition to those listed in Chapter 2, the following must be noted:

- Wind data – It is important to note that the macro-scale wind data which was used for this assessment can be inaccurate at the site-specific level and therefore can only be used to give a high-level indication of potential capacity and output within Herefordshire. Developers will normally require wind speeds to be accurately monitored using anemometers for an extended period (typically at least one to two years) for commercial scale developments.
- Cumulative effects – Multiple wind turbine developments can have a variety of cumulative effects. Cumulative landscape and visual effects, in particular, would clearly occur if all the identified small wind development potential were to be realised. Cumulative effects, however, cannot be taken into account in a high-level assessment of this nature and must be considered on a development-by-development basis.
- Site-specific features and characteristics – In practice, developments outside protected areas may potentially impact on amenity and sensitive 'receptors' such as protected species. These impacts can only be assessed via a site-specific survey. Such limitations are highlighted within the assumptions in Appendix A.
- Aviation – Operational airports and airfields were initially considered to be potential constraints on wind development. However, aviation interests and MOD land were not used as constraints to define technically suitable land, as impacts and mitigation need to be considered on a development-by-development basis.
- Issues affecting deployability – This study has assessed the technical potential for the development of wind turbines. Certain limitations of the resource assessment with respect to deployable wind potential have already been noted in the previous section. For example, cumulative impacts can only be considered fully when developments come forward in practice, but would generally be expected to reduce the overall deployable capacity. In addition to this, there are four particular factors that will influence the deployable potential of wind generation: landscape sensitivity, grid connection, development income and planning issues.

These factors would also need to be considered when determining the suitability of a site for development.

Ground-mounted solar potential

3.5 Figure 3.3, Table 3.2 and Table 3.3 below provide a summary of technical potential for ground-mounted solar energy within Herefordshire. Table 3.2 presents the technical potential for ground mounted solar. Table 3.3 presents the technical potential for only land parcels of size 0.6ha or more. As the full technical potential is very large, utilisation of 1%, 3% and 5% of the resource is also quantified. Adopting the 3% development scale would result in a total potential technical capacity from ground-mounted solar PV across the County of 2,891MW – this equates to an area of 2,470ha and a carbon saving of 458 kilotonnes of CO_2 per year. These statistics present technical potential in addition to any identified existing large-scale ground-mounted solar development, which were treated and constraints within the study (see Appendix A). It is noted that in practice, all of this technical potential would not be developed within the County.

3.6 In addition, the map in Figure 3.4 presents areas which have been identified via the GIS analysis to have technical potential for solar development.

3.7 In order to illustrate the GIS tool parameters, a series of constraints maps were produced and are included in Appendix C.

Figure 3.3: Ground mounted solar potential capacity and carbon savings [See reference **25**] **within Herefordshire**

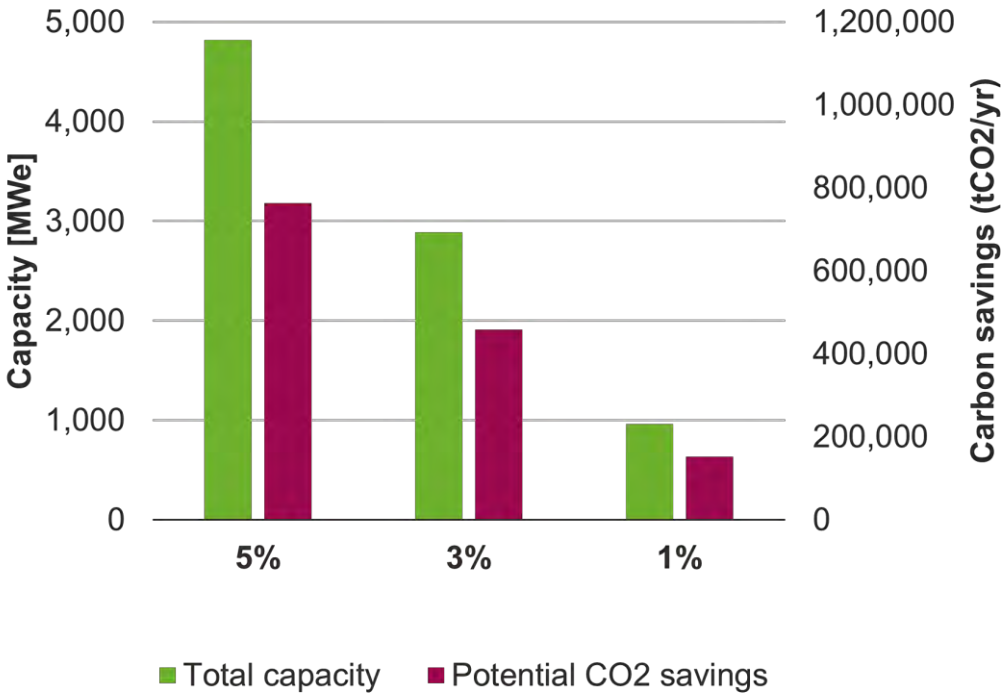


Table 3.2: Potential ground mounted solar capacity, output, carbon savings [See reference **26**] **and coverage within Herefordshire**

Scale	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings	Area	Percent of County
100% of tech. resource	96,377MW	83,513GWh/year	15,283 tonnes/year	115,653ha	53.1%
5% of tech. resource	4,819MW	4,176GWh/year	764 tonnes/year	5,783ha	2.7%
3% of tech. resource	2,891MW	2,505GWh/year	458 tonnes/year	3,470ha	1.6%
1% of tech. resource	964MW	835GWh/year	153 tonnes/year	1,157ha	0.5%

Table 3.3: Potential ground mounted solar capacity, output, carbon savings [See reference **27**] **and coverage within Herefordshire: Minimum site size 0.6ha**

Scale	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings	Area	Percent of County
100% of tech. resource	95,329MW	82,605GWh/year	15,117 tonnes/year	114,395ha	52.5%
5% of tech. resource	4,766MW	4,130GWh/year	756 tonnes/year	5,720ha	2.6%
3% of tech. resource	2,860MW	2,478GWh/year	454 tonnes/year	3,432ha	1.6%

Scale	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings	Area	Percent of County
1% of tech. resource	953MW	826GWh/year	151 tonnes/year	1,144ha	0.5%

Figure 3.4

3.8 An assessment of this nature will necessarily have certain limitations. In addition to those listed in Chapter 2, this includes cumulative impacts, which this high-level assessment cannot take into account, but which would affect consideration of planning applications in practice.

3.9 Ground-mounted solar development is less constrained relative to wind development, in terms of the factors that can reasonably be considered within a high-level resource assessment. As such, a large area of land has been identified as technically suitable for ground-mounted solar development. However, in practice, development of all or even the majority of this land for ground-mounted solar would clearly not be appropriate.

3.10 Other considerations that would also reduce the deployable potential of ground-mounted solar PV in practice include landscape sensitivity, grid connection and development income. These factors would also need to be considered when determining the suitability of a site for development.

Secondary constraints and opportunities for wind and ground-mounted solar

3.11 The maps in Appendix D display the secondary constraints and opportunities for wind and ground-mounted solar development. As noted in the assumptions in Appendix A, these are to be presented on the online webmap to help developers understand the potential constraints and opportunities that may influence the developability of identified land with technical potential. Supporting policy text within the Local Plan could then be added to direct people to use this webmap as a tool to begin site searching. However, further site based feasibility studies, beyond the scope of this study, would be required to determine the actual suitability of locations for wind and ground mounted solar development.

Roof-mounted solar potential

3.12 Figure 3.5 and Table 3.4 below provide a summary of technical potential for roof-mounted solar energy within Herefordshire. The analysis within this report included the following rooftop solar deployment scenarios:

- A – All buildings;
- B – All residential properties only; and
- C – All large industrial buildings only.

3.13 Within the scenarios, the following sub-divisions of results were also included: 100% deployment; 10% deployment; and unconstrained deployment, which excludes properties affected by secondary heritage constraints (listed buildings and buildings within conservation areas or scheduled monuments). Figure 3.6 to Figure 3.9 present areas which have been identified via the GIS analysis to have technical potential for roof-mounted solar development. In addition, Figure 3.7 displays the estimated substation catchment areas. These catchments were estimated by Geospatial Insight by interpolating known point substation locations to create estimated polygon catchments. These could be overlaid with grid data to identify suitable rooftop solar locations that would be able to connect to available grid capacity.

3.14 The assessment results indicate that there is technical potential to deliver up to around 808MW of rooftop solar PV energy capacity in Herefordshire. This capacity equates to 106,998 solar installations and has the technical potential to deliver carbon savings of up to 188,994 kilotonnes of CO_2 per year.

3.15 The results also indicate that the largest potential yields of electricity generation via rooftop solar PV could be achieved at the following locations:

- Industrial site, Holmer Road – Potential for 7.6MWp capacity
- Site A, Moreton Business Park – Potential for 2.2MWp capacity
- Site B, Moreton Business Park – Potential for 1.5MWp capacity

- Industrial site, Robinsons Business Park – Potential for 1.5MWp capacity

3.16 The Council could further analyse the rooftop solar assessment results, including by:

- Overlaying the results on Council-owned properties to identify potential for the Council to deliver rooftop solar.
- Overlaying the results with estimated substation catchments and grid data to identify potential for large installations in locations of available grid capacity (see paragraph 3.13).
- Using the results overlaid with known addresses to contact companies and landowners with large industrial or agricultural solar PV potential to encourage development. This could include investigating private-wire connection opportunities for high-energy consuming activities.
- The Council could re-work the data to consider alternative export/on-site use scenarios to the 50:50 scenario considered within this study (see paragraph 2.47).
- Present results on a web dashboard to encourage property owners to identify the rooftop solar potential on their properties and encourage development. This dashboard could present additional attribute information, such as the potential economic savings from rooftop solar developments over 20 years.
- Additional work could be commissioned to update the potential financial savings data, based on more up to date/live-updating financial data.
- Identified flat roofs could be investigated further for the potential to develop green roofs.

3.17 If the data is to be made publicly available, it is noted that the Council should include the necessary caveats regarding its use: Geospatial Insight make no representations or warranties of any kind, express or implied, about the completeness, reliability, accuracy, suitability with respect to information, products, services, graphics or images contained in their data service for any purpose. The information contained in the survey is for information purposes only. Any reliance you place on such information is therefore strictly at your own

risk. In no event will Geospatial Insight be liable for any loss or damage including, without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of profits arising out of, or in connection with, the use of any service provided.

Figure 3.5: Roof-mounted solar capacity and carbon savings [See reference **28**] **within Herefordshire**

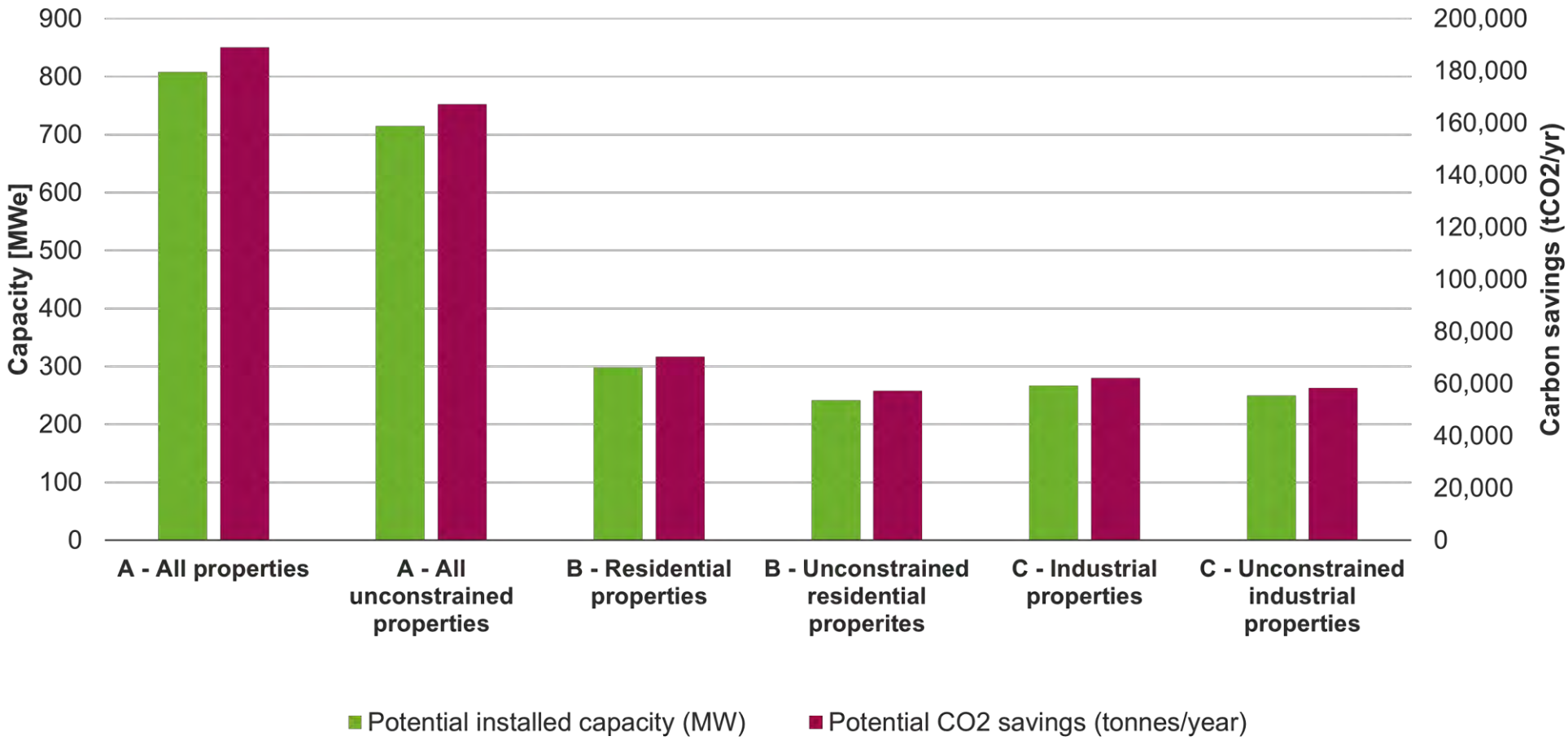


Table 3.4: Potential roof-mounted solar capacity, output and carbon savings [See reference **29**] **within Herefordshire: A - All buildings**

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource	All	808MW	977GWh/year	188,994 tonnes/year
100% of tech. resource	0-3,000kWh	62MW	78GWh/year	15,142 tonnes/year
100% of tech. resource	3,001-10,000kWh	217MW	263GWh/year	50,951 tonnes/year
100% of tech. resource	10,001-20,000kWh	126MW	150GWh/year	29,073 tonnes/year
100% of tech. resource	20,001-100,000kWh	198MW	238GWh/year	46,108 tonnes/year
100% of tech. resource	>100,001kWh	205MW	247GWh/year	47,720 tonnes/year
100% of tech. resource excluding secondary heritage constraints	All	715MW	865GWh/year	167,315 tonnes/year
100% of tech. resource excluding secondary heritage constraints	0-3,000kWh	55MW	69GWh/year	13,383 tonnes/year
100% of tech. resource excluding secondary heritage constraints	3,001-10,000kWh	185MW	224GWh/year	43,372 tonnes/year
100% of tech. resource excluding secondary heritage constraints	10,001-20,000kWh	106MW	126GWh/year	24,460 tonnes/year

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource excluding secondary heritage constraints	20,001-100,000kWh	176MW	212GWh/year	41,004 tonnes/year
100% of tech. resource excluding secondary heritage constraints	>100,001kWh	193MW	233GWh/year	45,097 tonnes/year
10% of tech. resource	All	81MW	98GWh/year	18,899 tonnes/year
10% of tech. resource excluding secondary heritage constraints	All	71MW	87GWh/year	16,732 tonnes/year

Table 3.5: Potential roof-mounted solar capacity, output and carbon savings [See reference **30**] **within Herefordshire: B - Residential properties**

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource	All	298MW	364GWh/year	70,464 tonnes/year
100% of tech. resource	0-3,000kWh	45MW	57GWh/year	11,082 tonnes/year
100% of tech. resource	3,001-10,000kWh	142MW	173GWh/year	33,532 tonnes/year
100% of tech. resource	10,001-20,000kWh	70MW	83GWh/year	16,135 tonnes/year
100% of tech. resource	20,001-100,000kWh	32MW	38GWh/year	7,416 tonnes/year
100% of tech. resource	>100,001kWh	10MW	12GWh/year	2,300 tonnes/year
100% of tech. resource excluding secondary heritage constraints	All	242MW	296GWh/year	57,258 tonnes/year
100% of tech. resource excluding secondary heritage constraints	0-3,000kWh	39MW	51GWh/year	9,791 tonnes/year
100% of tech. resource excluding secondary heritage constraints	3,001-10,000kWh	118MW	144GWh/year	27,872 tonnes/year
100% of tech. resource excluding secondary heritage constraints	10,001-20,000kWh	56MW	67GWh/year	12,887 tonnes/year

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource excluding secondary heritage constraints	20,001-100,000kWh	22MW	26GWh/year	5,049 tonnes/year
100% of tech. resource excluding secondary heritage constraints	>100,001kWh	7MW	9GWh/year	1,658 tonnes/year
10% of tech. resource	All	30MW	36GWh/year	7,046 tonnes/year
10% of tech. resource excluding secondary heritage constraints	All	24MW	30GWh/year	5,726 tonnes/year

Table 3.6: Potential roof-mounted solar capacity, output and carbon savings [See reference 31] within Herefordshire: C - Large industrial buildings

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource	All	267MW	322GWh/year	62,251 tonnes/year
100% of tech. resource	<100,000kWh	62MW	75GWh/year	14,531 tonnes/year
100% of tech. resource	100,000-300,000kWh	126MW	153GWh/year	29,666 tonnes/year
100% of tech. resource	300,000-600,000kWh	36MW	43GWh/year	8,366 tonnes/year
100% of tech. resource	600,000-1,200,000kWh	23MW	27GWh/year	5,180 tonnes/year
100% of tech. resource	1,200,000-2,800,000kWh	12MW	15GWh/year	2,835 tonnes/year
100% of tech. resource	>2,800,000kWh	8MW	9GWh/year	1,673 tonnes/year
100% of tech. resource excluding secondary heritage constraints	All	250MW	302GWh/year	58,344 tonnes/year
100% of tech. resource excluding secondary heritage constraints	<100,000kWh	57MW	69GWh/year	13,248 tonnes/year
100% of tech. resource excluding secondary heritage constraints	100,000-300,000kWh	120MW	146GWh/year	28,245 tonnes/year
100% of tech. resource excluding secondary heritage constraints	300,000-600,000kWh	32MW	38GWh/year	7,419 tonnes/year

Scale	System Size	Potential Installed Capacity	Electricity Output	Potential CO_2 Savings
100% of tech. resource excluding secondary heritage constraints	600,000-1,200,000kWh	23MW	27GWh/year	5,180 tonnes/year
100% of tech. resource excluding secondary heritage constraints	1,200,000-2,800,000kWh	11MW	13GWh/year	2,579 tonnes/year
100% of tech. resource excluding secondary heritage constraints	>2,800,000kWh	8MW	9GWh/year	1,673 tonnes/year
10% of tech. resource	All	27MW	32GWh/year	6,225 tonnes/year
10% of tech. resource excluding secondary heritage constraints	All	25MW	30GWh/year	5,834 tonnes/year

Figure 3.6

Figure 3.7

Figure 3.8

Figure 3.9

Chapter 4

Next Steps

4.1 The findings and mapping produced by this study have identified, at a high level, land and roofs within Herefordshire that have technical potential to deliver wind and solar developments. The GIS data produced can be used by the Council within a live and dynamic webmap of renewable energy potential across Herefordshire.

4.2 This can be used by the Council, landowners, grid operators, potential developers, major energy users and other stakeholders to identify potential opportunities for renewable developments, including “matchmaking” between potential energy demand and supply providers. Further site-specific study could then be undertaken to identify the feasibility of individual sites for development.

4.3 Further high-level study could also be undertaken to identify the technical potential for other renewable technologies within the County. In addition, the Council could use the data to produce a heat-map of the renewable potential across all technologies, to understand the total technical generation potential for example within a substation catchment. This could be used to identify ‘clusters’ of potential development sites to make cases for network re-enforcement. However, further site-specific study would still be required to identify the feasibility of individual sites for development.

4.4 Additionally, a landscape sensitivity assessment could be undertaken to assess the sensitivity of Herefordshire’s landscape to wind and solar developments. This would provide evidence for the Council to inform planning decisions and planning policy.

4.5 With regards to future wind development within Herefordshire specifically, as noted in Chapter 2, current national policy states that wind turbines will only be considered acceptable within “an area identified as suitable for wind energy development in the development plan or a supplementary planning document;

and, following consultation, it can be demonstrated that the planning impacts identified by the affected local community have been fully addressed and the proposal has their backing following consultation, it can be demonstrated that the planning impacts identified by the affected local community have been appropriately addressed and the proposal has community support" **[See reference** 32**]**.

4.6 Moreover, the adopted Herefordshire Local Plan Core Strategy Policy SD2 – Renewable and low carbon energy generation, also includes wording in line with the NPPF as outlined in paragraph 4.5 **[See reference** 33**]**.

4.7 Therefore, in order for any deployable wind developments to be delivered within Herefordshire, the Council would need to undertake further work in addition to this study in order to identify and designate areas suitable for wind energy within the County. Suitable areas for solar energy could also be identified within the Local Plan. In addition, to encourage renewable development within the County, supportive policies for renewable development could be included within the Local Plan, and additional work could be commissioned to develop such policy options.

4.8 Herefordshire Council are in the process of updating their Local Plan **[See reference** 34**]** and the evidence in this report and the emerging webmap could therefore be used to inform planning policy within this, including identifying suitable areas for wind. However, as noted in paragraph 4.7, further work would be necessary in order to identify these suitable areas for wind.

Appendix A

Assessment Assumptions

Appendix A

Key Assumptions to be Applied in the Assessment of Renewable Energy Resource

Introduction

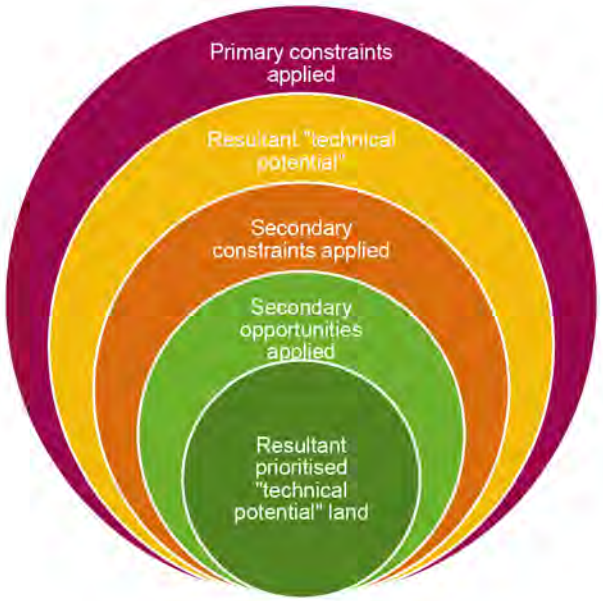
A.1 This note sets out the key assumptions that were used within the assessments of technical potential for wind and ground mounted solar. The assumptions used within the assessment of technical potential for roof mounted solar are included in **Chapter 2**.

Overview

A.2 To identify land with the opportunity to deliver wind and ground mounted solar developments, primary constraints to these technologies were mapped to identify the remaining unconstrained land within Herefordshire. This unconstrained land represents the technical potential for wind and ground mounted solar. This "technical potential" could be used to define areas of potential suitability for wind within the Local Plan in accordance with footnote 54 of the NPPT (Please note, footnotes 54 does not cover solar).

A.3 Following this, secondary constraints and opportunities were overlayed to identify land within the areas of technical potential that have greater or lower potential suitability for development (see **Figure A.1**). These secondary constraints and opportunities could be presented on the online webmap to enable planners, renewable developers, community groups and members of the public to begin the process of identifying the most suitable sites for development.

Figure A.1: Method overview



Emission Factors

A.4 To determine the potential CO_2 savings from the identified potential renewable resources, the identified potential electricity/heating output was multiplied by the emissions factors of the fuels the renewable energy generation would replace. In the case of the technologies being assessed, it assumed that electricity from the national grid will be replaced by the energy they produce. The emissions factors for grid electricity at present is 0.183kgCO_2e/kWh[1].

Wind Resource Assessment Parameters: Primary Constraints

A.5 The potential wind development resource within Herefordshire was assessed using a Geographic Information Systems (GIS) approach. This involved mapping a variety of technical and environmental parameters to identify parts of the county which are constrained with respect to wind development at various scales. The remaining land was then identified as having 'technical potential' (subject to further site-specific assessment at application stage). The parameters of the GIS tool are set out in **Table A.1**.

A.6 The maximum theoretical wind generation capacity of the areas of technical potential was estimated using:

- Standardised turbine densities and assumed turbine maximum generation capacities (the latter expressed in Megawatts (MW));
- One or more assumed capacity factors based on historic data broken down at least to regional level (using data from the Department for Business, Energy and Industrial Strategy (BEIS) relating to Feed in Tariff (FiT) installations)[2]; and
- The assumption that, where land has technical potential for multiple turbine scales, the largest scale will be developed in preference to smaller scales.

[1] National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats: Annual average carbon intensity of electricity (five year forecast from 2022)

[2] An energy generator's 'capacity factor' can be defined as the actual energy yield produced over a period of time expressed as a proportion of the energy yield that would have been produced if the generator had operated at its full generation capacity continuously over the same period.

Table A.1: Assumptions used in the assessment of technical potential for onshore wind – Constraints

Parameter	Assumption	Data Source	Justification and Notes
Wind Turbine Size	Five turbine sizes were considered: ■ Very large (150-220m tip height) ■ Large (100-150m tip height) ■ Medium (60-100m tip height) ■ Small (25-60m tip height) ■ Very small (<25m tip height) Assessment was based on notional turbine sizes, approximately intermediate within each class size i.e.: ■ Very large: 185m tip height, 4MW capacity ■ Large: 125m tip height, 2.5MW capacity ■ Medium: 80m tip height, 0.5MW capacity ■ Small: 45m tip height, 0.05MW capacity	■ LUC ■ Research into turbine manufacturers ■ BEIS renewable energy planning database and other databases containing information on wind turbine applications	There are no standard categories for wind turbine sizes. The categories chosen are based on consideration of current and historically 'typical' turbine models at various different scales. The approach is intended to be flexible in the light of uncertainty regarding future financial support for renewable energy. A review of wind turbine applications across the UK showed tip heights ranging from less than 20m up to around 220m, with larger turbine models in demand from developers following the reduction in financial support from Government[3]. Due to the structure of the financial support system in the past, smaller turbines (those in the medium to small categories) have tended to be deployed as 1-2 turbine developments. As this is a strategic scale study, notional turbine sizes, approximately intermediate within each class size, were used to represent each scale of turbine within this assessment. No map-based assessment of 'very small' turbines was undertaken. The type of buffers applied to constraints for the assessment of other turbine size categories in many cases do not reasonably apply to very small turbines. Equally, mapping a strategic county-wide 'resource' for very small turbines (which are generally developed individually in association with particular farm or other buildings) is not particularly meaningful. Instead, it is recommended that policy references the entire plan area as suitable for very small wind in principle (subject to site-specific assessment).
Wind Speed	Exclude:	■ Global Wind Atlas/Vortex ■ Industry practice	Wind speed requirements change with turbine scale and model. Some turbine manufacturers produce models which may operate at lower wind speeds and the configuration of certain turbine models can be altered to improve yield in lower wind speed environments.

[3] LUC review in July 2023

Parameter	Assumption	Data Source	Justification and Notes
	■ All areas with mean annual average wind speed <5m/s at 50m above ground level (agl).		Future changes in government policy and turbine technology could allow developments to be deliverable at lower wind speeds than are currently viable. A 5m/s threshold was applied to take account of such changes.
Roads	Exclude: ■ Roads (excl. restricted access tracks) with a buffer of the height of the turbine (to blade tip height) +10%.	■ Ordnance Survey OpenRoads	These buffers were applied as a safety consideration. The buffer distance is based on standard safety distances used by wind turbine developers and the DECC Renewable and Low-carbon Energy Capacity Methodology[4]. Restricted access tracks were excluded from consideration as these predominantly comprise of forestry and other tracks which could be more easily diverted than standards roads.
Railways	Exclude: ■ Railways with a buffer of the height of the turbine (to blade tip height) +10%.	■ Ordnance Survey VectorMap District	This buffer was applied as a safety consideration, based on the same principles as used for roads.
Electricity Lines	Exclude: ■ Major transmission lines (132kV minimum) with a buffer of the height of the turbine (to blade tip height) +10%.	■ Ordnance Survey OpenMap ■ National Grid	This buffer was applied as a safety consideration. It is derived from guidance by the Energy Networks Association (Engineering Recommendation L44) and National Grid (Technical Advice Note 287). It is noted that this guidance also states that a buffer of 3x the rotor diameter should be applied to account for turbine wake downwind of a turbine impacting the weathering of electricity lines. However, this also states that this impact is variable depending on factors including turbine positioning. This would require site-level study and consultation with the relevant DNO. As such, this buffer distance was not applied as a constraint. Further study would be required to consider transmission lines operated by the local DNO Western Power Distribution.

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

Parameter	Assumption	Data Source	Justification and Notes
Gas Pipelines	Exclude: ■ Gas pipelines with a 1.5x hub height buffer.	■ National Grid	This buffer was applied as a safety consideration. It is derived from guidance by the United Kingdom Onshore Pipeline Operators' Association (UKOPA/GP/013 Edition 1). It is noted that only National Grid open data was available for use within this study. Further site-specific study would be required to consider any other buried pipelines not contained within this dataset.
Airports and Airfields	Exclude: ■ Operational airports and airfields.	■ Ordnance Survey OpenMap Local Functional Site layer with the theme 'Air Transport'	OS VectorMap Local Functional Site data with the theme Air Transport was used in the assessment. It is noted that land within consultation zones surrounding airports and airfields may also be unsuitable for wind turbine development, and further consultation between potential developers and airport and airfields is required to determine if there is any impact from a proposed development.
Noise	Exclude: ■ Sensitive[5] and non-sensitive receptor[6] buffer zones based on turbine size: – Very large scale: 500m for residential/other sensitive receptors, 250m for non-residential. – Large scale: 480m for residential/other sensitive receptors, 230m for non-residential. – Medium scale: 400m for residential/other sensitive receptors, 180m for non-residential.	■ OS Addressbase ■ OS OpenMap	Wind turbines generate sound during their operation, and their noise impacts upon nearby properties must be limited to appropriate levels, defined in particular by the 'ETSU' Guidance – The Assessment and Rating of Noise from Wind Farms (1995) (as supplemented by the Institute of Acoustics). The relationship between turbine size and the separation distance from properties at which acceptable noise levels will be achieved is in practice quite complex and variable. However, the present assessment has applied specialist acoustic advice to define minimum distances below which it is generally unlikely that the required noise levels under ETSU-R-97 will be achievable. The buffer for a noise level of 35dB LA90 for small-medium turbines and 38dB LA90 for large-very large turbines was used as the minimum limit applied to sensitive receptors in a typical rural location.

[5] Sensitive receptors include residential properties, schools, hospitals and care homes. These were identified via the LLPG data.
[6] Non-relevant addresses that have no applicable noise receptors were excluded, identified via the LLPG data, including: ancillary buildings, car parking, garages, non-buildings.

Parameter	Assumption	Data Source	Justification and Notes
	– Small scale: 180m for residential/other sensitive receptors, 80m for non-residential. For properties outside (but close to) the authority boundary, indicative buffers were applied to the available property/buildings data from OS VectorMap. As this data does not distinguish commercial and residential properties, and it was not possible to verify uses by other means, non-residential buffers were used throughout.		The approach taken necessarily involves applying various assumptions, including: ■ An assumed single turbine development in all cases (rather than multiple turbines); and ■ The assumption that no properties will be 'financially involved' in the wind development or are located in an existing nosier area (financial involvement and existing elevated baseline noise levels may allow higher noise levels to be accepted in individual cases). The limitations associated with such assumptions are considered preferable to avoiding the use of noise-related separation distances for the assessment, bearing in mind that noise is a key factor that influences the acceptable siting of turbines in practice. The assessment defines the minimum distances below which adherence to the Industry standard (ETSU-R-97) noise guidance would not be possible and it should not be inferred that the proposed distances represent acceptance of any given proposal within the areas of identified suitable potential as site based noise monitoring and assessments would still be required. Note: Within the County, where address points did not overlay OS OpenMap buildings data, points were buffered 5m to estimate building footprint. Where OS OpenMap buildings did not overlay address point data, these buildings were assumed to be of non-sensitive use[7]. Moreover, due to lack of sufficient data, buildings outside of the County were assumed to be of non-sensitive use. This was to ensure that land was not unnecessarily ruled as being constrained to wind development, as a result of non-sensitive buildings being mistakenly assessed as being sensitive. It is noted further site specific study would be required to determine the necessary buffer distance between specific buildings and proposed turbines.
Buildings	Exclude: ■ Buildings with a buffer of the height of the turbine (to blade tip height) +10%.	■ OS Addressbase ■ OS OpenMap	National Planning Practice Guidance notes that the topple distance +10% is a safe separation distance between turbines and buildings.

[7] Where OS buildings overlayed non-relevant addresses (see footnote 6) these were excluded from consideration.

Parameter	Assumption	Data Source	Justification and Notes
			The same building and Addressbase datasets used in the consideration of noise was used to determine the location of buildings for this parameter.
Future Developments, Safeguarded Land and Employment Sites	Exclude: ■ Site allocations from Herefordshire's Plan: – Committed Sites; – Proposed housing site; and – Safeguarded Employment Sites.	■ Herefordshire Council	Generally unsuitable for wind turbine development, unless allocations contain relatively large undeveloped portions. Identification of suitable land for wind within specific allocation boundaries would require a separate site-specific study. In addition, it is assumed that opportunities for renewables within such sites will already be considered as part of their design.
Country Parks	Exclude: ■ Country Parks.	■ Natural England	The only Country Park designated within Herefordshire is Queenswood Country Park. Herefordshire Council advised that wind development within this would not be acceptable. As such this was treated as a constraint to wind development.
Existing Renewable Energy Developments	Exclude: ■ Land boundaries of consented and operational renewable energy installations.	■ Herefordshire Council ■ BEIS ■ Aerial imagery ■ LUC windfarm database	The quarterly BEIS Renewable Energy Planning Database, Herefordshire Council data and the LUC internal windfarm database was used to determine the locations of operational and consented renewable energy installations. To approximate the site boundary, land was excluded based on Herefordshire Council boundary data in combination with assessment of surrounding recent aerial imagery. For existing wind developments, it was assumed these were of notional medium scale tip height and occupied a 5 x 3 rotor diameter oval spacing[8], with the major axis of the oval oriented towards the prevailing wind direction, taken to be south-west (see turbine spacing below). Existing roof-mounded solar PV developments and advanced conversion technologies are building-integrated and therefore were excluded via the consideration of existing built development as a constraint.

[8] To mitigate impacts on the productivity of wind turbines located close to one another caused by wind turbulence, it is standard practice for developers to maintain an oval of separation between turbines that is equal to 5 times the turbine rotor diameter (the cross sectional dimension of the circle swept by the rotating blades) on the long axis, and 3 times the rotor diameter on the short axis.

Parameter	Assumption	Data Source	Justification and Notes
			Additionally, existing landfill gas developments were not considered a constraint to wind developments, as there is potential that turbines could be incorporated onto such existing sites. Existing battery developments were not included as, due to their small scale, their exact location within a site was difficult to identify. Moreover, there is potential for battery and turbine developments to also be co-located.
Terrain	Exclude: ■ Slopes greater than 15%	■ EA Lidar DTM	This is a development/operational constraint. Developers have indicated that this is the maximum slope they would generally consider feasible for development. Although it is theoretically possible to develop on areas exceeding 15% slopes, turbine manufacturers are considered unlikely to allow turbine component delivery to sites where this is exceeded.
Water Environment	Exclude: ■ Watercourses and waterbodies with a 50m buffer.	■ Ordnance Survey VectorMap Local	A 50m buffer was applied around all rivers and waterbodies to take account of good practice such as that relating to pollution control during construction. OS Survey OpenMap Local surface water area data includes waterways of approximately a minimum of 2m width. OpenMap Local surface water line data is line data, and so a 1m buffer was applied to approximate a footprint of smaller waterways.
Woodland	Exclude: ■ Ancient Woodland Inventory with a 50m buffer; and ■ Woodland as shown on the National Forest Inventory with a 50m buffer including: – Assumed woodland; – Broadleaved; – Conifer; – Coppice; – Coppice with standards; – Low density;	■ Forestry Commission ■ Natural England	All areas of woodland were excluded with a +50m buffer to reduce risk of impact on bats. A 50m clearance distance of turbine blades from tree canopies and other habitat features is standard practice and endorsed by Natural England guidance set out in 'TIN051'. A 50m horizontal buffer from turbine masts is a reasonable proxy clearance for the purposes of a strategic study, bearing in mind unknowns concerning tree height and turbine dimensions. In addition, a 50m buffer cannot be applied to all linear habitat features and individual trees due to a lack of data for a study of this scale. Further site specific study would therefore be required to accurately define buffer distances between turbines and adjacent woodland. The following National Forestry Inventory categories of woodland were considered non-permanent or non-woodland and therefore not excluded as wind turbine development may be suitable in these locations: ■ Cloud/shadow;

Parameter	Assumption	Data Source	Justification and Notes
	– Mixed mainly broadleaved; – Mixed mainly conifer; and – Young trees.		■ Failed; ■ Felled; ■ Group prep; ■ Shrub; ■ Uncertain; and ■ Windblown.
Orchards	Exclude: ■ Orchard as shown in the Priority Habitat Inventory.	■ Natural England	A 50m clearance distance of turbine blades from tree canopies and other habitat features is standard practice and endorsed by Natural England guidance set out in 'TIN051'. A 50m horizontal buffer from turbine masts is a reasonable proxy clearance for the purposes of a strategic study bearing in mind unknowns concerning tree height and turbine dimensions. In addition, 50m buffer cannot be applied to all linear habitat features and individual trees due to a lack of data for a study of this scale. Further site specific study would therefore be required to accurately define buffer distances between turbines and adjacent orchards.
Geological Designations	Exclude: ■ Locally Important Geological Sites.	■ Herefordshire Council/University of Worcester	As protected by: ■ Town and Country Planning Act 1990 ■ Herefordshire Local Plan Core Strategy 2011-2031
Biodiversity (International Designations)	Exclude international designations[9]: ■ Special Areas of Conservation (SAC).	■ Natural England	As protected by: ■ Conservation of Habitats and Species Regulations 2017 (as amended)
Biodiversity (National Designations)	Exclude national designations: ■ Sites of Special Scientific Interest; and	■ Natural England	As protected by: ■ Wildlife and Countryside Act 1981

[9] There are no Special Protection Areas (SPA), potential SPAs, potential SACs, Ramsar site or propose Ramsar sites within the county.

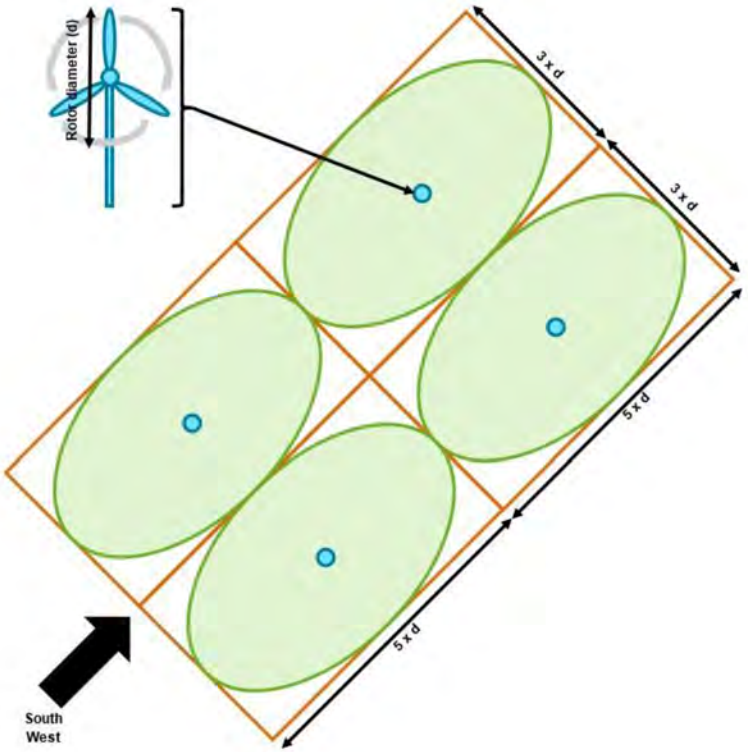
Parameter	Assumption	Data Source	Justification and Notes
	■ National Nature Reserves.		■ Conservation of Habitats and Species Regulations 2017 (as amended)
Biodiversity (Regional and Local Designations)	Exclude other designations[10]: ■ Local Nature Reserves; ■ Local Wildlife Sites; and ■ Wildlife Trust Reserves.	■ Natural England ■ Herefordshire Council ■ Herefordshire Biodiversity Record Centre ■ Herefordshire Wildlife Trust	Generally, would not be suitable for renewables development based on law/policy/guidance including: ■ NPPF ■ Natural Environment and Rural Communities Act 2006 ■ Herefordshire Local Plan Core Strategy 2011-2031 It is noted that further site-specific study would be required to consider non-designated features.
Cultural Heritage	Exclude[11]: ■ Registered Parks and Gardens; ■ Scheduled Monuments; ■ Listed Buildings; ■ Conservation Areas; and ■ Locally Listed buildings.	■ Historic England ■ Herefordshire Council	As protected by: ■ NPPF ■ The Convention Concerning the Protection of the World Cultural and Natural Heritage ■ National Heritage Act 1983 ■ Ancient Monuments and Archaeological Areas Act of 1979 ■ Planning (Listed Buildings and Conservation Areas) Act 1990 ■ Herefordshire Local Plan It is noted that further site specific study would be required to determine if any unexpected archaeological remains or undesignated but nationally significant features are present that would require consideration, as well as the setting of historic features.

[10] There are no RSPB Reserves within the county
[11] There are no World Heritage Sites or Registered Battlefields within the county

Parameter	Assumption	Data Source	Justification and Notes
			Note: Listed building point data was buffered 5m to estimate building footprints where they did not intersect or have the same name as Herefordshire locally listed building polygon data. In addition, listed building line data was buffered 0.5m to approximate the size of designated wall features.
Minimum Development Size	Unconstrained areas of land were excluded if they were below a minimum developable size of 40m width and an area that varied per turbine size: ■ Very large: 0.8ha ■ Large: 0.6ha ■ Medium: 0.4ha ■ Small: 0.2ha	■ N/A	The minimum development size was based on developer knowledge of recent wind turbine developments, and accounts for the estimated land take requirements for a single turbine base, the adjacent laydown area and other immediate infrastructure requirements adjacent to the turbine itself. However, further site specific study would be required in order to determine the land take requirements of individual turbines depending on factors such as their model and location.
Turbine Spacing	The following standardised turbine densities were considered when determining the overall potential for turbine development across Herefordshire: ■ Very large: 4 per km^2 (assuming a rotor diameter of 130m) ■ Large: 8 per km^2 (assuming a rotor diameter of 90m) ■ Medium: 22 per km^2 (assuming a rotor diameter of 55m) ■ Small: 167 per km^2 (assuming a rotor diameter of 20m)	■ N/A	The calculation of potential wind capacity involved applying an assumption concerning development density. In practice, turbines are spaced within developments based on varying multiples of the rotor diameter length. Although turbine separation distances vary, a 5 x 3 rotor diameter oval spacing[12], with the major axis of the oval oriented towards the prevailing wind direction, taken to be south-west as the 'default' assumption in the UK, was considered a reasonable general assumption at the present time in this respect. In practice, site-specific factors such as prevailing wind direction and turbulence are taken into account by developers, in discussion with turbine manufacturers. Bearing in mind the strategic nature of the present study, the density calculation did not take into account the site shape, and a standardised rectangular grid density based on a 5 x 3 rotor diameter was used instead (see image below).

[12] To mitigate impacts on the productivity of wind turbines located close to one another caused by wind turbulence, it is standard practice for developers to maintain an oval of separation between turbines that is equal to 5 times the turbine rotor diameter (the cross sectional dimension of the circle swept by the rotating blades) on the long axis, and 3 times the rotor diameter on the short axis.

Figure A.2: Wind turbine spacing



A.7 The parameters below have not been used to exclude land for the purposes of this study. This does not mean that these constraints are not present or do not require consideration on a specific site.

Table A.2: Assumptions to be used for the assessment of technical potential for onshore wind – Constraints considered but not used

Parameter	Assumption	Data Source	Justification and Notes
Electricity Grid	No land excluded on this basis.	■ Western Power Distribution	As grid capacity is so variable with little certainty in advance of where there could be capacity for additional electricity generation to be connected, no land was excluded on this basis for the technical assessment. Further consultation would be required with WPD to determine the feasibility to connect specific sites to the electricity grid. Moreover, for larger wind turbine schemes, developers commonly deliver substations and additional grid infrastructure as required to support the additional generation capacity requirements of the development, limiting concerns regarding connecting to constrained parts of the existing grid.
NATS Safeguarding Areas	Guidance includes reference to the following safeguarding areas: ■ 30km for aerodromes with a surveillance radar facility; ■ 17km for non-radar equipped aerodromes with a runway of 1,100m or more, or 5km for those with a shorter runway; ■ 4km for non-radar equipped unlicensed aerodrome with a runway of more than 800m or 3km with a shorter runway; ■ 10km for the air-ground-air communication stations and navigation aids; and ■ 15 nautical miles (nm) for secondary surveillance radar.	■ NATS	Further consultation between potential developers and NATS is required to determine if there is any impact from a proposed development. NATS safeguarding areas were therefore not excluded.

Parameter	Assumption	Data Source	Justification and Notes
	These are indicative of potential constraints to wind development but cannot be used to definitely exclude land as unsuitable.		
Shadow Flicker	No land excluded on this basis.	N/A	Wind turbines may in some circumstances cause 'shadow flicker' within nearby properties. However, shadow flicker effects can be readily mitigated and so shadow flicker was not considered as a constraint for the purposes of this study.
Residential Amenity	No land excluded on this basis.	N/A	It is noted that it may be inappropriate to develop wind turbines in proximity to residential properties, due to impacts upon residential amenity. However, due to the potential for micro siting, property aspect and potential for mitigation, it would require further site specific study to determine whether wind turbines would be suitable in proximity to residential properties. Therefore, this factor would require consideration within a site specific residential and visual amenity assessment.
National Landscapes (formerly Area of Outstanding Natural Beauty – AONB)	No land excluded on this basis.	Natural England	The management plans for the Malvern Hills and Wye Valley National Landscapes do not restrict renewable developments within the designations. As such, no land was excluded on this basis. It is noted that further site-specific landscape sensitivity and visual impact assessment would be required to consider these designations and assess the potential suitability of sites for wind development within or in proximity to the National Landscapes. As of the 22nd November 2023, Areas of Outstanding National Beauty (AONB) are referred to as 'National Landscapes'. In legal terms they are still defined as AONBs.
MOD Land	No land excluded on this basis.	OpenStreetMap	Although some MOD land may be unsuitable for wind turbine development, for example due to interference with aircraft movements, much MOD land may be suitable for wind turbine developments. Further consultation between potential developers and the MOD is required to determine if there is any impact from a proposed wind development. As such, no land was excluded on this basis.

Parameter	Assumption	Data Source	Justification and Notes
National Park	No land excluded on this basis.	■ Natural England	There are no National Parks located within the County. As such, no land was excluded on this basis.
Public Rights of Way and Cycle Paths	No land excluded on this basis.	■ Herefordshire Council ■ SusTrans	Public Rights of Way and cycle paths can be diverted if necessary to ensure they are safely distanced from wind turbines. Public Rights of Way and cycle paths were therefore not excluded.
Unregistered Parks and Gardens	No land excluded on this basis.	■ Herefordshire Council	It may not be suitable for wind developments to be located within unregistered parks and gardens. However, this is site dependent and would require further study. As such, unregistered parks and gardens were not excluded.
Blade Oversail of Biodiversity and Cultural Heritage Designations	No land excluded on this basis.	■ N/A	Depending on individual designated site characteristics, it may not be suitable for the blades of adjacent wind turbines to oversail the site. However, this is site dependent and would require further study. As such, a blade oversail buffer was not excluded.

Ground-Mounted Solar Resource Assessment Parameters: Primary Constraints

A.8 Herefordshire's technical potential for ground mounted solar PV development was assessed in a similar way to the potential for wind. The key GIS tool parameters are set out in **Table A.3** below.

A.9 The maximum solar PV capacity of the area of technical potential was estimated using an assumed development density expressed as Megawatts (MW) per hectare; and regional capacity factor[13] (again, derived from historic data broken down to at least regional level).

A.10 As solar PV is essentially modular, the land with technical potential was not differentiated by project scale.

[13] An energy generator's 'capacity factor' can be defined as the actual energy yield produced over a period of time expressed as a proportion of the energy yield that would have been produced if the generator had operated at its full generation capacity continuously over the same period.

Table A.3: Assumptions used for assessment of the technical potential for commercial/large scale ground-mounted solar – Constraints

Parameter	Assumption	Data Source	Justification and Notes
Development Size Categories	None.	■ N/A	Solar development is more 'modular' than wind (development size is dictated by the number of panels, which themselves do not differ greatly in size) and constraints are not affected by project scale in the way that they are for wind. Therefore, the identification of available land for ground-mounted solar has not been broken down into discrete project sizes but rather any land technically suitable for development has been identified.
Roads	Exclude: ■ Roads.	■ Ordnance Survey OpenRoads	Physical features preventing the development of ground-mounted solar PV were excluded. There is no requirement for safety buffers in relation to these with respect to ground-mounted solar PV. Restricted access tracks were excluded from consideration as these predominantly comprise of forestry and other tracks which could be more easily diverted than standards roads. Note: Only line data for roads was available and in order to create a footprint from the road centre, it was assumed that single carriageways are 10m in width, dual carriageways 20m and motorways 30m.
Railways	Exclude: ■ Railways.	■ Ordnance Survey OpenMap	Physical features preventing the development of ground-mounted solar PV were excluded. There is no requirement for safety buffers in relation to these with respect to ground-mounted solar PV. Note: In order to create a footprint from the railway centrelines data, it was assumed that railways were 15m in width.
Planning/Land Use Other	Exclude: ■ Registered Common Land; ■ Open Access Land; ■ Local public green/open space, including: – Allotments; – Amenity green space;	■ Natural England ■ Herefordshire Council	Due to land take requirements, these land uses/types were considered generally to constrain ground-mounted solar development, particularly at larger scales, although in some circumstances they may offer opportunities for smaller scale development collocated with their other facilities. They were excluded from the resource assessment but may be subject to bespoke policies with the Local Plan allowing development to take place in principle subject to defined criteria being satisfied. The open spaces considered within this study were consistent with the open spaces assessed within the 2023 Herefordshire Natural Environment Evidence Update.

Parameter	Assumption	Data Source	Justification and Notes
	– Cemeteries and churchyards; – Civic space; – Green chain or corridor; – Incidental greenspace; – Natural and semi natural green space; – Outdoor sports facility; – Provision for children and teenagers; and – Country Parks.		
Buildings	Exclude: ■ All buildings with a 10m buffer.	■ OS OpenMap Local data	Buildings were buffered by 10m to account for shading and impacts on solar output. It is noted that further site specific study considering building heights and orientation in relation to the site would be required to determine the exact buffers required to account for shading.
Future Developments, Safeguarded Land and Employment Sites	Exclude: ■ Site allocations from Herefordshire's Plan: – Committed Sites; – Proposed housing site; and – Safeguarded Employment Sites.	■ Herefordshire Council	Generally these will be unsuitable for ground-mounted solar, although there may be some potential for installations on undeveloped land/open space within these areas. Identification of this potential would require a separate, site-specific study. In addition, it is assumed that opportunities for renewables within such sites will already be in development as part of their allocation.
Existing Renewable Energy Developments	Exclude: ■ Land boundaries of consented and operational renewable energy installations.	■ Herefordshire Council ■ BEIS ■ Aerial imagery ■ LUC windfarm database	The quarterly BEIS Renewable Energy Planning Database, Herefordshire Council data and the LUC internal windfarm database was used to determine the locations of operational and consented renewable energy installations. To approximate the site boundary, land was excluded based on Herefordshire Council boundary data in combination with assessment of surrounding recent aerial imagery. For existing wind developments, it was assumed these were of notional medium scale tip height and

Parameter	Assumption	Data Source	Justification and Notes
			occupied a 5 x 3 rotor diameter oval spacing[14], with the major axis of the oval oriented towards the prevailing wind direction, taken to be south-west (see turbine spacing below). Existing roof-mounded solar PV developments and advanced conversion technologies are building-integrated and therefore were excluded via the consideration of existing built development as a constraint. Additionally, existing landfill gas developments were not considered a constraint to solar developments, as there is potential that solar panels could be incorporated onto such existing sites. Existing battery developments were not included as, due to their small scale, their exact location within a site was difficult to identify. Moreover, there is potential for battery and solar developments to also be co-located.
Minerals Sites with a 250m buffer	Exclude: ■ All operational minerals sites with a 250m buffer; and ■ Allocated minerals sites with a 250m buffer.	■ Herefordshire Council	The IAQM 2016 Guidance on the Assessment of Mineral Dust Impacts for Planning indicates that adverse dust impacts from sand and gravel sites are uncommon beyond 250m and beyond 400m from hard rock quarries measured from the nearest dust generating activities. Only point data was available for mineral sites within the study area. Buffers were applied to these within this study, but further site-specific study would be required to make full consideration of these using site boundary data.
Terrain	Exclude: ■ Areas with north-east to north-west aspect and inclinations greater than 7 degrees; and	■ EA Lidar DTM	Although it is possible to develop Ground-mounted solar PV installations on slopes facing north-east to north-west, it would generally not be economically viable to do so. However, slopes that are north-east to north-west facing and below 7° are considered potentially suitable[15], as generation output will not be significantly affected.

[14] To mitigate impacts on the productivity of wind turbines located close to one another caused by wind turbulence, it is standard practice for developers to maintain an oval of separation between turbines that is equal to 5 times the turbine rotor diameter (the cross sectional dimension of the circle swept by the rotating blades) on the long axis, and 3 times the rotor diameter on the short axis.
[15] Based on current standard developer practice.

Parameter	Assumption	Data Source	Justification and Notes
	■ All areas with inclinations greater than 15 degrees.		
Agricultural Land Use	Exclude: ■ Agricultural land use classifications grades 1.	■ Natural England	Agricultural Land Use is a consideration, with grades 1, 2 and 3a land being classed as *"the best and more versatile (BMV)"* land and having higher value for food production. Further investigation would be required of grade 3 land to determine whether it is grade 3a or b, as available data does not distinguish these. Ground-mounted Solar PV projects, over 50kWp, should ideally utilise previously developed land, brownfield land, contaminated land, industrial land or agricultural land preferably of classification 3b, 4, and 5. However, solar developments can be built on BMV land, if they have been deemed to pass the sequential test, whereby sites on lower grade a non-agricultural land are prioritised over BNM land. Within Herefordshire, the majority of land is grade 2 or 3 agricultural land, and there are existing solar farms present on some of this. As such, only grade 1 (excellent quality) agricultural land was treated as a constraint to solar development, and further site-specific study would be required to determine if sites on lower grade BMV would be suitable based on the sequential text.
Water Environment	Exclude: ■ Watercourses and waterbodies with a 50m buffer.	■ Ordnance Survey VectorMap Local	A 50m buffer was applied around all rivers and waterbodies to take account of good practice such as that relating to pollution control during construction. OS Survey OpenMap Local surface water area data includes waterways of approximately a minimum of 2m width. OpenMap Local surface water line data is line data, and so a 1m buffer was applied to approximate a footprint of smaller waterways.
Woodland	Exclude: ■ Ancient Woodland Inventory with a 20m buffer; and ■ Woodland as shown on the National Forest Inventory with a 20m buffer including: – Assumed woodland;	■ Forestry Commission ■ Natural England	Forested areas were buffered by 20m to account for shading and impacts on solar output. It is noted that further site specific study considering woodland heights and orientation in relation to the site would be required to determine the exact buffers required to account for shading. The following National Forestry Inventory categories of woodland were considered non-permanent or non-woodland and therefore not excluded as ground mounted solar development may be suitable in these locations:

Parameter	Assumption	Data Source	Justification and Notes
	– Broadleaved; – Conifer; – Coppice; – Coppice with standards; – Failed; – Felled; – Group prep; – Low density; – Mixed mainly broadleaved; – Mixed mainly conifer; – Shrub; and – Young trees.		■ Cloud/shadow; ■ Uncertain; and ■ Windblown.
Orchards	Exclude: ■ Orchard as shown in the Priority Habitat Inventory.	■ Natural England	Ground-mounted solar panels could not be delivered within orchards due to the presents of trees that would limit ground space and would cause shading and associated and impacts on solar output. As orchard trees are typically shorter than those within woodlands, a buffer was not applied to these to account for shading. It is noted however that further site specific study considering orchard heights and orientation in relation to the site would be required to determine the exact buffers required to account for shading.
Geological Designations	Exclude: ■ Locally Important Geological Sites.	■ Herefordshire Council/University of Worcester	As protected by: ■ Town and Country Planning Act 1990 ■ Local Plan Core Strategy 2011-2031

Parameter	Assumption	Data Source	Justification and Notes
Biodiversity (International Designations)	Exclude international designations[16]: ■ Special Areas of Conservation (SAC).	■ Natural England	As protected by: ■ Conservation of Habitats and Species Regulations 2017 (as amended)
Biodiversity (National Designations)	Exclude national designations[17]: ■ Sites of Special Scientific Interest; and ■ National Nature Reserves.	■ Natural England	As protected by: ■ Wildlife and Countryside Act 1981 ■ Conservation of Habitats and Species Regulations 2017 (as amended)
Biodiversity (Regional and Local Designations)	Exclude other designations[18]: ■ Local Nature Reserves; ■ Local Wildlife Sites; and ■ Wildlife Trust Reserves.	■ Natural England ■ Herefordshire Council ■ Herefordshire Biodiversity Record Centre ■ Herefordshire Wildlife Trust	Generally, would not be suitable for renewables development based on law/policy/guidance including: ■ NPPF ■ Natural Environment and Rural Communities Act 2006 ■ Herefordshire Local Plan It is noted that further site-specific study would be required to consider non-designated features.
Cultural Heritage	Exclude[19]: ■ Registered Parks and Gardens; ■ Scheduled Monuments; ■ Listed Buildings; ■ Conservation Areas; and ■ Locally Listed buildings.	■ Historic England ■ Herefordshire Council	As protected by: ■ NPPF ■ The Convention Concerning the Protection of the World Cultural and Natural Heritage ■ National Heritage Act 1983

[16] There are no Special Protection Areas (SPA), potential SPAs, potential SACs, Ramsar site or propose Ramsar sites within the county.
[17] There are no RSPB Reserves within the county.
[18] There are no RSPB Reserves within the county.
[19] There are no World Heritage Sites or Registered Battlefields within the county.

Parameter	Assumption	Data Source	Justification and Notes
			■ Ancient Monuments and Archaeological Areas Act of 1979 ■ Planning (Listed Buildings and Conservation Areas) Act 1990 ■ Herefordshire Local Plan It is noted that further site specific study would be required to determine if any unexpected archaeological remains or undesignated but nationally significant features are present that would require consideration, as well as the setting of historic features. Note: Listed building point data was buffered 5m to estimate building footprints where they did not intersect or have the same name as Herefordshire locally listed building polygon data. In addition, listed building line data was buffered 0.5m to approximate the size of designated wall features.
Minimum Development Size	Unconstrained areas of land were excluded if they were below a minimum developable size of 0.6ha.	■ N/A	A minimum development size of 0.6ha was set in agreement with Herefordshire Council.
Development Density	1.2 hectares per MW.	■ N/A	The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) states that, along with associated infrastructure, generally a solar farm requires between 2 to 4 acres for each MW of output. This equates to 0.8-1.6ha per MW. For this study, the average of 1.2ha per MW was used. It its noted that on sites where solar farms are co-located with wind turbines, the value of MW per ha may increase as infrastructure may be able to be shared between the technologies.

A.11 The parameters below have not been used for the purposes of this study. This does not mean that these constraints are not present or do not require consideration on a specific site.

Table A.4: Assumptions used for the assessment of technical potential for commercial/large scale ground-mounted solar – Constraints considered but not used

Parameter	Assumption	Data Source	Justification and Notes
Solar Irradiance	No land excluded on this basis.	■ Global Solar Atlas	Using modern solar panel technology, the vast majority of land within England is deemed suitable for solar panel development in terms of solar irradiance. Any land unsuitable due to slope and aspect which limit the total hours of direct daily sunlight within a location, were excluded from consideration as based on the above constraints table. Therefore, no land was excluded from this assessment based on this, and solar irradiance levels they were mapped for information only to indicate where the more productive sites may be located.
Electricity Grid	No land excluded on this basis.	■ Western Power Distribution	Grid connection is a key consideration for solar developments, as additional grid connections costs, such as long cable distances and additional substation requirements, can significantly hinder the economic viability of this technology. However, as grid capacity is so variable with little certainty in advance of where there could be capacity for additional electricity generation to be connected, no land was excluded on this basis for the technical assessment. Further consultation would be required with WPD to determine the feasibility to connect specific sites to the electricity grid.
Gas Pipelines	No land excluded on this basis.	■ National Grid	Although the presence of buried pipelines could impact the suitability of overlaying above-ground solar panels, mitigation and panel layout design can be applied to limit impacts. Further site-specific study would be required to consider this parameter. As such, no land was excluded on this basis.
Electricity Lines	No land excluded on this basis.	■ Ordnance Survey OpenMap ■ National Grid	Although overhead lines have the potential to cause some limited shading of solar panels, and thereby impact on potential PV generation potential, panel layout design and solar tracking systems can limit impacts. Further site-specific study would be required to consider this parameter. As such, no land was excluded on this basis.

Parameter	Assumption	Data Source	Justification and Notes
Residential Amenity	No land excluded on this basis.	■ N/A	It is noted that it may be inappropriate to develop solar farms in proximity to residential properties, due to impacts upon residential amenity. However, due to the potential for micro siting, property aspect and potential for mitigation, it would require further site specific study to determine whether solar developments would be suitable in proximity to residential properties. This factor could be considered within a future landscape sensitivity assessment. No land was excluded on this basis from the technical assessment.
All Operational Waste Sites	No land excluded on this basis.	■ Herefordshire Council	Waste sites will frequently be quite highly constrained with respect to ground-mounted solar development (e.g. areas of active landfill) but equally may present opportunities in some circumstances, particularly when they are to be decommissioned/restored during a plan period. Waste sites were excluded from the identified ground-mounted solar resource but potentially subject to bespoke policy wording in the local plan. Only point data was available for waste sites within the study area. These could not be considered within the assessment. Therefore, further site-specific study would be required to make consideration of these.
National Landscapes (formerly Area of Outstanding Natural Beauty – AONB)	No land excluded on this basis.	■ Natural England	The management plans for the Malvern Hills and Wye Valley National Landscapes do not restrict renewable developments within the designations. As such, no land was excluded on this basis. It is noted that further site-specific landscape sensitivity and visual impact assessment would be required to consider these designations and assess the potential suitability of sites for wind development within or in proximity to the National Landscapes. As of the 22nd November 2023, Areas of Outstanding National Beauty (AONB) are referred to as 'National Landscapes'. In legal terms they are still defined as AONBs.
MOD Land	No land excluded on this basis.	■ OpenStreetMap	Although some MOD land may be unsuitable for solar development due to the land take requirements of the technology, much MOD land may be suitable for solar developments. Further consultation between potential developers and the MOD is required to determine if there is any impact from a proposed development. As such, no land was excluded on this basis.

Parameter	Assumption	Data Source	Justification and Notes
National Park	No land excluded on this basis.	▪ Natural England	There are no National Parks located within the county. As such, no land was excluded on this basis.
Public Rights of Way/Cycle Paths	No land excluded on this basis.	▪ Herefordshire Council ▪ DEFRA ▪ SusTrans	Public Rights of Way and cycle paths can be diverted if necessary around or safely through ground mounted solar developments, and these impacts are considered as part of the assumed development density. Public Rights of Way and cycle paths were therefore not excluded.
Unregistered Parks and Gardens	No land excluded on this basis.	▪ Herefordshire Council	It may not be suitable for wind developments to be located within unregistered parks and gardens. However, this is site dependent and would require further study. As such, unregistered parks and gardens were not excluded.
Airports and Airfields	No land excluded on this basis.	▪ Ordnance Survey VectorMap Local Functional Site layer with the theme 'Air Transport' ▪ Aerial imagery	Glint and glare caused by solar panels is a consideration for aviation safety. However, this is site dependent and scheme design can enable solar developments to be situated within airports and airfields themselves. As such, only the airport and airfield buildings and hardstanding should treated as constraints to solar development. Although airport buildings were treated as constraints to solar development, considered under *"Buildings"*, no spatial data was available to map runways and in-use airport hardstanding. Therefore, further site-specific study would be required to consider these.

Wind and Ground-Mounted Solar Resource Assessment Parameters – Secondary Constraints and Opportunities

A.12 Following the assessment of technical potential (which only considered primary constraints) all unconstrained land was reviewed to take account of secondary constraints and opportunities – i.e. to show which areas may have greater potential for development.

A.13 In the analysis of secondary constraints, areas were evaluated based on their proximity to features that might influence their developability. For example, an arbitrary radius of 1km was applied around the National Landscapes (formerly AONBs) to take account of potential issues relating to the setting of the National Landscape. This buffer is arbitrary and further site-based assessments would be needed to verify if this buffer is appropriate in reality. For the purpose of a strategic assessment however, this was deemed to be a proportional and pragmatic approach. The buffers applied vary for the features considered, as set out in **Table A.5** to **Table A.8**.

A.14 As Herefordshire is located adjacent to the Welsh border and these arbitrary radiuses surrounding constraints and opportunities could extend beyond the County, both English and Welsh datasets were considered.

A.15 The results of the secondary constraints and opportunities analysis are to be presented on the online webmap. Supporting policy text within the Local Plan could then be added to direct people to use this webmap as a tool to begin site searching. However, further site based feasibility studies, beyond the scope of this study, would be required to determine the actual suitability of locations for wind and ground mounted solar development.

Wind Resource Secondary Constraints and Opportunities

Table A.5: Wind resource assessment secondary constraints

Parameter	Secondary Constraints	Data Source	Justification and Notes
National Landscapes (formerly Area of Outstanding Natural Beauty – AONB)	Land that is: ■ Located within or within 1km of a National Landscape.	■ Natural England ■ Natural Resources Wales	Planning permission may be more difficult to obtain for sites within or close to the designation. As of the 22nd November 2023, Areas of Outstanding National Beauty (AONB) are referred to as 'National Landscapes'. In legal terms they are still defined as AONBs.
Geological Designations	Land located within 1km of: ■ Locally Important Geological Sites.	■ Herefordshire Council/University of Worcester	As protected by: ■ Town and Country Planning Act 1990 ■ Herefordshire Local Plan Core Strategy 2011-2031 Wind development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Biodiversity (International designations)	Land located within 1km of international designations[20]: ■ Special Areas of Conservation.	■ Natural England ■ Natural Resources Wales	As protected by: ■ Conservation of Habitats and Species Regulations 2017 (as amended) Wind development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.

[20] There are no Special Protection Areas (SPA), potential SPAs, potential SACs, Ramsar site or proposed Ramsar sites within 1km of the county

Parameter	Secondary Constraints	Data Source	Justification and Notes
Biodiversity (National designations)	Land located within 1km of national designations: ■ Sites of Special Scientific Interest; and ■ National Nature Reserves.	■ Natural England ■ Natural Resources Wales	As protected by: ■ Wildlife and Countryside Act 1981 ■ Conservation of Habitats and Species Regulations 2017 (as amended) Wind development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Biodiversity (Regional and local designations)	Land located within 1km of regional and local designations[21]: ■ Local Nature Reserves; ■ Local Wildlife Sites; and ■ Wildlife Trust Reserves.	■ Natural England ■ Herefordshire Council	As protected by: ■ National Planning Policy Framework ■ Natural Environment and Rural Communities Act 2006 Wind development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Cultural Heritage	Land that is within 1km of[22]: ■ Registered parks and gardens; ■ Scheduled monuments; ■ Listed buildings; ■ Conservation Areas; and ■ Locally Listed buildings. Land that is:	■ Historic England ■ Cadw ■ Welsh Government ■ Herefordshire Council	As protected by: ■ National Planning Policy Framework ■ Planning Policy Wales ■ The Convention Concerning the Protection of the World Cultural and Natural Heritage ■ National Heritage Act 1983 ■ Ancient Monuments and Archaeological Areas Act of 1979 ■ Planning (Listed Buildings and Conservation Areas) Act 1990

[21] There are no RSPB Reserves within the county.
[22] There are no World Heritage Sites or Registered Battlefields within 1km of the county.

Parameter	Secondary Constraints	Data Source	Justification and Notes
	■ Located within or within 1km of a Registered Historic Landscape.		Wind development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations. It is noted that further site specific study would be required to determine if any unexpected archaeological remains or undesignated but nationally significant features are present that would require consideration, as well as the setting of historic features. Note: Listed building point data was buffered 5m to estimate building footprints where they did not intersect or have the same name as Herefordshire locally listed building polygon data. In addition, listed building line data was buffered 0.5m to approximate the size of designated wall features.
Flood Zones	Land that is: ■ Located within Flood Zone 3.	■ Environment Agency	Wind development will not necessarily be infeasible within areas of greater flood risk, however the delivery of ground-mounted solar development in such locations may be more complex and costly.
Agricultural Land Use	Land that is: ■ Is located within agricultural land use classifications grades 1 and 2.	■ Natural England	Agricultural Land Use is a consideration, with grades 1, 2 and 3a land being classed as "the best and more versatile (BMV)" land and having higher value for food production. Further investigation would be required of grade 3 land to determine whether it is grade 3a or b, as available data does not distinguish these, and grade 3a land would additionally need to be considered as part of a development siting. Wind energy developments have a lesser land take than ground-mounted solar, and agricultural practices can still be undertaken at wind farms. However, the turbines and infrastructure such as access tracks may limit the productivity of a site and as such may wind developments may be less deliverable on higher grade agricultural land.
Noise	Land within:	■ OS Addressbase ■ OS OpenMap Local Buildings layer	As noted above, wind turbines generate sound during their operation, and their noise impacts upon nearby properties must be limited to appropriate levels. To indicate which area of land within the identified potentially "technical" suitable land, may be more difficult to develop in terms of noise, the same acoustic advice was used as per the technical assessment. However, the following assumptions were applied:

Parameter	Secondary Constraints	Data Source	Justification and Notes
	■ Sensitive[23] and non-sensitive receptor[24] buffer zones based on turbine size: – Very large scale: 800m for residential/other sensitive receptors, 500m for non-residential. – Large scale: 750m for residential/other sensitive receptors, 480m for non-residential. – Medium scale: 600m for residential/other sensitive receptors, 400m for non-residential. – Small scale: 300m for residential/other sensitive receptors, 180m for non-residential.		■ Multiple turbine developments in all cases (assumed three turbines in a line generating noise); and ■ The assumption that no properties will be 'financially involved' in the wind development or are located in an existing nosier area (financial involvement and existing elevated baseline noise levels may allow higher noise levels to be accepted in individual cases, and were considered as part of the technical assessment above). Note: Within the Authority, where address points did not overlay OS OpenMap buildings data, points were buffered 5m to estimate building footprint. Where OS OpenMap buildings did not overlay address point data, these buildings were assumed to be of non-sensitive use[25]. Moreover, due to lack of sufficient data, buildings outside of the authority were assumed to be of non-sensitive use. This was to ensure that land was not unnecessarily ruled out as being constrained to wind development, as a result of non-sensitive buildings being mistakenly assessed as being sensitive. It is noted further site specific study would be required to determine the necessary buffer distance between specific buildings and proposed turbines.
Planning/Land Use Other	Exclude: ■ Registered Common Land; ■ Open Access Land; and ■ Local public green/open space, including: – Allotments; – Amenity green space;	■ Natural England ■ Herefordshire Council	Wind energy developments have a lesser land take than ground-mounted solar. However, the turbines and infrastructure such as access tracks may limit the usability of such recreational land uses and as such may wind developments may be less deliverable on them. The open spaces considered within this study were consistent with the open spaces assessed within the 2023 Herefordshire Natural Environment Evidence Update.

[23] Sensitive receptors include residential properties, schools, hospitals and care homes. These were identified via the LLPG data.
[24] Non-relevant addresses that have no applicable noise receptors were excluded, identified via the LLPG data, including: ancillary buildings, car parking, garages, non-buildings.
[25] Where OS buildings overlayed non-relevant addresses (see footnote 24) these were excluded from consideration.

Parameter	Secondary Constraints	Data Source	Justification and Notes
	– Cemeteries and churchyards; – Civic space; – Green chain or corridor; – Incidental greenspace; – Natural and semi natural green space; – Outdoor sports facility; – Provision for children and teenagers; and – Country Parks.		

Table A.6: Wind resource assessment secondary opportunities

Parameter	Secondary Opportunities	Data Source	Justification and Notes
Roads	Land that: ■ Is located within 500m of a main road (A Road) or motorway junction.	■ OS OpenRoads	Wind sites are likely to be more deliverable if located in closer proximity to existing road networks suitable for HGVs.
Brownfield Land	Land that: ■ Is located within brownfield land.	■ Herefordshire Council	Developments that re-use previously developed land are more likely to be considered more favourably when being considered for planning permission.
Electricity Grid	Land that: ■ Is located within 1km of a substation.	■ National Grid	Small scale (but not private wire) wind sites, such as community wind developments, are likely to be more deliverable and less costly to develop if located closer to existing electricity infrastructure. Further study of sites, landownership and costs would be required to determine the actual distance from a substation that could be viable to connect to. Further study would be required to make consideration of transmission lines operated by the local DNO Western Power Distribution.

Parameter	Secondary Opportunities	Data Source	Justification and Notes
Existing Industrial Sites	Land that: ■ Is located within 500m of industrial sites.	■ Herefordshire Council	Land in proximity to industrial sites may be more attractive to developers to deliver private wire connections to the industrial sites.
Existing Renewable Energy Developments	Land that: ■ Is located within 1km of an existing or consented renewable development.	■ Herefordshire Council ■ BEIS ■ Aerial imagery ■ LUC windfarm database	Co-locating developments may make developments more deliverable, such as through reduced construction costs, use of shared infrastructure, and increased continuity of supply to compensate for intermittencies in generation. In addition, the colocation of ground-mounted solar panels at wind developments can increase the generation efficiency of the site in comparison to the land take required.
Identified Areas of Potential for Solar Development	Land that: ■ Is located in areas identified as having "technical potential" for solar.	■ LUC	Co-locating developments may make developments more deliverable, such as through reduced construction costs, use of shared infrastructure, and increased continuity of supply to compensate for intermittencies in generation.
Wind Speed	Land that: ■ Is located within areas of higher wind speeds.	■ Global Wind Atlas	Locations with higher wind speeds are likely to have a greater generation potential and therefore are more likely to be financially viable and deliverable.

Ground-Mounted Solar Resource Secondary Constraints and Opportunities

Table A.7: Ground-mounted solar resource assessment secondary constraints

Parameter	Secondary Constraints	Data Source	Justification and Notes
National Landscapes (formerly Area of Outstanding Natural Beauty – AONB)	Land that is: ■ Located within or within 1km of a National Landscape.	■ Natural England ■ Natural Resources Wales	Planning permission may be more difficult to obtain for sites within or close to the designation. As of the 22nd November 2023, Areas of Outstanding National Beauty (AONB) are referred to as 'National Landscapes'. In legal terms they are still defined as AONBs.

Parameter	Secondary Constraints	Data Source	Justification and Notes
Geological Designations	Land located within 1km of: ■ Locally Important Geological Sites.	■ Herefordshire Council/University of Worcester	As protected by: ■ Town and Country Planning Act 1990 ■ Herefordshire Local Plan Core Strategy 2011-2031 Ground-mounted solar development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Biodiversity (International designations)	Land located within 1km of international designations[26]: ■ Special Areas of Conservation.	■ Natural England ■ Natural Resources Wales	As protected by: ■ Conservation of Habitats and Species Regulations 2017 (as amended) Ground-mounted solar development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Biodiversity (National designations)	Land located within 1km of national designations: ■ Sites of Special Scientific Interest; and ■ National Nature Reserves.	■ Natural England ■ Natural Resources Wales	As protected by: ■ Wildlife and Countryside Act 1981 ■ Conservation of Habitats and Species Regulations 2017 (as amended) Ground-mounted solar development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Biodiversity (Regional and local designations)	Land located within 1km of regional and local designations[27]: ■ Local Nature Reserves;	■ Natural England ■ Herefordshire Council	As protected by: ■ National Planning Policy Framework ■ Natural Environment and Rural Communities Act 2006

[26] There are no Special Protection Areas (SPA), potential SPAs, potential SACs, Ramsar site or proposed Ramsar sites within 1km of the county.
[27] There are no RSPB Reserves within the county.

Parameter	Secondary Constraints	Data Source	Justification and Notes
	■ Local Wildlife Sites; and ■ Wildlife Trust Reserves.		Ground-mounted solar development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations.
Cultural Heritage	Land that is within 1km of[28]: ■ Registered parks and gardens; ■ Scheduled monuments; ■ Listed buildings; ■ Conservation Areas; and ■ Locally Listed buildings. Land that is: ■ Located within or within 1km of a Registered Historic Landscape.	■ Historic England ■ Cadw ■ Welsh Government ■ Herefordshire Council	As protected by: ■ National Planning Policy Framework ■ Planning Policy Wales ■ The Convention Concerning the Protection of the World Cultural and Natural Heritage ■ National Heritage Act 1983 ■ Ancient Monuments and Archaeological Areas Act of 1979 ■ Planning (Listed Buildings and Conservation Areas) Act 1990 Ground-mounted solar development may be appropriate in close proximity to some designations, however planning permission may be more difficult to obtain for sites close to such designations. It is noted that further site specific study would be required to determine if any unexpected archaeological remains or undesignated but nationally significant features are present that would require consideration, as well as the setting of historic features.
Flood Zones	Land that is: ■ Located within Flood Zone 3.	■ Environment Agency	Ground-mounted solar development will not necessarily be infeasible within areas of greater flood risk, however the delivery of ground-mounted solar development in such locations may be more complex and costly.
Agricultural Land Use	Land that is:	■ Natural England	Agricultural Land Use is a consideration, with grades 1, 2 and 3a land being classed as "the best and more versatile (BMV)" land and having higher value for food

[28] There are no World Heritage Sites or Registered Battlefields within 1km of the county.

Parameter	Secondary Constraints	Data Source	Justification and Notes
	■ Located within agricultural land use classification grade 2.		production. Grade 1 land is considered as a primary constraint to solar development. Further investigation would be required of grade 3 land to determine whether it is grade 3a or 3b, as available data does not distinguish these, and grade 3a land would additionally need to be considered as part of a development siting.

Table A.8: Ground-mounted solar resource assessment secondary opportunities

Parameter	Secondary opportunities	Data Source	Justification and Notes
Electricity Grid	Land that: ■ Is located within 1km of a substation.	■ National Grid	Ground-mounted solar sites are likely to be more deliverable and less costly to develop if located closer to existing electricity infrastructure. Further study of sites, landownership and costs would be required to determine the actual distance from a substation that could be viable to connect to. Further study would be required to make consideration of transmission lines operated by the local DNO Western Power Distribution.
Brownfield Land	Land that: ■ Is located within brownfield land.	■ Herefordshire Council	Developments that re-use previously developed land are more likely to be considered more favourably when being considered for planning permission.
Existing Industrial Sites	Land that: ■ Is located within 500m of industrial sites.	■ Herefordshire Council	Land in proximity to industrial sites may be more attractive to developers to deliver private wire connections to the industrial sites.
Existing Renewable Energy Developments	Land that: ■ Is located within 1km of an existing or consented renewable development.	■ Herefordshire Council ■ BEIS ■ Aerial imagery ■ LUC windfarm database	Co-locating developments may make developments more deliverable, such as through reduced construction costs, use of shared infrastructure, and increased continuity of supply to compensate for intermittencies in generation. In addition, the colocation of ground-mounted solar panels at wind developments can increase the generation efficiency of the site in comparison to the land take required.

Parameter	Secondary opportunities	Data Source	Justification and Notes
Identified Areas of Potential for Wind Development	Land that: ■ Is located in areas identified as having "technical potential" for wind.	■ LUC	Co-locating developments may make developments more deliverable, such as through reduced construction costs, use of shared infrastructure, and increased continuity of supply to compensate for intermittencies in generation. In addition, the colocation of ground-mounted solar panels at wind developments can increase the generation efficiency of the site in comparison to the land take required.
Solar Irradiance	Land that: ■ Is located within areas of higher solar irradiance values.	■ Global Solar Atlas	Using modern solar panel technology, the vast majority of land within England is deemed suitable for solar panel development in terms of solar irradiance. However, locations with higher solar irradiance are likely to have a greater generation potential and therefore are likely to be more financially viable and deliverable.

Appendix B

Wind Maps

Figure B.1

Figure B.2

Figure B.3

Figure B.4

Figure B.5

Figure B.6

Figure B.7

Figure B.8

Appendix C

Ground-Mounted Solar PV Maps

Figure C.1

Figure C.2

Figure C.3

Figure C.4

Figure C.5

Appendix D

Secondary Constraints and Opportunities

Figure D.1

Figure D.2

Figure D.3

Figure D.4

Figure D.5

Figure D.6

Figure D.7

Figure D.8

Figure D.9

Appendix E

Data List

E.1 The following data sources were used within this study. Refer to Chapter 2 and Appendix A for details on how each of these data sources were used:

- Additional data used by Geospatial Insight for the assessment of rooftop solar PV potential, including: BEIS Greenhouse gas reporting: conversion factors 2022 CO_2 factors, LiDAR data, NimbleFins imported electricity costs, Renewable Energy Hub exported electricity rates, Ordnance Survey building polygons and LiDAR.
- BEIS (2023) Quarterly and annual load factors.
- BEIS renewable energy planning database.
- Cadw Listed Buildings, Registered Historic Landscape, Registered Parks and Gardens, Scheduled Monuments.
- Environment Agency Flood Zones, LiDAR DTM.
- Esri Aerial imagery.
- Forestry Commission National Forestry Inventory.
- Geospatial Insight estimated substation catchments.
- Global Solar Atlas solar irradiance.
- Global Wind Atlas/Vortex wind speeds.
- Herefordshire Biodiversity Record Centre Local Wildlife Sites.
- Herefordshire Council/University of Worcester Locally Important Geological Sites.
- Herefordshire Council brownfield land, Conservation Areas, industrial sites, Listed Buildings, minerals sites, open space, site allocations.
- Herefordshire Wildlife Trust Wildlife Trust Reserves.

- Historic England Conservation Areas, Listed Buildings, Registered Parks and Gardens, Scheduled Monuments.
- LUC industry experience.
- National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022).
- National Grid electricity lines, gas lines, substations.
- Natural England Agricultural Land Classification, Areas of Outstanding Natural Beauty, Ancient Woodland, Country Parks, Local Nature Reserves, National Nature Reserves, Open Access Land, Priority Habitat Inventory, registered common Land, Sites of Special Scientific Interest, Special Areas of Conservation.
- Natural Resources Wales Areas of Outstanding Natural Beauty, National Nature Reserves, Special Areas of Conservation, Sites of Special Scientific Interest.
- Ordnance Survey OpenMap airports and airfields, buildings, electricity lines.
- Ordnance Survey OpenRoads.
- Ordnance Survey VectorMap District railways.
- Ordnance Survey VectorMap Local waterbodies and watercourses.
- OS Addressbase.
- Research into turbine manufacturers.
- Welsh Government Conservation Areas.

References

1 Department for Levelling Up, Housing and Communities (2023) National Planning Policy Framework, footnote 54

2 Herefordshire Council (2015) Herefordshire Local Plan Core Strategy 2011-2031

3 Department for Business, Energy and Industrial Strategy (2013, updated 2023) Energy Trends: UK Renewables – Renewable electricity capacity and generation (ET 6.1 – quarterly) (September 20233)

4 BEIS (2023) Renewable Energy Planning Database (REPD): July 2023

5 To mitigate impacts on the productivity of wind turbines located close to one another caused by wind turbulence, it is standard practice for developers to maintain an oval of separation between turbines that is equal to 5 times the turbine rotor diameter (the cross sectional dimension of the circle swept by the rotating blades) on the long axis, and 3 times the rotor diameter on the short axis.

6 BEIS (2023) Quarterly and annual load factors. The average of all the available load factors for the West Midlands was used.

7 National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022)

8 Cleve Hill Solar Park (2020) Cleve Hill Solar Park granted development consent – 28/05/2020

9 Department for Business, Energy and Industrial Strategy (2013, updated 2023) Energy Trends: UK Renewables – Renewable electricity capacity and generation (ET 6.1 – quarterly) (September 20233)

10 Department for Business, Energy and Industrial Strategy (2014, updated 2023) Solar photovoltaics deployment. Using June 2023 data within Table 2, considering all FiTs (standalone), RO (ground mounted) and CfDs (ground-mounted) within the UK.

11 BEIS (2023) Renewable Energy Planning Database (REPD): July 2023

12 Department for Energy Security and Net Zero (2023) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)

13 BEIS (2023) Quarterly and annual load factors. The average of all the available load factors for the West Midlands was used.

14 National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022)

15 As of the 22nd November 2023, Areas of Outstanding National Beauty (AONB) are referred to as 'National Landscapes'. In legal terms they are still defined as AONBs.

16 HM Government (2015) The Town and Country Planning (General Permitted Development) (England) Order 2015

17 BEIS (2020) Sub-regional Feed-in Tariffs statistics: March 2019

18 BEIS (2023) Renewable Energy Planning Database (REPD): July 2023

19 NimbleFins (2023) Average Cost of Electricity per kWh in the UK 2023

20 The Renewable Energy Hub UK (2023) The Smart Export Guarantee in 2022

21 BEIS (2022) Greenhouse gas reporting: conversion factors 2022

22 Listed building point data was buffered 5m to estimate building footprints where they did not intersect or have the same name as Herefordshire locally listed building polygon data. In addition, listed building line data was buffered 0.5m to approximate the size of designated wall features. Where these or Herefordshire locally listed building polygon data intersected Geospatial Insight's rooftop data it was assumed that these roofs were situated upon listed buildings.

23 It is assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.183kgCO_2e/kWh (National Grid (2023) Future Energy Scenarios: FES

2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022))

24 It is assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.183kgCO_2e/kWh (National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022))

25 It is assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.183kgCO_2e/kWh (National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022))

26 It is assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.183kgCO_2e/kWh (National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022))

27 It is assumed that the electricity generated from the identified wind potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.183kgCO_2e/kWh (National Grid (2023) Future Energy Scenarios: FES 2023 Data workbook – Key Stats; Annual average carbon intensity of electricity (five year forecast from 2022))

28 The Geospatial Insight rooftop solar assessment assumes that the electricity generated from the identified solar potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.193kgCO_2e/kWh (BEIS (2022) Greenhouse gas reporting: conversion factors 2022).

29 The Geospatial Insight rooftop solar assessment assumes that the electricity generated from the identified solar potential would result in

negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.193kgCO_2e/kWh (BEIS (2022) Greenhouse gas reporting: conversion factors 2022).

30 The Geospatial Insight rooftop solar assessment assumes that the electricity generated from the identified solar potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.193kgCO_2e/kWh (BEIS (2022) Greenhouse gas reporting: conversion factors 2022).

31 The Geospatial Insight rooftop solar assessment assumes that the electricity generated from the identified solar potential would result in negligible carbon emissions and would replace that currently provided by the national grid, which has an emission factor of 0.193kgCO_2e/kWh (BEIS (2022) Greenhouse gas reporting: conversion factors 2022).

32 Department for Levelling Up, Housing and Communities (2023) National Planning Policy Framework, footnote 54

33 Herefordshire Council (2015) Herefordshire Local Plan Core Strategy 2011-2031

34 Herefordshire Council (2023) Local Plan 2021-2041

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