# 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.

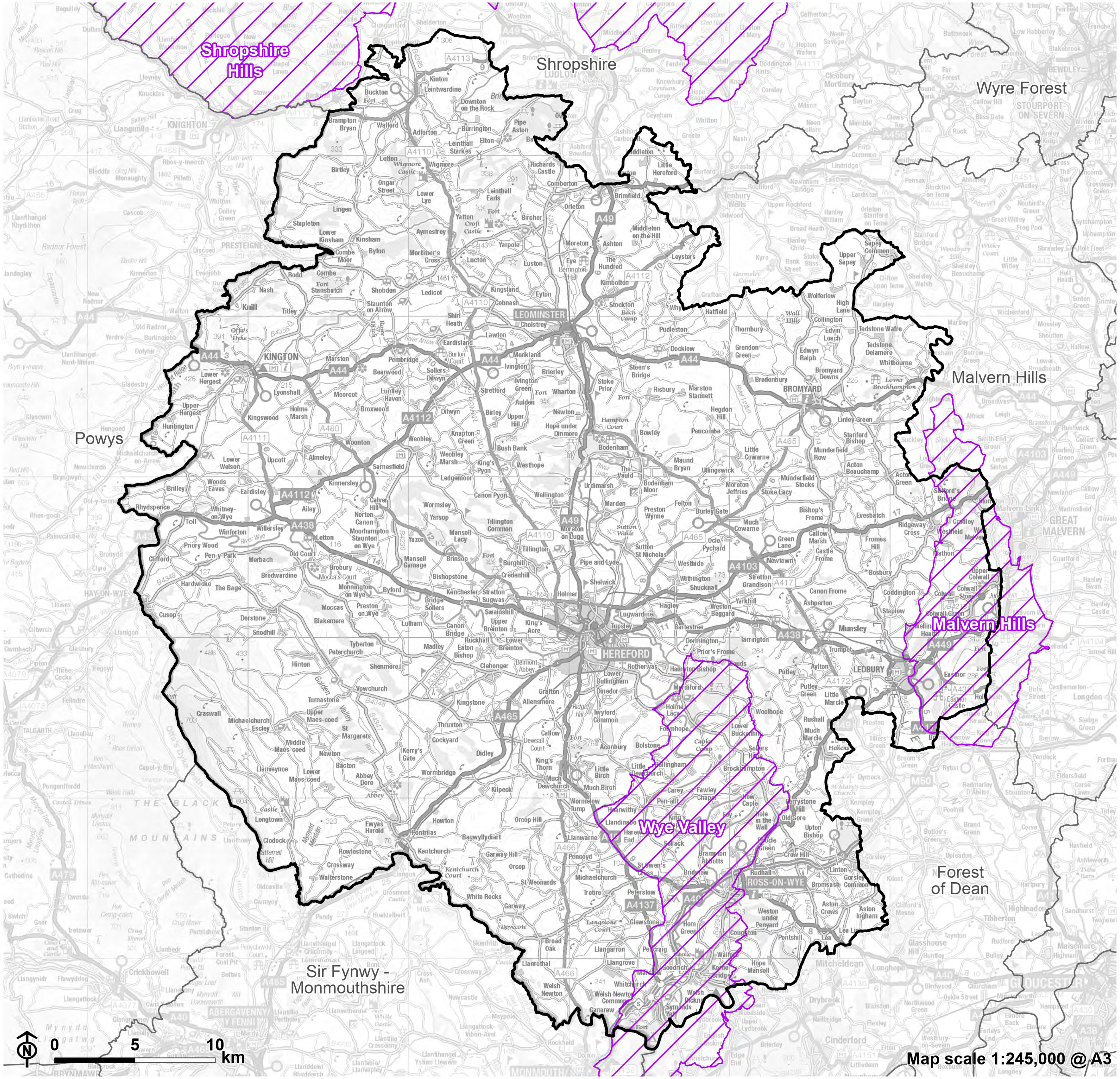
**1.5** The remainder of this report is structured as follows:

- 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.

Renewable Energy Assessment
Herefordshire Council

**Figure 1.1: Study area context**




- Local authority
- Neighbouring local authority
- National Landscape (formerly Area of Outstanding Natural Beauty)



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# 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 0.183kg$CO_2$e/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 0.183kg$CO_2$e/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 7.5$m^2$ 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.

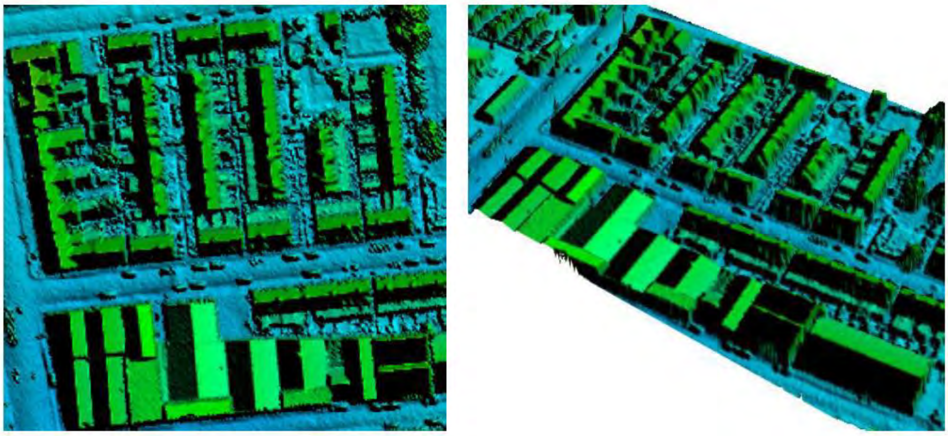
## Assumptions used to identify land with technical potential

**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).

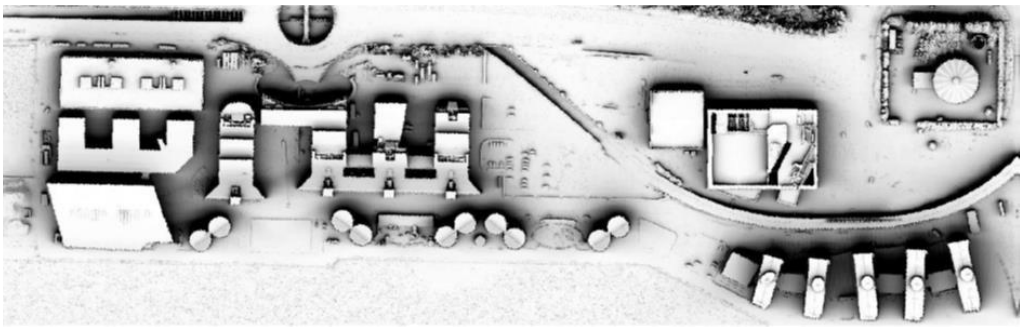
### Figure 2.1: Example of DSM



**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 $CO_2$e 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**

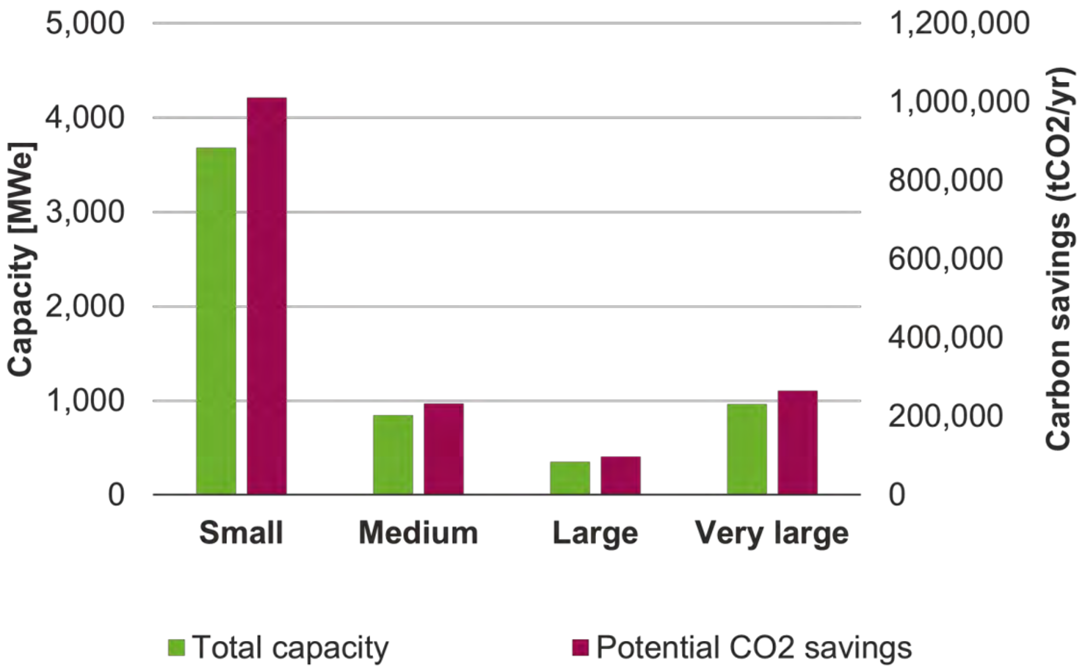


**Table 3.1: Onshore wind potential capacity, output, carbon savings [See reference 24] and coverage within Herefordshire**

| 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%** |

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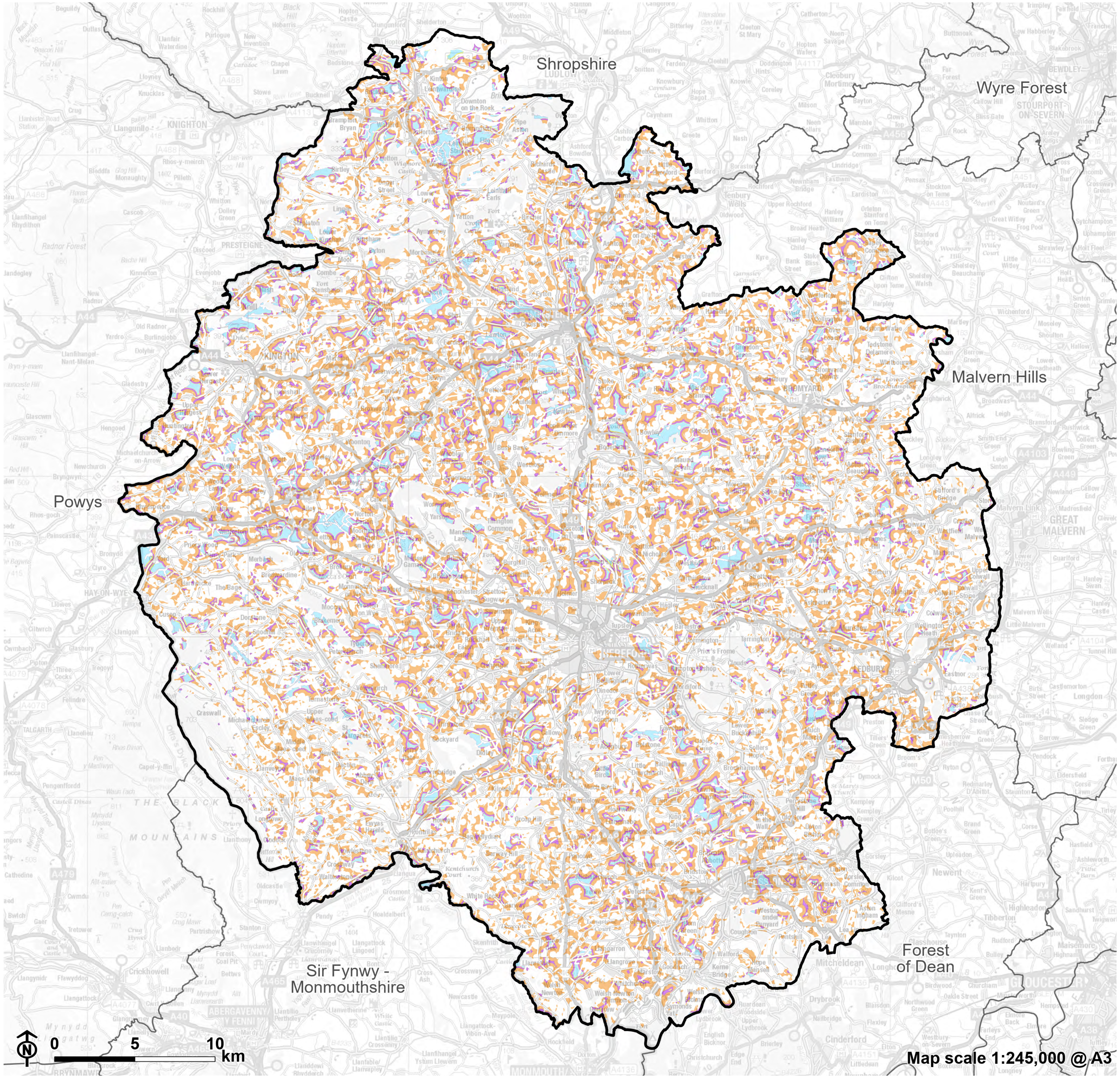
**Figure 3.2: Opportunities for wind development**




Local authority
Neighbouring local authority
Suitable area for all turbine scales
Suitable area for small to large turbines only
Suitable area for small to medium turbines only
Suitable area for small turbines only
No technical potential

**Notes**:
Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.



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**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**

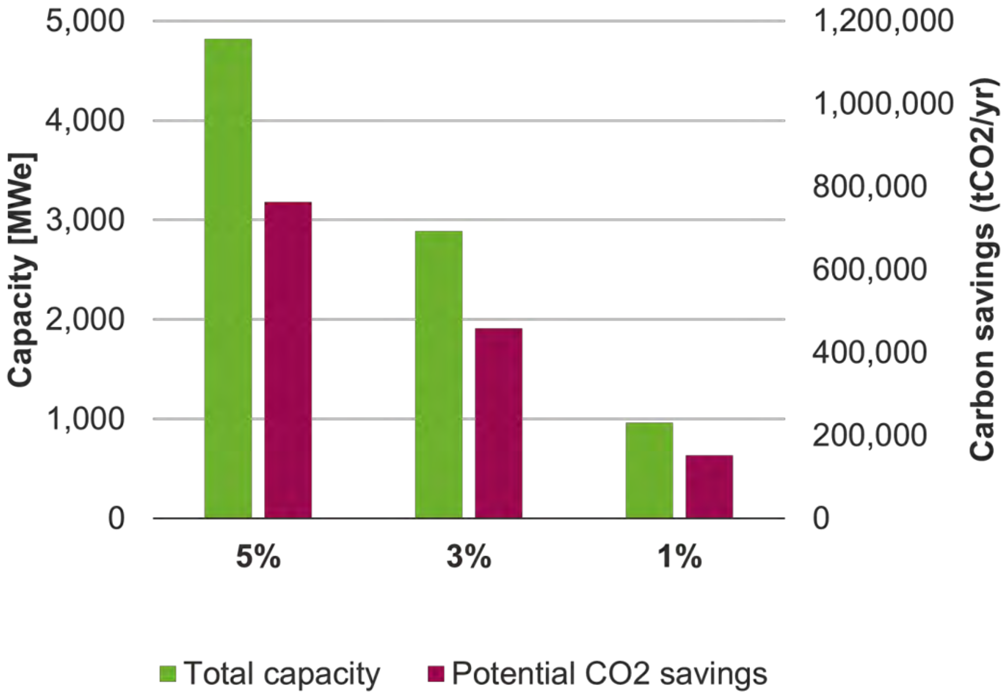

**Table 3.2: Potential ground mounted solar capacity, output, carbon savings [See reference 26] and coverage within Herefordshire**

| 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% |

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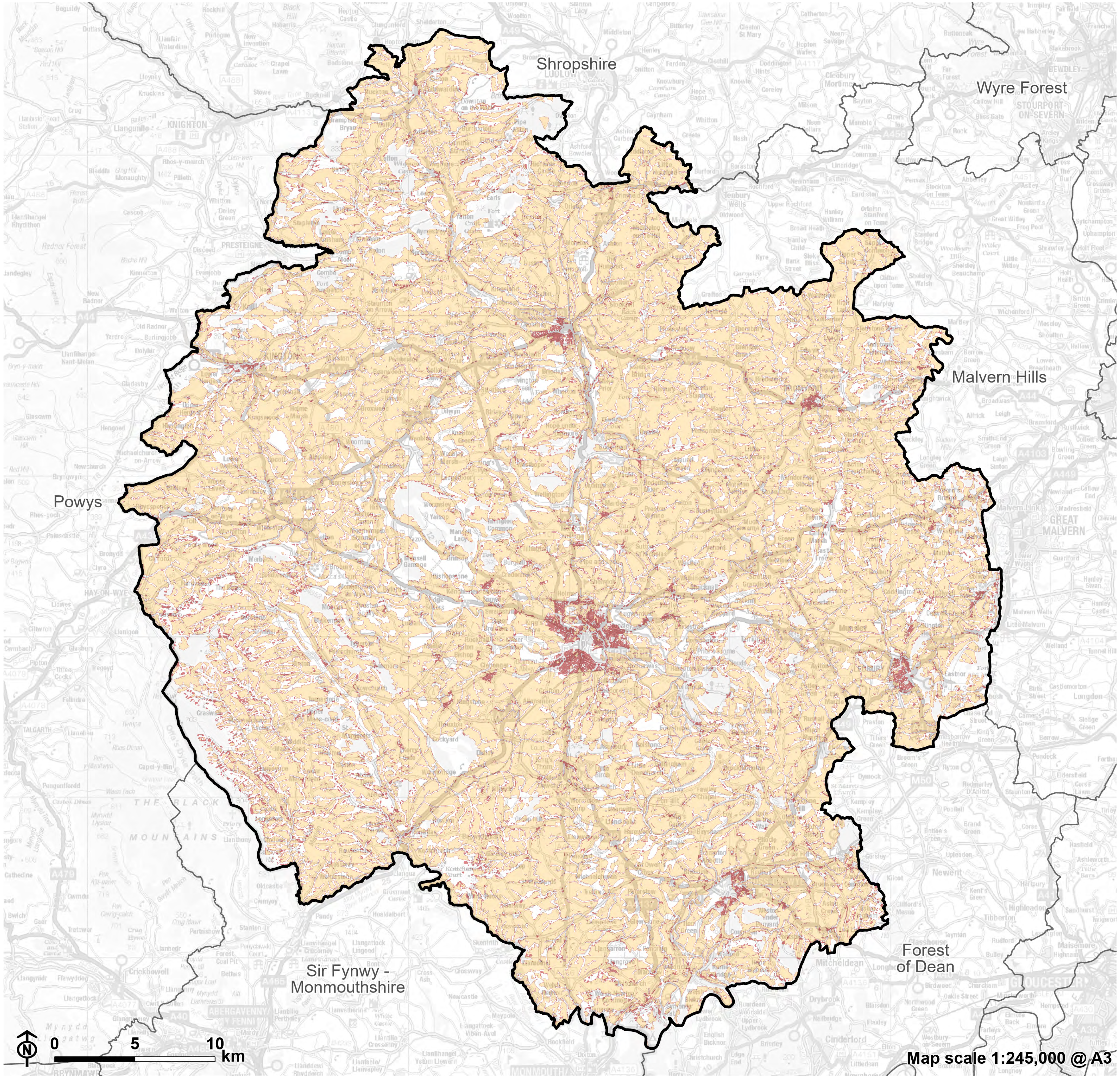
**Figure 3.4: Opportunities for ground mounted solar development**




- Local authority
- Neighbouring local authority
- Area with potential for ground mounted solar development above 0.6ha
- Area with potential for ground mounted solar development under 0.6ha
- No technical potential

**Notes**:
Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.

**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

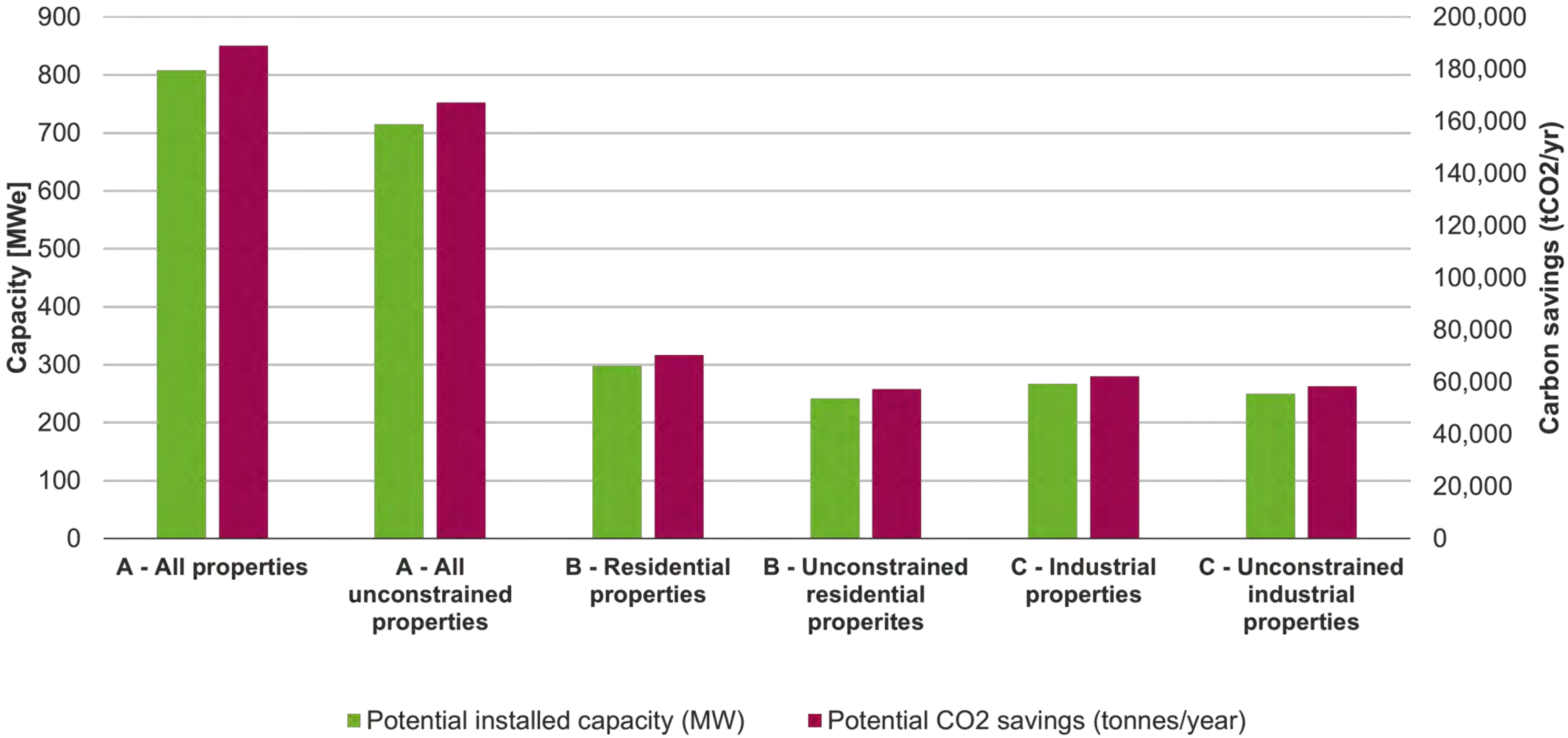
- Industrial site, Robinsons Business Park – Potential for 1.5MWp capacity

**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 |

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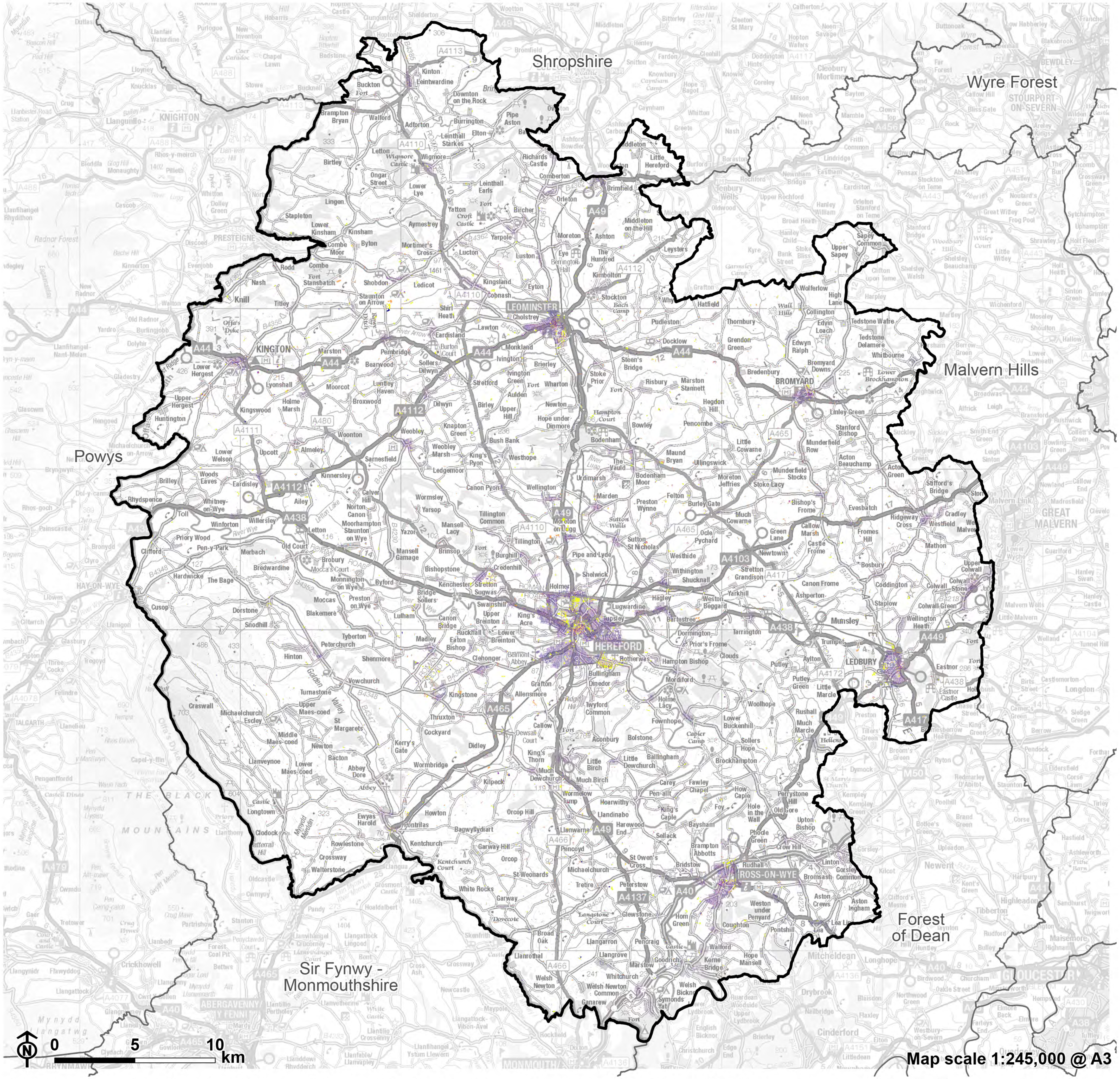
**Figure 3.6: Technical potential for rooftop solar**




Local authority
Neighbouring local authority

**Potential annual yield (kWh)**

- 0 - 3,000
- 3,001 - 10,000
- 10,001 - 20,000
- 20,001 - 100,000
- > 100,001

**Notes:**

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Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.



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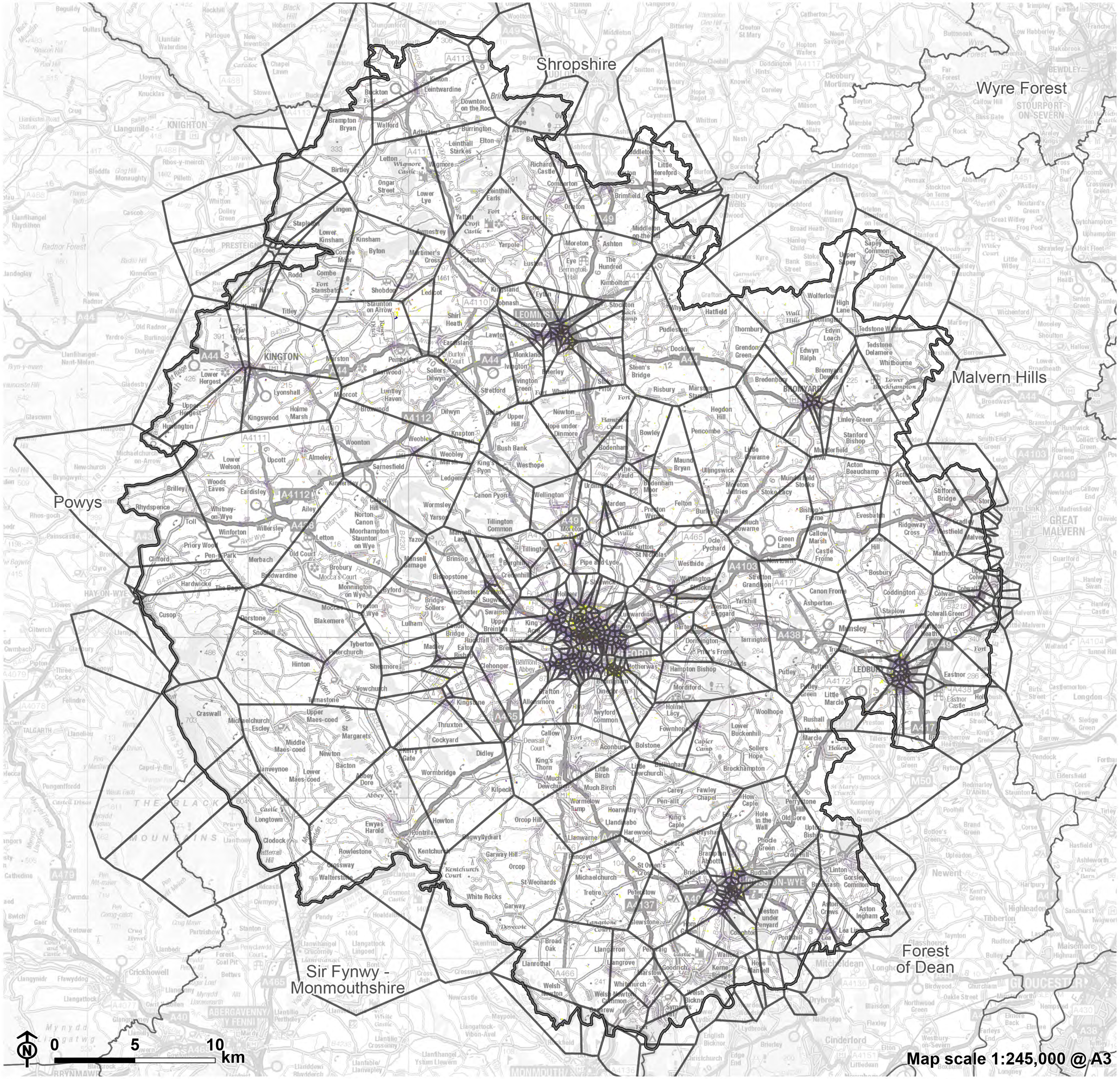
## Figure 3.7: Technical potential for rooftop solar and estimated substation catchments




- Local authority
- Neighbouring local authority
- Estimated substation catchments

**Potential annual yield (kWh)**

- 0 - 3,000
- 3,001 - 10,000
- 10,001 - 20,000
- 20,001 - 100,000
- > 100,001

**Notes:**

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Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.



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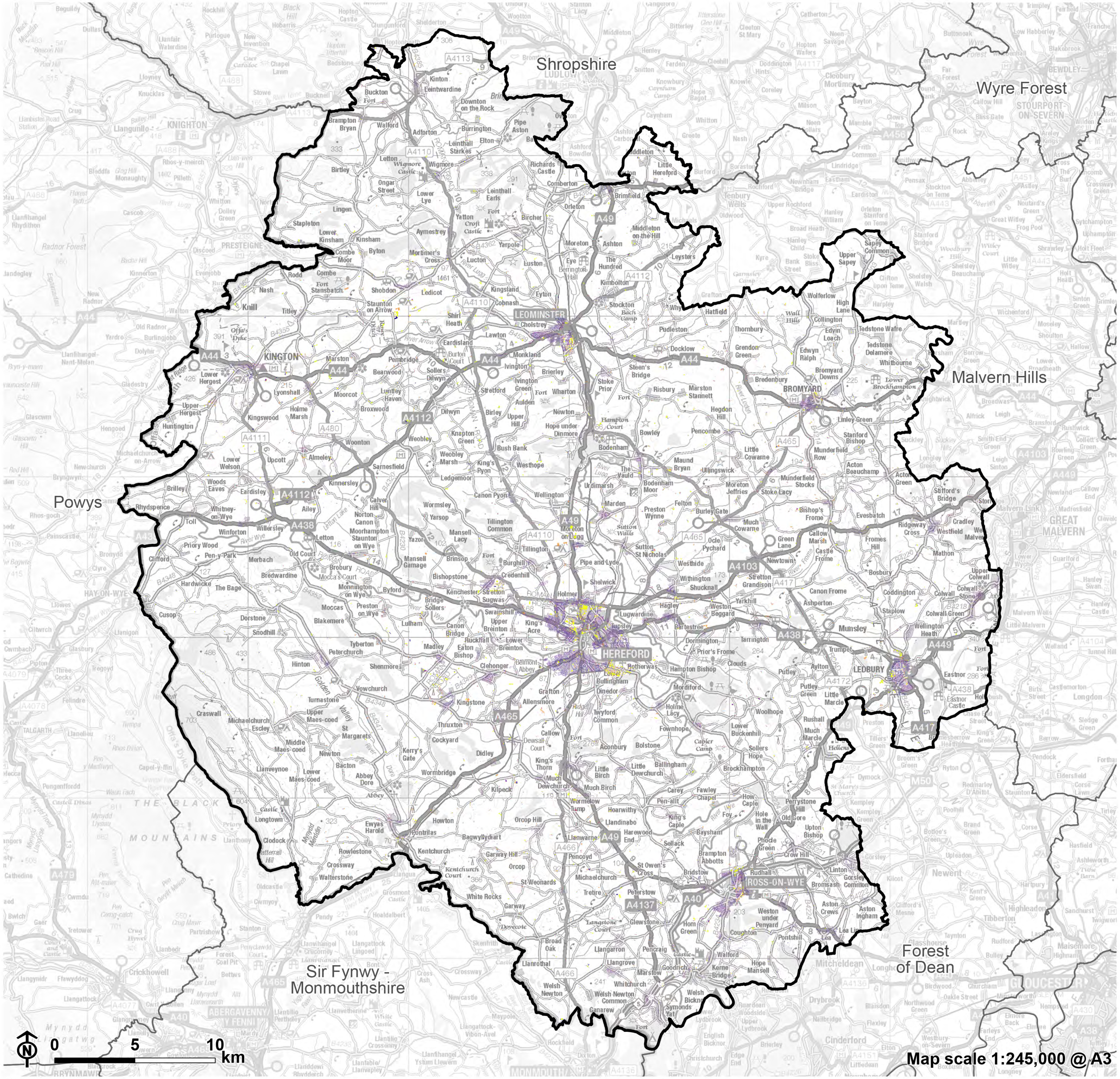
**Figure 3.8: Technical potential for rooftop solar - excluding secondary heritage constraints**




Local authority
Neighbouring local authority
**Potential annual yield (kWh)**
0 - 3,000
3,001 - 10,000
10,001 - 20,000
20,001 - 100,000
> 100,001

**Notes:**
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Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.



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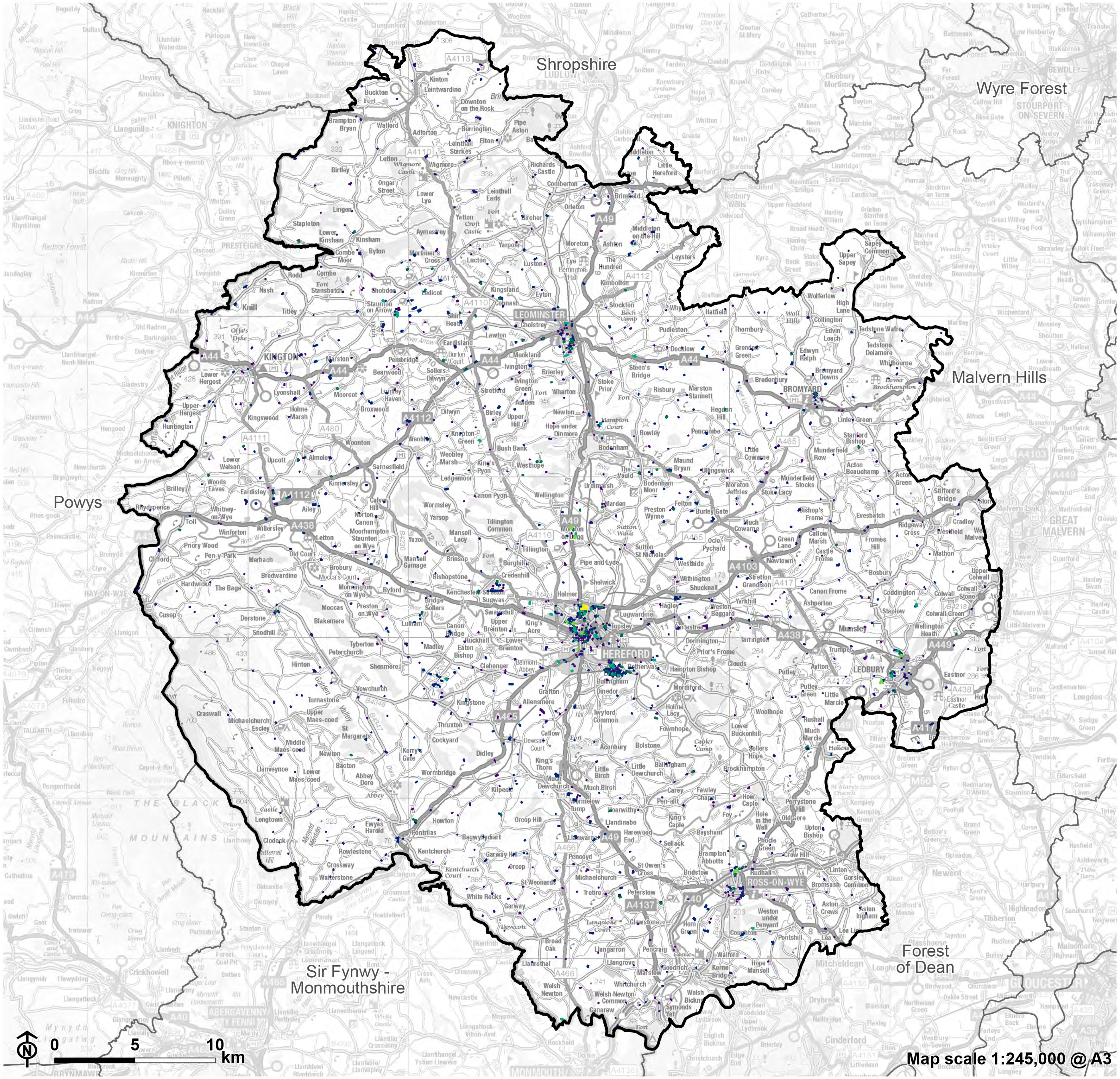
**Figure 3.9: Technical potential for rooftop solar - Large industrial opportunities (above 50kWp capacity)**




Local authority
Neighbouring local authority

**Potential annual yield (kWh)**

- < 100,000
- 100,000.01 - 300,000.00
- 300,000.01 - 600,000.00
- 600,000.01 - 1,200,000.00
- 1,200,000.01 - 2,800,000.00
- > 2,800,000

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Please refer to this map in conjunction with the assessment assumptions detailed in Appendix A.



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# 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.