CARBON TRUST

Renewable Energy Assessment

For Bridgend County Borough Council

January 2020

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Executive summary

Planning Policy Wales edition 10 (PPW 10) sets out the requirements for clean growth and the decarbonisation of energy, which relates to wider legal obligations, needs and policies at an international, UK, Wales, and local level.

In addition to wider national targets to achieve net zero carbon emissions by 2050, Welsh Government has introduced the following targets specifically related to local energy generation and ownership, to be achieved by 2030:

- 70% of Wales' electricity consumption to be generated from renewable sources,
- 1 GW of locally owned renewable electricity capacity in Wales,
- Renewable energy projects in Wales to include an element of local ownership.

To achieve the targets above, local authority planning departments will need to work with renewable energy developers and ensure that renewable energy generation within their authorities is maximised.

PPW 10 acknowledges, *"…the planning system plays a key role in delivering clean growth and the decarbonisation of energy"* (Welsh Government, 2018, p. 87). In order to ensure that this role is fulfilled, PPW 10 places a requirement on planning authorities to develop an evidence base to inform the development of renewable energy and low carbon energy policies. The Welsh Government's *Practice Guidance: Planning for Renewable and Low Carbon Energy – A Toolkit for Planners, September 2015,* "the Toolkit" (Welsh Government, 2015) is identified within PPW 10 as it provides a methodology for developing an evidence base to inform spatially based renewable energy policies for inclusion within Local Development Plans (LDP). Whilst providing a clear methodology for evidence base creation, PPW 10 acknowledges that the *"…approach should be adapted to local circumstances to enable renewable energy opportunities to be maximised…"* (Welsh Government, 2018, p. 92).

The Toolkit has been used to inform and guide this renewable energy assessment, but where appropriate, the methods have been updated to account for the local and temporal context of the Bridgend Local Development Plan 2018-2033.

Within this assessment, the current and future energy demands of the county borough, and progress in meeting these demands from local low carbon energy generation assets, have been estimated. Against this backdrop, a resource assessment has been undertaken of land within the county borough boundary to identify the potential for renewable and low carbon energy project deployment from a resource perspective.

The following technologies have been considered:

- Wind energy
- Ground mounted solar PV
- Biomass energy
- Energy from waste
- Hydropower energy
- Buildings integrated solar PV

Previous work undertaken with Bridgend County Borough Council (BCBC) under the Smart Systems and Heat programme (ETI, 2018b, ESC, 2018b) relating to the potential for low carbon heating within the county borough was drawn on to inform the low carbon heating potential and opportunities within the county borough.

The potential resource available has been compared with projected future energy demands and it is considered unlikely that all of BCB's future energy needs will be able to be generated from within the county borough from renewable and low carbon sources, due to the impracticalities of deploying the level of ground mounted solar PV potential identified within the assessment.

Additional energy generated in other parts of the country and offshore will also be relied upon. With this in mind, BCBC should consider setting ambitious renewable energy deployment targets to maximise the use of the local resources available within the county borough. The county borough has high wind resource and solar resource, with much of the county borough designated for priority large-scale wind and solar developments in Welsh Government's (2019a) Draft National Development Framework.

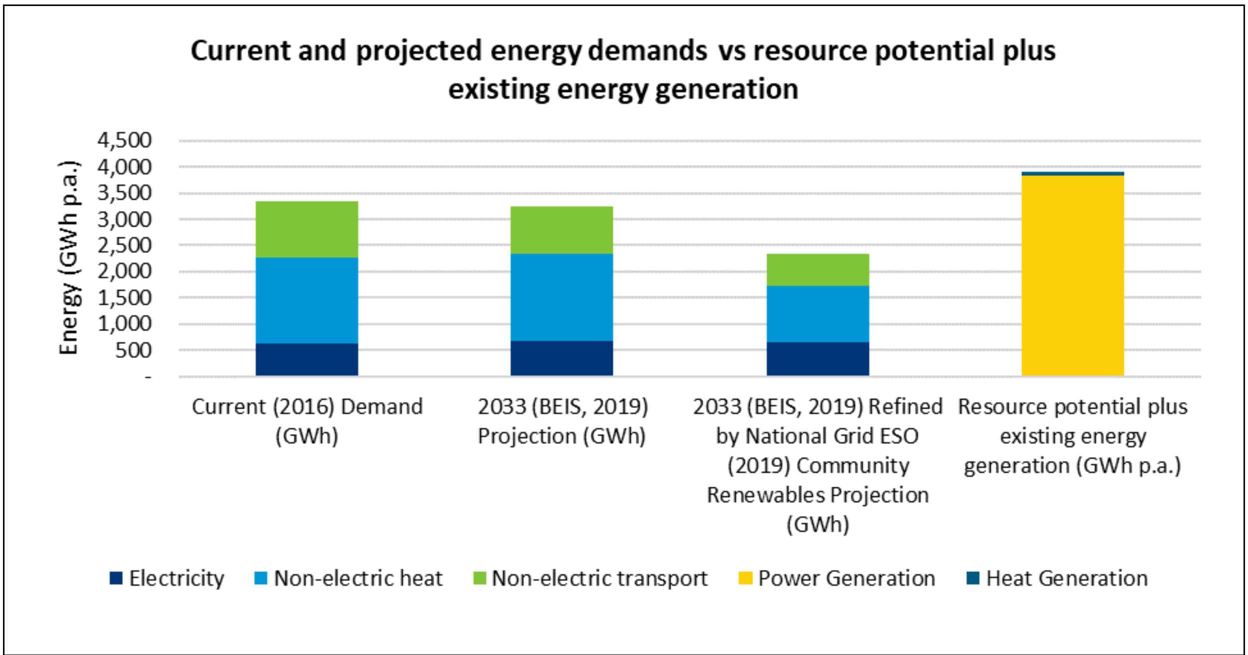


Figure 1: Summary of current and projected energy demand vs energy generation potential identified in BCB

Specific strategic development sites that may be integrated into the LDP have been considered with regard to meeting their potential energy demand from renewable sources. In order to reduce future energy demand, strict policies that look to maximise the energy efficiency of new development should be introduced as well as integrating energy generation into wider development proposals, and ensuring that low carbon heating systems are installed.

Following development of the evidence bases, a period of stakeholder engagement was undertaken to help inform policy recommendations for BCBC to consider when drafting the Local Development Plan.

Policy recommendations include:

> **Targets:** Adopt a local renewable power deployment target of 340 MW_e and 418 GWh_e p.a. (with 81 MW_e and 191 GWh_e p.a. anticipated to be met by wind energy and the remainder to be met by a mixture of ground mounted and roof mounted solar developments) and a heat target of 30% of the county borough's domestic properties to be fitted with low carbon heating systems by 2030.

> **Repowering:** Adopt positive policies regarding the repowering of existing renewable generation assets when they reach the end of their current planning consents.

> **Local Search Areas:** Prioritise the least sensitive landscape character areas for wind and solar developments (LCA1: Llangynwyd Rolling Uplands & Forestry/LCA8: Ogmore Forest and

Surrounding Uplands, and LCA 12: Newton Down Limestone Plateau respectively) as Local Search Areas where developments would be favoured,
- **Energy Efficiency:** Require higher building fabric efficiencies than current building regulations and ensure these are met by requiring robust monitoring following construction.
- **Integration of Renewable Energy Generation:** Require integration of renewable energy generation technology (in particular solar PV and solar thermal) into new building development.
- **Low Carbon Heating:** Prevent new developments from connecting to the gas network and instead require a hierarchy of low carbon heating solutions to be considered.
- **Sustainable Travel:** Ensure new developments include infrastructure designed to encourage walking, cycling, public transport use and electric vehicles.

BCBC has been at the forefront of energy systems innovation, through their involvement in the Smart Systems and Heat programme, the FREEDOM project and their own innovative energy projects.

In addition to the planning policy recommendations provided above, BCBC can continue to lead the decarbonisation agenda by:

- Continuing to pursue their own innovation projects and enabling others to deliver innovation projects within the county borough, through delivery of the BCBC Smart Energy Plan (ESC, 2018b),
- Considering supportive policies for new additional energy system infrastructure including electric vehicle charging infrastructure and battery storage,
- Sharing learning from decarbonisation projects with others (private and public sector),
- Supporting energy systems that are developed for the benefit of the community,
- Requiring green infrastructure and biodiversity enhancements to be included in all new developments,
- Developing and investing in additional renewable energy generation and energy efficiency projects on BCBC's (or other stakeholders') own estate, and
- Ensuring that climate change impact and sustainable development is considered throughout all BCBC's procurement and operational activities

Undertaking these action points will assist BCBC in achieving their aim of making *"…Bridgend a decarbonised, digitally connected smart County Borough"* (ESC, 2018b, p.7).

Abbreviations

AD	Anaerobic Digestion
ASHP	Air Source Heat Pump
BCB	Bridgend County Borough
BCBC	Bridgend County Borough Council
BEIS	Department for Business, Energy and Industrial Strategy
CCUS	Carbon Capture Use and Storage
CHP	Combined Heat and Power
COP	Coefficient of Performance
DEFRA	Department for Environment, Food and Rural Affairs
DNS	Development of National Significance
EOP	Energy Opportunities Plan
ESC	Energy Systems Catapult
ETI	Energy Technologies Institute
EV	Electric Vehicle
GSHP	Ground Source Heat Pump
HP	Heat Pump
LCA	Landscape Character Area
LDP	Local Development Plan
MBT	Mechanical Biological Treatment
MTCBC	Merthyr Tydfil County Borough Council
NDF	National Development Framework
NFI	National Forestry Inventory
NRW	Natural Resources Wales
PPW 10	Planning Policy Wales Edition 10
RTPI	Royal Town Planning Institute
SCCC	Swansea City and County Council
SPG	Supplementary Planning Guidance
STA	Solar Trade Association
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

1.1 Policy context

Planning Policy Wales edition 10 (PPW 10) sets out the requirements for clean growth and the decarbonisation of energy, which relates to wider legal obligations, needs and policies at an international, UK, Wales, and local level.

The UK was the first country to set legally binding carbon targets (an 80% reduction in carbon emissions by 2050 against a 1990 baseline) through the *Climate Change Act (2008)*. These targets were later reflected in the *Environment (Wales) Act (2016).* Understanding of the urgency and importance of tackling climate change has grown since the Climate Change Act was enacted. In 2015, parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to accelerate and intensify efforts to tackle climate change, aiming to keep global temperature rise below 2^{o}C (UNFCCC, 2019). In 2019, following a wave of climate activism and recommendations from the Climate Change Committee (Climate Change Committee, 2019) that the UK should increase their carbon targets to net-zero by 2050, the Welsh Government and the UK Government declared a climate emergency and committed to setting new net zero carbon targets for 2050.

Under the *Environment (Wales) Act (2016)*, Wales is required to reduce net greenhouse gas emissions by at least 80% by 2050 (against a baseline set in legislation) with interim targets and carbon budgets established to ensure this target is met. In March 2019, Welsh Government published a plan, *Prosperity for All: A Low Carbon Wales*, which sets out how the first carbon budget (2016-2020) will be met. This plan pulls together 76 existing pieces of policy from across Welsh Government, UK Government, and the EU and sets out 100 policies and proposals to accelerate the transition to a low carbon economy. Within this plan, local authorities are identified as having a significant role to play and previous work that Bridgend County Borough Council (BCBC) and the Energy Systems Catapult (ESC) have undertaken is highlighted (Welsh Government, 2019b).

In addition to requirements set out in the *Environment (Wales) Act (2016)*, Welsh Government has introduced the following targets specifically related to local energy generation and ownership, to be achieved by 2030:

- 70% of Wales' electricity consumption to be generated from renewable sources
- 1 GW of locally owned renewable electricity capacity in Wales
- Renewable energy projects in Wales to include an element of local ownership.

To achieve the targets above, local authority planning departments will need to work with renewable energy developers and ensure that renewable energy generation within their authorities is maximised.

The low carbon transition has been identified in the *UK Clean Growth Strategy* (HM Government, 2017) and *Prosperity for All: A Low Carbon Wales (2019)* as a means of growing the economy and improving the social well-being of UK and Welsh inhabitants (Welsh Government, 2019b). Within Wales the role that renewable energy plays within the wider concept of sustainable development has long been acknowledged, with *One Wales; One Planet (2009)* setting out the Welsh Government's ambitions for a sustainable economy, and a strong, healthy and just society that only uses its fair share of the world's resources (Welsh Government, 2009). The *Well Being of Future Generations (Wales) Act (2015)* places an obligation on all public bodies in Wales to consider the long-term impact of the decisions made, with respect to all elements of sustainable development to ensure that the well-being of future generations is safeguarded. At a local level, BCBC has set out a vision in the Bridgend County Borough Council Smart Energy Plan "*…to make Bridgend a decarbonised, digitally connected smart County Borough"* (ESC, 2018b, p.3). In achieving this vision, it aims to *"…transition to a low carbon, decentralised energy system that works for its individuals, communities and businesses"* (ESC, 2018b, p. 3).

1.2 Renewable Energy Assessment purpose and content

PPW 10 acknowledges, *"…the planning system plays a key role in delivering clean growth and the decarbonisation of energy"* (Welsh Government, 2018, p. 87). In order to ensure that this role is fulfilled, PPW 10 places a requirement on planning authorities to develop an evidence base to inform the development of renewable energy and low carbon energy policies. The Welsh Government's *Practice Guidance: Planning for Renewable and Low Carbon Energy – A Toolkit for Planners, September 2015,* "the Toolkit" (Welsh Government, 2015) is identified within PPW 10 as it provides a methodology for developing an evidence base to inform spatially based renewable energy policies for inclusion within Local Development Plans. Whilst providing a clear methodology for evidence base creation, PPW 10 acknowledges that the *"…approach should be adapted to local circumstances to enable renewable energy opportunities to be maximised…"* (Welsh Government, 2018, p. 92).

The Toolkit provides specific steps for the production of relevant and robust evidence bases for different generation technologies, upon which planning policy can be based (Welsh Government, 2015). The edition current at the time of writing this report (Welsh Government, 2015) uses an assessment of Pembrokeshire as an example for the Toolkit, with future forecasts and targets for 2020. The BCBC Local Development Plan (LDP) will cover the period from 2018-2033, as such some of the specific step-by-step methods provided within the Toolkit are not suitable for the current renewable energy evidence base, due to the differing timescales. To address this issue, the method employed within this assessment has been amended where necessary to ensure that the outputs are fit for purpose and the Toolkit's requirements are met.

From 2015-2019, BCBC were a partner in the Smart Systems and Heat programme, which was designed to address the market failure associated with decarbonising domestic heating and unlock its commercial opportunities, through innovation (ESC, 2018b). Bridgend County Borough's (BCB) energy systems were modelled at a local area scale using bespoke dynamic energy modelling software. This identified the most cost-effective routes to decarbonising domestic heating in BCB, for many possible future energy scenarios, and led to the development of:

> the Bridgend Local Area Energy Strategy (ETI, 2018b), for reducing carbon emissions from buildings by 95% by 2050 ("the Strategy"), and
> a Smart Energy Plan (ESC, 2018b), for delivery of the first phase of the Strategy, which looks to test innovations that may help to accelerate decarbonisation of heating through a pipeline of projects.

With respect to potential for future low carbon heating developments, the findings and data generated from the Smart Systems and Heat programme have been utilised rather than undertaking a separate modelling exercise following the guidance provided in the Toolkit.

This evidence base aims to estimate the scale of resource available within the county borough that is available for use, in order to provide some focus for local policy and targets. It does not identify individual sites or projects but provides an understanding of the likely suitability of the county borough for further development of different technologies. Whilst BCBC are interested in understanding the scale of resource within the county borough to help inform local policy, Welsh Government are generating similar evidence bases to help inform national policy. A consultation on the National Development Framework 2020-2040 was issued on 7th August 2019 (Welsh Government, 2019a) and whilst this is not enacted policy, the details of the consultation have been reviewed in the process of undertaking this assessment. The National Development Framework (NDF) is a new spatial development plan for addressing key national priorities (including decarbonisation) through the planning system (Welsh Government, 2019a). It is considered to be the highest tier of development plan to be built on at a regional level by Strategic Development Plans and at a local level by Local Development Plans (Welsh Government, 2019a). One of the 11 outcomes of the NDF is to develop "*a Wales where people live […] in places which are decarbonised.*" (Welsh Government, 2019a, p. 17). The draft NDF identifies priority areas for large-scale (over 10 MW) solar and wind energy developments and district heat networks, as shown in Figure 2. These areas are considered further in section 7, which considers priority areas for the development of ground mounted solar PV, wind and district heating.

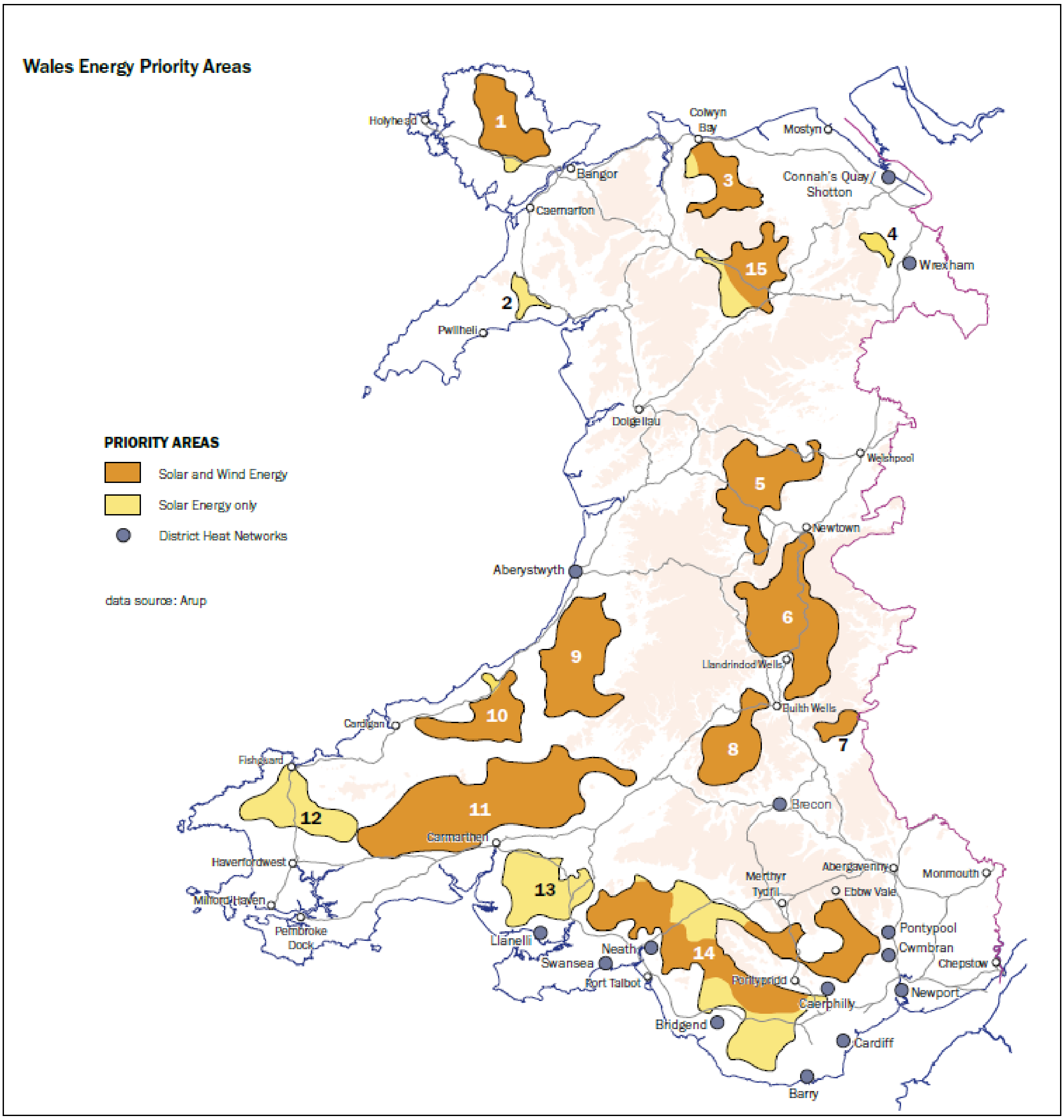


Figure 2: Wales priority energy areas

(Welsh Government, 2019a, p. 42)

Bridgend's Rural Development Plan team "Reach" commissioned a report in 2017 that looked to identify opportunities for community renewable energy schemes in rural areas of Bridgend (Juno Energy and Gower Power, 2017). Unlike this evidence base, the study undertaken for Reach looked to identify specific community-scale projects that were likely to be economically viable for community energy groups to develop (Juno Energy and Gower Power, 2017). The study identified a total capacity of 20 MW of potential generation capacity from 55 sites, identified for solar PV, hydro, biomass or heat pump deployment (Juno Energy and Gower Power, 2017). No wind sites were identified due to the wind speeds considered necessary for a community scale wind development in the assessment and no anaerobic digestion plants were identified (Juno Energy and Gower Power, 2017).

1.3 Overall method

1.3.1 Scope of the assessment

The current and future energy demands of the county borough, and progress in meeting these demands from local low carbon energy generation assets, have been estimated. Against this backdrop, a resource assessment has been undertaken of land within the county borough boundary to identify the potential for renewable and low carbon energy project deployment by 2033 if supportive policies are in place. The following technologies are considered:

- Wind energy
- Ground mounted solar PV
- Biomass energy
- Energy from waste
- Hydropower energy
- Building-integrated solar PV.

Previous work undertaken with BCBC relating to the potential for low carbon heating, including heat pumps and district heat networks, within the county borough is drawn on to inform the low carbon heating potential within the county borough. Specific strategic development sites that may be integrated into the LDP are considered with regard to meeting their potential energy demand from renewable sources.

1.3.2 Resource outside the scope of the assessment

In addition to the technologies outlined in section 1.3.1, there may be additional resource available, which could be exploited during the LDP period, including the following:

- Offshore wind developments
- Marine energy generation, including wave, tidal, ocean thermal energy conversion (OTEC) and salinity gradient technology
- Small-scale pumped hydro.

Whilst the potential uptake of building-integrated solar PV is considered in the assessment, the potential of other building-integrated technologies (e.g. solar thermal, micro-wind) is excluded, due to their site-specific nature, low-market share, historically low uptake and potential to compete for space with technologies considered within the assessment.

Offshore wind

The offshore wind industry has benefited from cost improvements in recent years, and has been included in recent Contracts for Difference auctions. Wales currently has 726 MW of installed offshore wind capacity concentrated in three projects in the Irish Sea (The Carbon Trust, 2018). The Carbon Trust (2018) undertook an assessment into the potential for further offshore wind developments in Welsh Waters for the Welsh Government, and found that:

"An additional 2 GW of offshore wind power could be delivered by just 2-3 projects in Wales, if site extensions and new site leases can be secured in Welsh waters and grid connected in Wales. Taking total offshore wind capacity to 2.8 GW […meeting…] nearly all (68%) of Wales' 70% renewable energy target by 2030." (The Carbon Trust, 2018, p.4)

The assessment found that the most attractive area for offshore wind development was in the Irish Sea off the coast of North Wales, *"…where large areas of seabed under 60m water depth could be exploited using fixed foundations".* (The Carbon Trust, 2018, p.5). With respect to waters near BCB, the report found that whilst areas within the Bristol Channel could support offshore wind farms, the area's complex geology and strong estuarine currents may impact economic viability and project competitiveness in this location (The Carbon Trust, 2018). Due to the cost competitive nature of developments, it is likely that other coastal areas of Wales, will be developed for offshore wind in advance of Bridgend County Borough's coastline.

Marine energy

With respect to marine energy, whilst the sector is experiencing a great deal of research and development the technologies are still in their infancy. Tidal range technologies are considered to be the most mature technology, with predictions that it will enter industrial roll-out in the early to mid-2020s, with other technologies entering this phase around 2030 (see Figure 3).

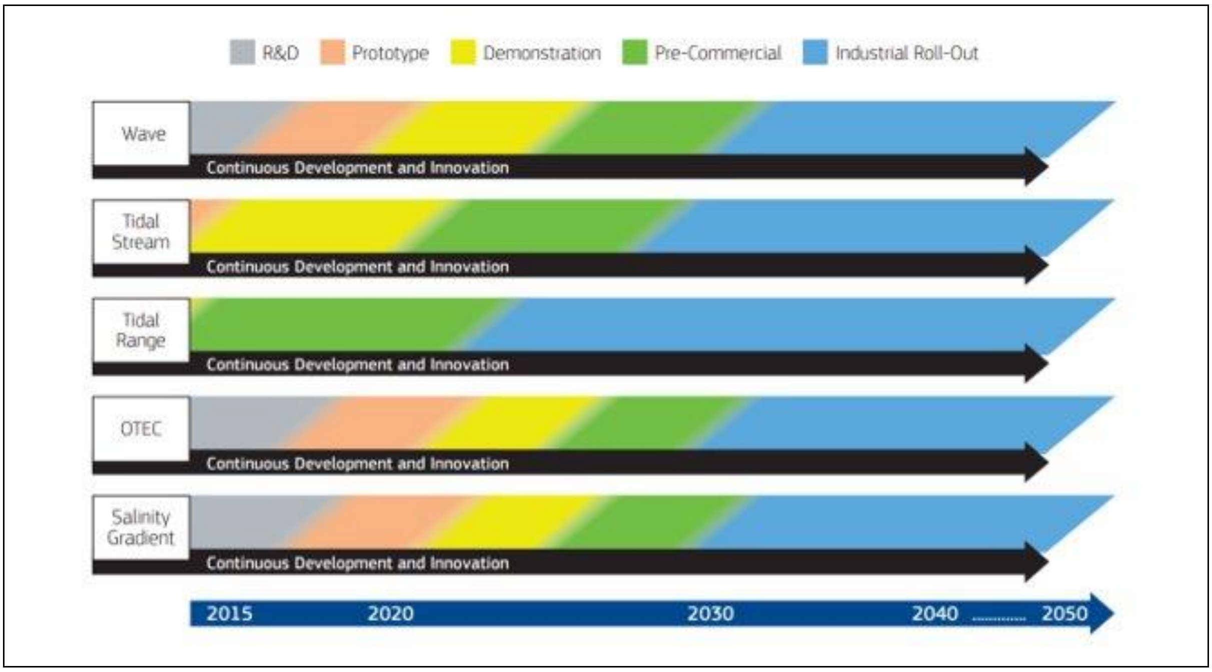


Figure 3: Development of marine energy technologies

(Ocean Energy Forum, 2016, p.23)

Summary details of the technologies included in Figure 3 are provided in Table 1.

Technology type	Summary information
Wave	There are many different types of wave energy generators under development looking at extracting energy from the waves in a variety of different ways and at different locations; onshore, near shore and deep water. Once these designs have progressed through to industrial roll-out, wave energy is likely to be a potential resource that Bridgend could look to exploit
Tidal	Tidal stream turbines capture the energy from a moving mass of water, through an operating principle similar to that of wind turbines. This technology is the closest of the marine energy generators to commercial operation with some developers participating in the Contracts for Difference auctions. As such, this could be a technology, which may look to locate in the Bridgend area during the LDP plan period. Tidal Barrage technology has received a lot of attention in South Wales in recent years due to the proposal for a barrage in Swansea Bay. The technology looks to build a sea wall in order to lock the tides into/out of a lagoon and generate energy by utilising the tidal height difference across the barrage. The high capital costs which have hindered the development of the Swansea project are likely to mean that this technology will not be considered in Bridgend during the LDP period.
Ocean Thermal Energy Conversion	Takes advantage of the temperature difference between deep cold ocean and warm sea surface with one commercial plant operating in Japan. The most suitable location for this technology is near the edge of continental shelves, where deep waters are located relatively close to land. Therefore, this technology is not considered suitable in the Bristol Channel.
Salinity Gradient (Osmotic)	This technology is very much in the theoretical/prototype stage of development. It uses differences in the salinity of seawater and fresh water to create a pressure difference across a membrane – the pressure difference between the waters can be used to drive a turbine. There are environmental consequences of increasing the salinity of both water sources, which need to be addressed during the development of this technology.

Table 1: Marine energy sources summary (outside of the scope of renewable energy assessment)

Small-scale pumped hydro

The increase in variable energy supply from renewable energy sources has led to increased interest in storage technologies. Pumped hydro provides a highly responsive, renewable storage capacity and is widely deployed throughout the world. The majority of hydro energy storage facilities are very large scale, with the four pumped hydro facilities in the UK providing a total of 2,829 MW of storage capacity. There has been recent interest in the potential for smaller scale pumped hydro to provide additional energy storage capacity, and there might be technical potential for these projects within BCB's upland areas. A study by Scottish Renewables (2016), however, has found that the benefits of pumped hydro projects are not fully realised economically within current market conditions (Scottish Renewables, 2016). As such, pumped hydro storage projects do not currently provide the returns to encourage investment in their deployment (Scottish Renewables, 2016). If regulators find a way to compensate hydro projects for the benefits that they can provide to the energy system, then it is possible that this will become an exploitable resource within BCB towards the end of the LDP period.

1.3.4 Overall method

Sections 2 to 5 provide details of the individual methods followed for the generation of each element of the evidence base within the Renewable Energy Assessment. The overall method for this assessment is summarised in Figure 4.

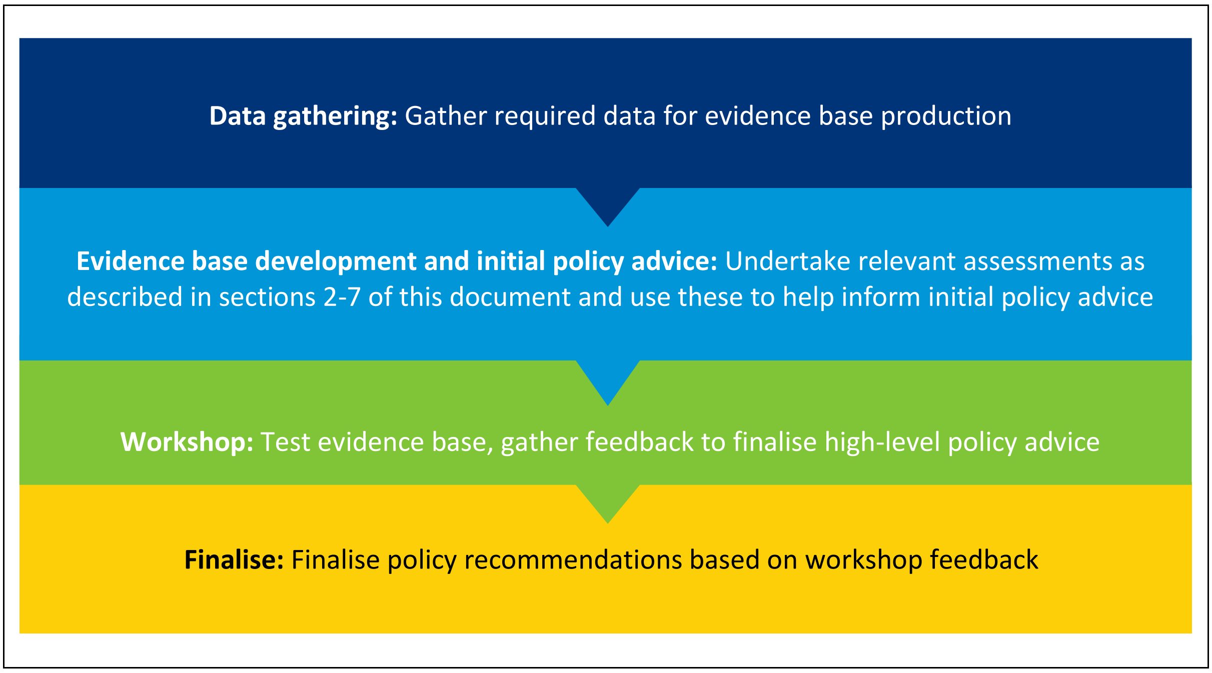


Figure 4: Overall project method

2. Existing and future energy demand baseline

In order to understand the scale of the decarbonisation challenge on a local level, the current and future energy demand of the county borough has been estimated.

2.1 Method

The method for estimating the existing and future energy baseline is provided in Figure 5.

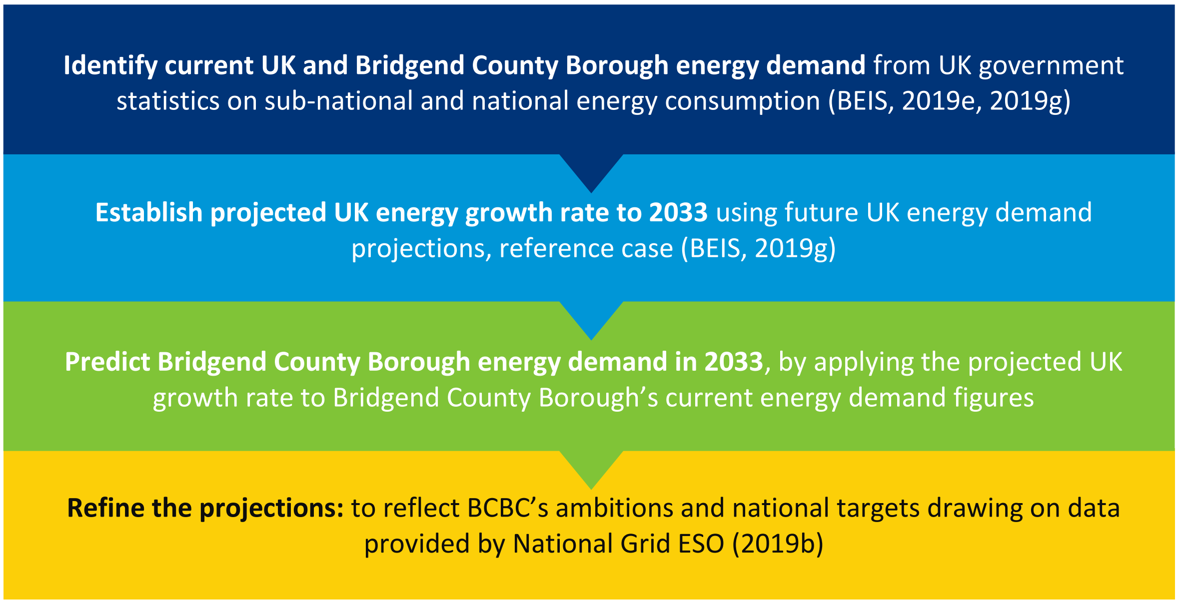


Figure 5: Method for estimating the existing and future energy baseline

Data provided by BEIS (2018, 2019g) is split into sector and fuel source. Welsh Government (2015) suggest that energy use is grouped into transport, heat and electricity. Due to the increasing electrification of heat and transport, in this study energy use has been grouped as follows:

- Electricity
- Non-electric heat
- Non-electric transport

For the purpose of this assessment energy demand associated with the iron and steel industry, aviation and shipping have been excluded from the growth rates calculated as they are not considered relevant to BCB's local energy demand.

The categories recommended by Welsh Government (2015) have been referred to and where recommendations are not provided, details given within the sub-national energy consumption data are used to inform allocation criteria (BEIS, 2018).

Future energy demand for 2033 has been initially estimated utilising up-to-date UK government energy projections (BEIS, 2019g), assuming that the energy consumption growth rates for BCB will equal the growth rates of the UK as a whole. The UK government produce energy and emissions projections on an annual basis in order to monitor progress towards meeting carbon targets and budgets and to support energy policy development (BEIS, 2019a). The projections take into consideration the impact of adopted policies and rely on assumptions regarding key variables which are likely to affect the future energy mix; including economic growth, fossil fuel prices, electricity generation costs and population growth (BEIS, 2019a). The main projection scenario is referred to as the "reference case" and is based on central projections for the key variables (BEIS, 2019f). The current future projections project the energy mix and emissions out to 2035. Under the reference case whilst it is forecast that the third carbon budget will be met, a shortfall in meeting the fourth and fifth carbon budgets is predicted (see Figure 6) (BEIS, 2019f). If additional policies are introduced or existing policies are strengthened this projection may change in future editions of the projections.

BCBC's Local Area Energy Strategy (ETI, 2018b) targets a 95% reduction in emissions from buildings by 2050. To achieve this a combination of energy efficiency improvements, electricity decarbonisation and heating system transformations are required.

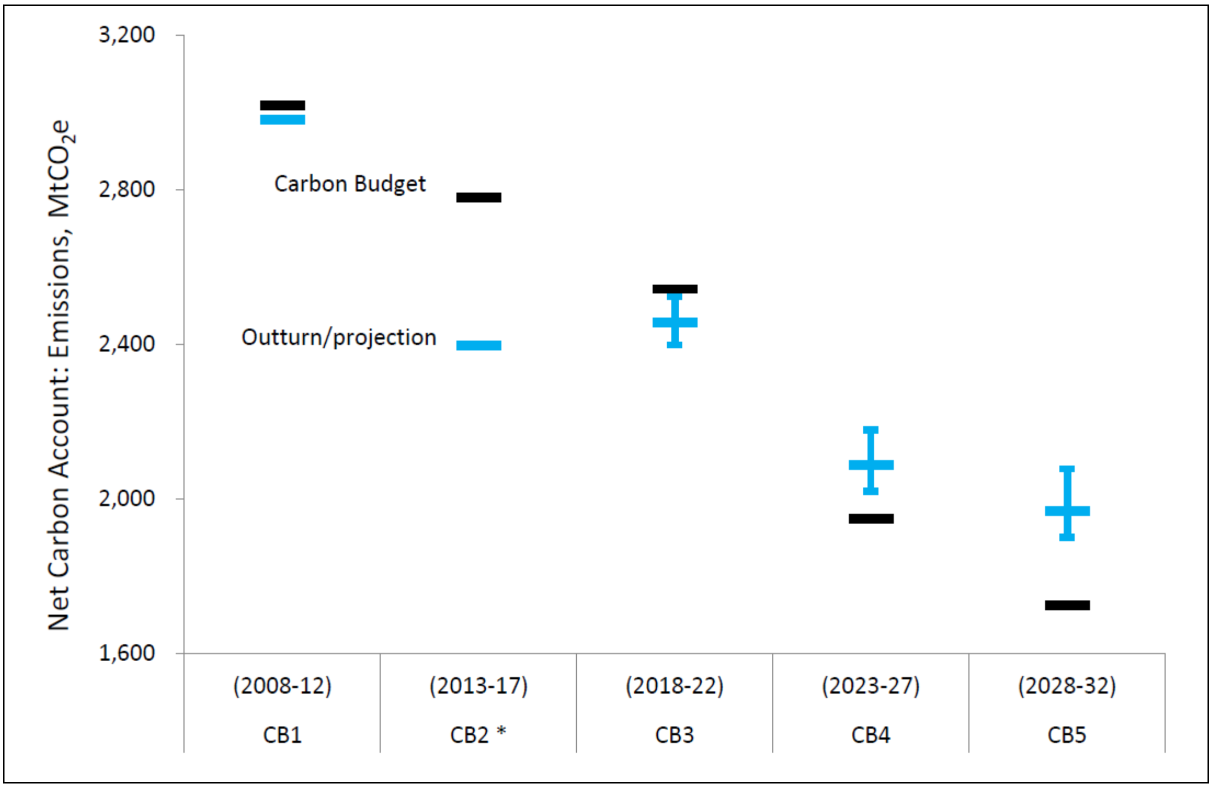


Figure 6: Actual and projected progress against carbon budgets

(BEIS, 2019f, p.18)

In addition to the BEIS (2019g) projections on future energy mixes, National Grid ESO, produce their own annual Future Energy Scenarios (National Grid ESO, 2019). These scenarios are not forecasts or predictions but credible pathways for how the energy system may evolve over the next 30 years. Four scenarios are included in the 2019 edition of the report (National Grid, 2019a), and these are based on a framework of two key drivers (see Figure 7):

> Speed of decarbonisation, and
> Level of decentralisation.

Two of the scenarios, Two Degrees and Community Renewables, meet the UK's 80% 2050 carbon reduction target (against a 1990 baseline), and two do not, Steady Progression and Consumer Evolution (National Grid ESO, 2019a).

Sensitivity analysis undertaken by National Grid ESO (2019a) investigated the challenge of achieving net zero carbon status by 2050. This found that whilst the *"…80 per cent decarbonisation target can be reached through multiple technology pathways … Net Zero requires greater action across all solutions. Action on electrification, energy efficiency and carbon capture will all be needed at a significantly greater scale than assumed in any of our core scenarios."* (National Grid ESO, 2019a, p.2)

Table 2 provides a summary of the core four scenarios.

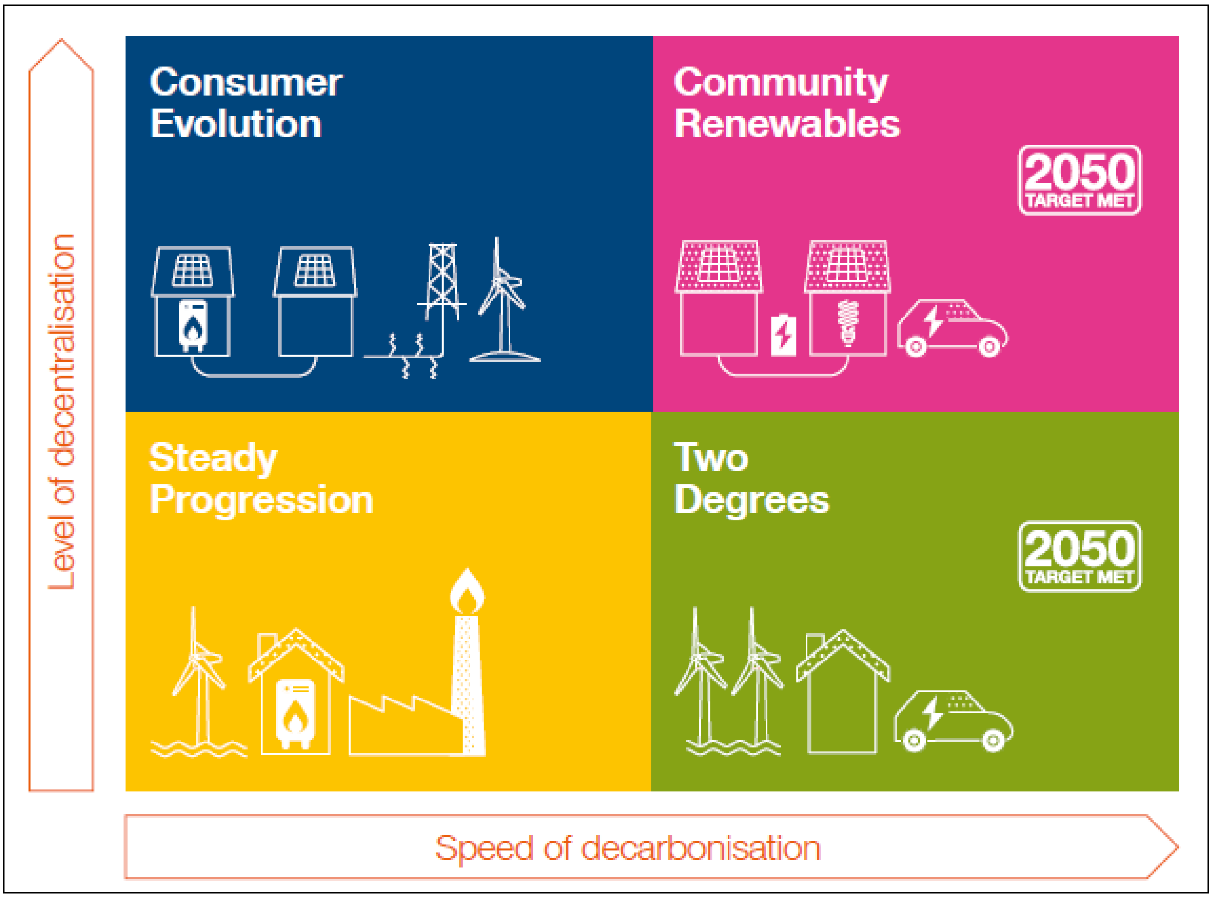


Figure 7: National Grid ESO Future Energy Scenarios

(National Grid ESO, 2019, p.17)

Consumer Evolution	Community Renewables
80% carbon reduction target is not met. Relatively high levels of decentralisation (55% of generation by 2050). There is slow consumer engagement and uptake of electric vehicles (EVs), with EVs becoming the most popular transport options from the early 2040s. Overall energy demands remain similar in 2050 to 2018, with 60% of demand met by gas. About one third of domestic heating is sourced from low carbon solutions by 2050.	**80% carbon reduction target met.** High levels of decentralisation (58% of generation capacity). High uptake of low carbon heating solutions with over 80% of domestic heating by 2050 provided by low carbon systems, including heat pumps, (electric and hybrid), district heating and biofuels. High levels of energy efficiency improvements. Rapid growth of storage capacity. Four-fold increase in wind generation by 2050 from 2018 levels. Lowest annual energy demand scenario, with a reduction of approximately 66% from 2018 levels.
Steady Progression	**Two Degrees**
80% carbon reduction target is not met. Some growth in large-scale centralised generation (e.g. offshore wind farms) takes place. Hydrogen begins to be blended into the gas network, however less than 20% of domestic heating is considered low carbon by 2050. Low levels of efficiency improvement (fabric and appliance) are achieved. Carbon Capture, Usage and Storage (CCUS) is commercialised and deployed. Highest total energy demand scenario with a slight increase on 2018 levels and over 60% of demand met by gas.	**80% carbon reduction target met.** Strong growth in renewables and centralised technologies – including a six-fold increase in offshore wind capacity between 2018 and 2050. Widespread roll out of hydrogen, with over a third of domestic heating provided by hydrogen. EVs are the most popular vehicle from 2035. Flexibility is provided through growing storage capacity and interconnections. CCUS is commercialised. Total energy demand reduces slightly from 2018 levels, with approximately 50% increase in electricity and 30% decrease in gas consumption.

Table 2: National Grid ESO Future Energy Scenarios Summary

(National Grid ESO, 2019a)

From the descriptions provided by National Grid ESO (2019a), the Community Renewables scenario is considered to most reflect the future described in the Bridgend Local Area Energy Strategy (ETI, 2018b) – with high uptake of low carbon heating solutions, particularly from heat pumps, district heating and biofuels. For this reason and as the BEIS (2019g) energy reference case does not meet the 4th and 5th carbon budgets, the 2033 energy projection estimated for the current energy reference case has been further refined using data provided by National Grid ESO (2019b) for the Community Renewables Scenario.

National Grid ESO (2019b) provide very detailed data on the modelling results for the Future Energy Scenarios work, including annual electricity demand, annual gas demand and annual road fuel demands (out to 2050). The growth rates for these three variables from 2016 (date of latest sub-national energy demand data (BEIS, 2019e)) to 2033 was calculated and applied to the UK overall energy data. For fuels not included in National Grid ESO's (2019b) data tables, the BEIS reference case scenario growth rates continued to be used. This includes petroleum products for uses other than road transport, non-electric renewables, and solid/manufactured fuels. Overall growth rates for electricity, non-electric heat, and non-electric transport were then calculated and applied to the current BCB energy demand data to refine the 2033 BCB energy demand forecast.

2.2 Results

Table 3 provides the current and predicted future energy demand for the UK, alongside projected growth rates for each sector, based on the BEIS reference case scenario and then revised to account for the Community Renewables projections for gas, electricity and road fuel. The current and future energy demand baseline for BCB is provided in Table 4 and Figure 8, again using both the BEIS reference case scenario and additional reduction suggested in the Community Renewables scenario.

Energy sector	Current (2016*) demand (GWh p.a.)	2033 Projected UK Energy Demand (BEIS, 2019g Reference case)		2033 Projected UK energy demand, refined to reflect National Grid ESO (2019b) Community Renewables scenario for gas, electricity and road fuel demand	
		Projected growth rate (%)	Predicted Future (2033) demand (GWh p.a.)	Projected growth rate (%)	Predicted Future (2033) demand (GWh p.a.)
Electricity	301,036 GWh	10%	332,379 GWh	+1%	304,023 GWh
Non-electric heat	680,674 GWh	+1%	686,523 GWh	-35%	444,560 GWh
Non-electric transport	477,441 GWh	-16%	403,254 GWh	-46%	256,341 GWh

Table 3: Current/future UK energy demand baseline

**The latest UK Government sub-national energy demand statistics published in 2019 provide data up to 2016.*

Energy sector	Current (2016*) demand (GWh p.a.)	2033 Projected BCB Energy Demand (BEIS, 2019g Reference case)		2033 Projected BCB energy demand, refined to reflect National Grid ESO (2019b) Community Renewables scenario for gas, electricity and road fuel demand	
		Projected growth rate (%)	Predicted Future (2033) demand (GWh p.a.)	Projected growth rate (%)	Predicted Future (2033) demand (GWh p.a.)
Electricity	616 GWh	10%	680 GWh	1%	622 GWh
Non-electric heat	1,647 GWh	1%	1,661 GWh	-35%	1,076 GWh
Non-electric transport	1,070 GWh	-16%	904 GWh	-46%	575 GWh
Total	3,333 GWh	-3%	3,245 GWh	-32%	2,272 GWh

Table 4: Current/future BCB energy demand baseline

**The latest UK government sub-national energy demand statistics published in 2019 provide data up to 2016.*

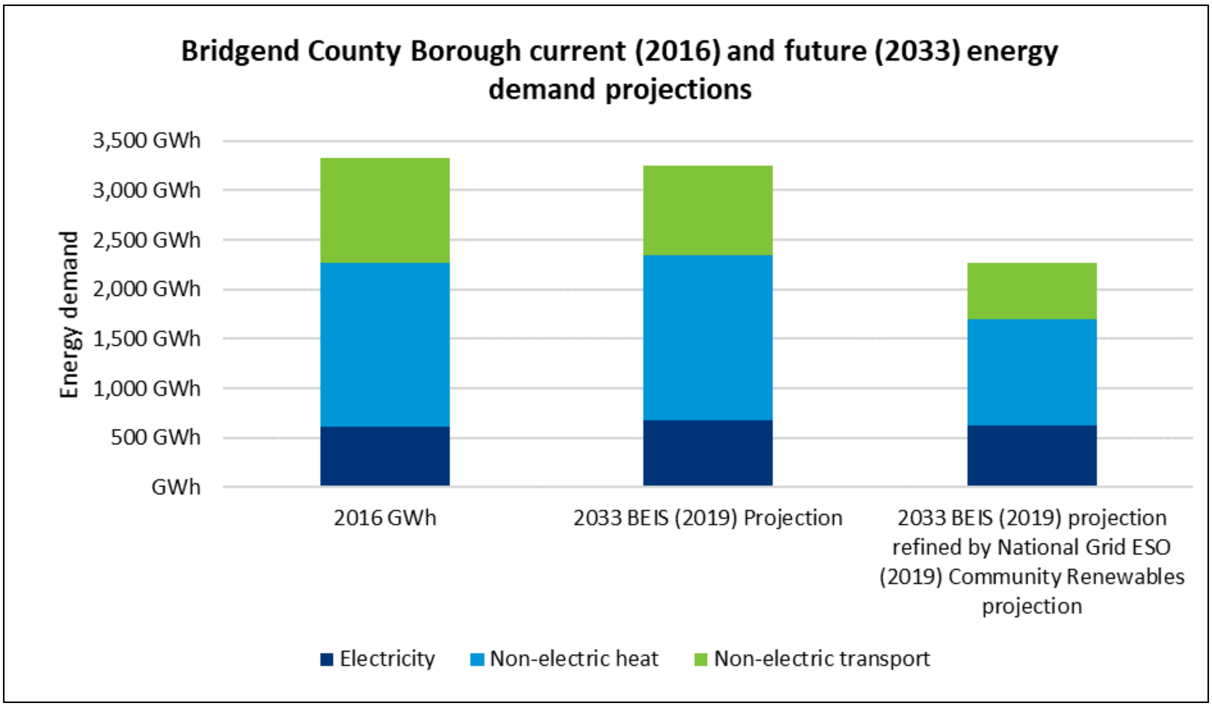


Figure 8: Bridgend County Borough current (2016) and future (2033) energy demand estimations

The current energy demand in BCB, is less than that reported in the previous Bridgend Renewable Energy Assessment, or predicted to be the demand in 2020 (BCBC, 2011c). This could indicate the successful deployment and integration of energy efficiency measures, both with respect to electrical appliances and building fabric.

The projected lower non-electric heating and non-electric transport demands, when the Community Renewables scenario data is considered, is likely due to higher levels of fabric efficiency improvements and electrification of heat and transport than is currently considered within the BEIS (2019f) reference case. Whilst the Community Renewables scenario projects higher levels of electrification of heat and transport, the growth rate is not as high as under the BEIS (2019f) reference case, which is likely due to the high levels of energy efficiency (both fabric and appliance) considered under the Community Renewables scenario.

Comparing the different projections helps to illustrate that the future energy system is not yet known or certain. The eventual mix of energy will depend on a range of factors, including:

- Economic growth
- Population changes
- Local and national energy policy
- Consumer engagement
- Technological advances

BCBC have shown commitment to the decarbonisation agenda, by setting the following strategic objectives within their Smart Energy Plan:

- *"to be a test bed for new energy system ideas and concepts; providing real-life case studies,*
- *to lead the decarbonisation agenda; by introducing new products and concepts to consumers,*
- *to attract new and existing energy and digitalisation businesses to trial ideas and grow within the county,*
- *to stimulate the local economy and develop employment opportunities through innovation and deployment of low carbon energy projects,*

> *to develop a joined-up approach to the energy transition engaging local academia, communities and businesses."*

(ESC, 2018b, pp.3-4)

With BCBC pursuing these objectives, it is considered that the county borough is well-placed to achieve greater energy demand reductions and energy mix transitions then are projected under the current BEIS (2019f) reference case projection. As such, the refined energy demand projection using the Community Renewables scenario data is considered to be a more suitable projection.

2.3 Conclusions

In order for Bridgend to achieve the energy targets set out in their Local Area Energy Strategy (ETI 2018b) and support the achievement of national energy targets, they need to decarbonise at a faster rate than the current reference projection set out by UK Government (BEIS, 2019g). This requires increased electrification of heat and transport. Large increases in energy efficiency (both with respect to electrical appliances and building fabric efficiency) are also required to offset the increase in electricity needs associated with electrification of heating and transportation and maintain electricity demands at a similar level to today.

3. Existing and proposed low and zero carbon energy technologies

There has been a lot of activity in the renewable energy sector during the last decade. The levels of existing and currently proposed low and zero carbon energy technologies within BCB have been estimated to understand current progress in transitioning to a low carbon economy.

3.1 Method

The following data sources have been used to establish the capacity of existing renewable and low carbon technologies in the county borough:

- Ofgem CHP and RO register (Ofgem, 2019a)
- Ofgem FIT register (Ofgem, 2019b)
- Renewable Heat Incentive Deployment Data (BEIS, 2019c)
- CFD register (Low Carbon Contracts Company, 2019)
- Renewable Energy Planning Database (BEIS, 2019b)
- Planning application data (BCBC, 2019)
- Data regarding wind turbines in south-east Wales (Blaenau Gwent County Borough Council, 2019)
- Data from ESC relating to domestic heating systems (ESC, 2019a)
- Freedom Project data (Wales and West Utilities, 2018)
- Energy Generation in Wales 2017 report (Regen, 2018)

The capacity of proposed low and zero carbon energy technologies has been determined from:

- BEIS' Renewable Energy Planning Database (BEIS, 2019b)
- Planning application data (BCBC, 2019)

An estimate of the current and proposed energy production has been prepared using typical capacity factors provided within the Toolkit (Welsh Government, 2015).

3.2 Results

Table 5 provides details of existing renewable generation capacity installed in the county borough. Table 6 gives details of the known proposed developments within the area, and Table 7 consolidates the information on both existing and proposed capacity within BCB.

Technology	Capacity (MW)	Capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh)
Onshore Wind	63.84	0.27	150,990
Solar PV (Ground mounted)	14.14	0.1	12,384
Solar PV (Roof-top)	8.13	0.1	7,120
Anaerobic Digestion (Power)	3.00	0.9	23,652
Hydro	0.05	0.37	150
Total estimated power generation	89.15		194,296
Heat Pumps	1	0.2	1,168 (thermal benefit assuming a Seasonal Performance Factor of 3, i.e. the energy generation is reduced by the assumed electrical input)
Biomass	6.6	0.3	17,345
Total estimated heat generation	7.6		18,513

Table 5: Existing renewable and low carbon energy projects within Bridgend County Borough

Notes regarding estimation and uncertainty of low carbon heating deployment

The Renewable Heat Incentive deployment data (BEIS, 2019b) records 30 domestic RHI recipients and 7.6 MW of non-domestic RHI projects in BCB. ESC (2019a) recorded 39 domestic heat pumps in BCB in 2014. The Freedom Project (Western Power Distribution and Wales and West Utilities, 2018) connected hybrid heat pumps (a combination of an air source heat pump and gas boiler) to 75 domestic properties in BCB. Regen (2018) estimated that there was 6 MW_{th} of biomass heat generation and 1 MW_e capacity of heat pumps installed in Bridgend County Borough.

Table 5 assumes that there is 6.6 MW_{th} of biomass heat generation and 1 MW_{th} of heat pump generation in Bridgend.

With respect to proposed low carbon heating projects, BCBC are developing two heat networks within the county borough;

1) Upper Llynfi Valley Minewater Heat Pump District Heat Network
2) Bridgend Town Gas CHP Heat Network.

Whilst it is proposed that the heat network in Bridgend will transition to a low carbon heat generation source following development, tables 6 and 7 only include details of the Upper Llynfi heat network.

Technology	Site	Capacity (MW)	Assumed capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh p.a.)
Onshore wind	Stormy Down (planning consent granted)	2.5	0.27	5,913
Onshore wind	Bryn (Natural Resources Wales' land – development rights granted)	Up to ~50 MW split between land in Bridgend and Neath Port Talbot County Boroughs, therefore assume 25 MW	0.27	59,130
Solar PV	Brynheulog (planning consent granted)	5.1	0.1	4,468
Solar PV	Court Colman (planning consent granted)	1	0.1	876
Biomass	Llynfi Power Station (planning consent granted)	25	0.9	197,100
Hydro	Evanstown (planning consent granted)	0.0365	0.37	118
Total Proposed Power Generators		58.6		267,605
Renewable Heat	Caerau Minewater District Heat (heat pump capacity)	1	0.2	1,168 (thermal benefit assuming a Seasonal Performance Factor of 3, i.e. the energy generation is reduced by the assumed electrical input)
Total Proposed Heat Generators		1		1,168

Table 6: Proposed renewable and low carbon energy projects within Bridgend County Borough

Technology	Capacity (MW)	Capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh)
Onshore Wind	91.34	0.27	216,033
Solar PV (Ground mounted)	20.24	0.1	17,728
Solar PV (Roof-top)	8.13	0.1	7,120
Anaerobic Digestion (Power)	3.00	0.9	23,652
Hydro	0.08	0.37	269
Biomass (Power)	25	0.9	197,100
Total estimated power generation	**147.79**		**461,901**
Heat Pumps	2	0.2	2,336 MWh (thermal benefit assuming a Seasonal Performance Factor of 3, i.e. the energy generation is reduced by the assumed electrical input)
Biomass (Heat)	6.6	0.3	17,345
Total estimated heat generation	**8.6**		**19,681**

Table 7: Capacity of existing and proposed renewable and low carbon energy projects within Bridgend County Borough

At the time of writing this report, the latest planning application submitted to BCBC for a renewable energy development was in August 2018 for a biomethane gas-to-grid facility to upgrade biogas generated at the operational anaerobic digestion plant at Stormy Down and inject it into the gas network (BCBC, 2019). The latest application for a completely new renewable energy generator was submitted in 2017 for a 1 MW solar farm at Court Colman (BCBC, 2019). The lack of planning applications for new renewable energy generators, and the reason why some of the developments listed in Table 6 have not yet been constructed is likely due to the removal of government incentives (the Feed-in Tariff and Renewables Obligations Certificates) for new generators. Since the removal of these incentives, costs for some renewable energy developments have reduced, in particular solar PV and onshore wind. Onshore wind is generally considered to be the most economical form of new electricity generation technology. This is likely to enable new larger wind farms to be developed, e.g. the recently tendered opportunity for a ~50 MW wind farm on Natural Resources Wales' land in TAN8 Strategic Search Area F; encompassing land in both Bridgend and Neath Port Talbot County Boroughs (NRW, 2018). Additional opportunities for smaller renewable energy developments are currently largely focused on private wire opportunities where the energy generated is directly connected to a nearby electricity load, enabling higher returns for the electricity generated, than if the electricity is exported to the electricity network.

The amount of operational low carbon energy generation in Bridgend equates to approximately 6% of current total energy demand and 9% of the estimated 2033 demand – as summarised in Figure 9. The current power generation equates to approximately 32% of the current electricity demand and 31% of the future 2033 demand. Figure 7 excludes the thermal generation provided by heat pumps, as the thermal demand to be met by heat pumps is represented as an electrical demand within the demand data. Figure 10 shows the sources of current energy generation, highlighting that the majority of energy is currently generated from wind. Figure 12 shows the sources of current and proposed energy generation. It indicates that if the Llynfi Power Station progresses this would produce a similar amount of energy as the proposed and current energy generation from wind, although note that the planning application documents for the Llynfi Power Station state that the raw materials for the power station will be sourced from both local and international sources of biomass and waste wood, and therefore the energy generation from the power station doesn't just represent local resource (Morgan Credit Energy (Wales) Ltd, 2011). Figure 10 does include the thermal energy generated by the heat pumps (minus the assumed electrical input).

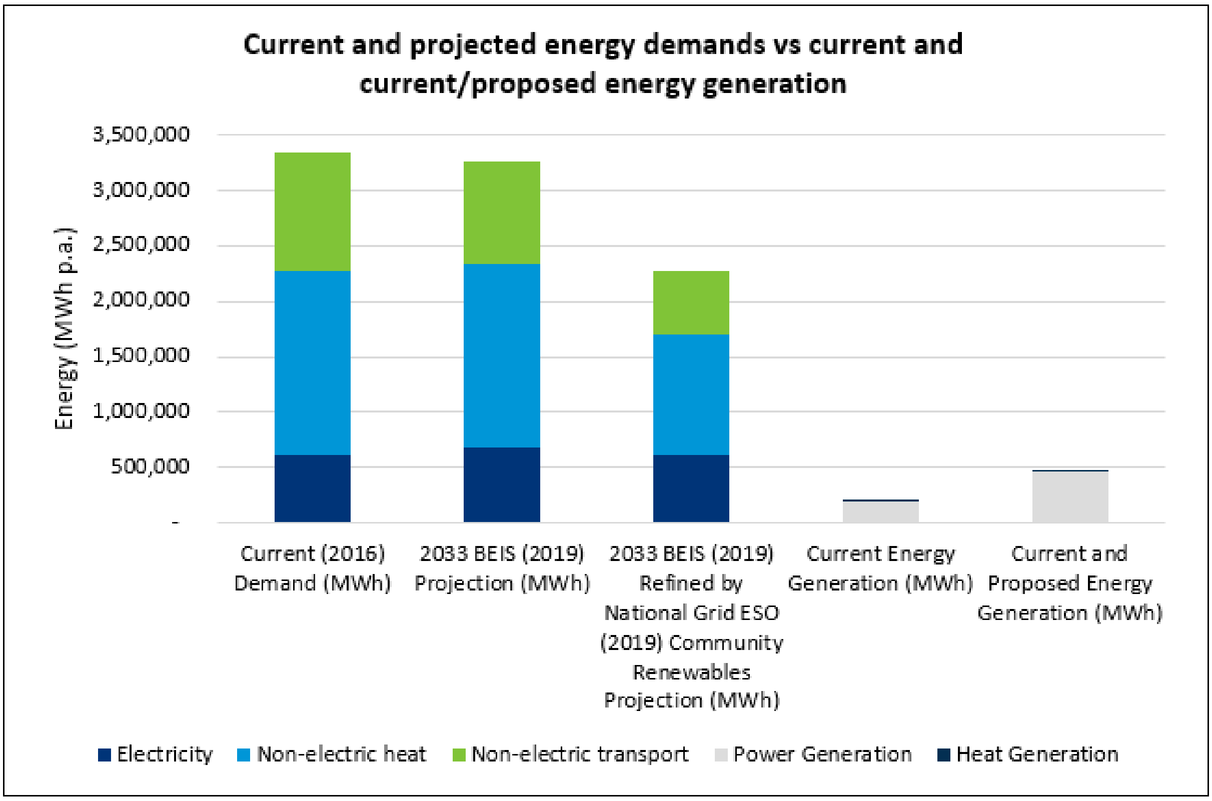


Figure 9: Comparison of current/future energy demand and current low carbon energy generation

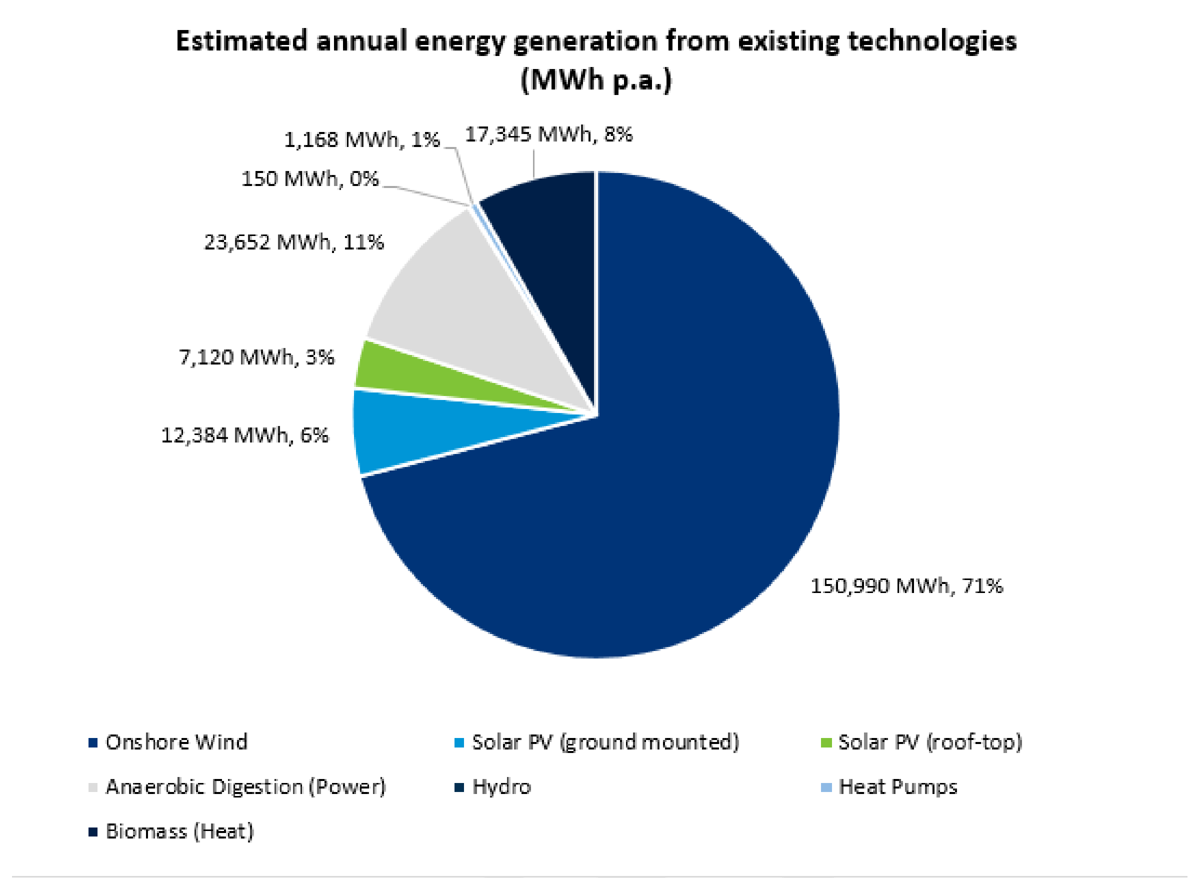


Figure 10: Estimated current annual energy generation in BCB

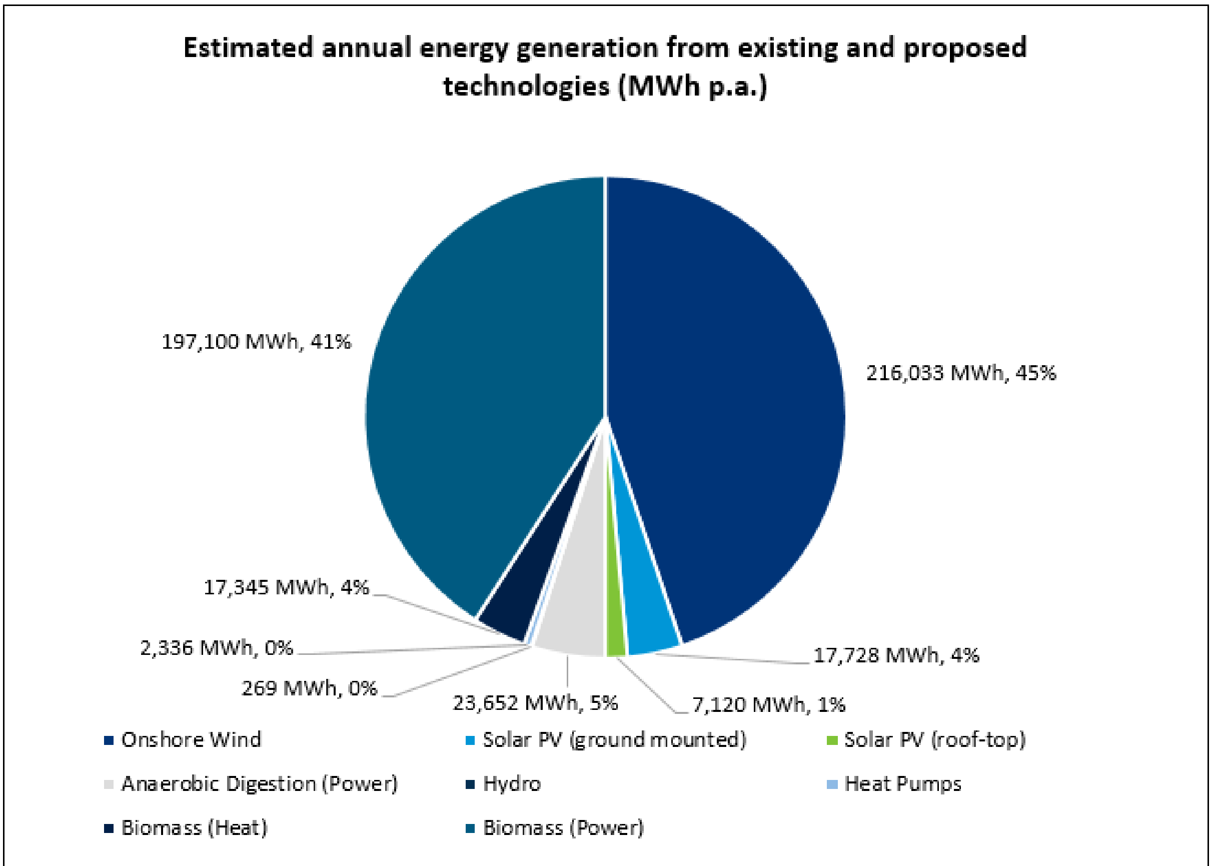


Figure 11: Estimated current and proposed annual energy generation in BCB

3.3 Conclusions

In order to meet/offset the proposed future energy demand of Bridgend County Borough, the level of renewable/low carbon energy generation needs to increase approximately ten-fold. To achieve 70% of electricity demand from renewable sources (in line with Welsh Government's national target for 2030), the renewable electricity generation needs to approximately double.

4. Renewable energy resource potential in Bridgend County Borough

4.1 Wind energy resource

The suitability of a particular site for a wind turbine development is dependent on a number of factors, including:

- wind resource
- land use (agricultural, leisure, designated for particular land use quality or ecological features)
- presence of aviation operations and communications infrastructure
- ecology features
- distance to properties and infrastructure

A strategic high-level constraints assessment of BCB has been undertaken to identify areas that are considered less constrained with respect to wind developments. From this, the accessible wind power potential within the county borough has been estimated.

Notes with respect to high-level constraints assessment

This is a high-level assessment and should not be used to automatically preclude any developments outside of the less-constrained area, or consent developments within the less-constrained areas. Individual site-specific studies are still necessary, but at a high-level, it identifies land that is likely to be more suitable and enables an indicative resource potential to be estimated.

4.1.1 Method

The method undertaken is summarised in Figure 12.

Decide on candidate wind turbine typology. Typical exclusion zones around constraints are dependent on the size of wind turbine considered, therefore a candidate wind turbine typology needs to be selected

Identify less constrained land: located outside of high-level constraints

Refine identified land using aerial imagery: so that most suitable land is retained

Identify wind clusters: Amalgamate any areas that are within four rotor diameters of one another

Estimate wind resource potential within "less-constrained" areas, assuming 10 MW/km^2 (Welsh Government, 2015)

Figure 12: Method for identifying wind resource capacity

Consideration of grid capacity and potential cumulative and landscape impact have not been considered within this assessment. These constraints are considered too site specific to be considered within a high-level assessment, though at the time of writing this report, grid constraints are being encountered across much of the distribution network. With respect to cumulative impact, it is possible that future developments can be sited in such a way that they are in keeping with existing wind turbines and therefore the impact of the development is reduced rather than increased due to the presence of existing wind turbines.

The candidate wind turbine typology used for the assessment was based on the following:

- Hub height: 80 m
- Rotor diameter: 80 m
- Tip height: 120 m
- Likely capacity: 2 MW

This turbine typology matches the example turbine provided by Welsh Government (2015). In a post-subsidy environment, a turbine of this size is more likely to achieve financial viability, than a smaller turbine. Additionally, given the urgency required to achieve national renewable energy targets, it is considered that the resource available should be maximised, whilst also considering potential visual and landscape impacts, and practical issues such as access for construction.

The high-level constraints considered within this assessment are summarised in Appendix 1.

4.1.2 Results

The assessment identified thirty-four clusters of land with potential for wind development. Details regarding the wind capacity associated with these individual clusters are provided in Appendix 2. A summary of the overall resource is provided in Table 8

Mapped results of the constraints analysis are provided in Appendix 3, as follows:

- Figure 32: shows areas of less constrained land for wind developments and existing wind turbines. The locations of the existing wind turbines do not exactly coincide with the less constrained areas identified, however they are clustered in close proximity to them. This clustering is considered to support the assertion that whilst high-level constraints assessments do not identify specific sites, they do identify, at a high-level, areas that are likely to be less constrained for development.
- Figure 33: identifies the thirty-four wind clusters (areas less constrained for wind developments within four rotor diameters of each other) following high level refinement using aerial imagery – removing areas of land that were considered unsuitable for a wind development (e.g. located on steep slopes or in a valley).

Initial total area of less constrained land	17.4 km^2
Revised area following high-level review with aerial imagery	14.9 km^2
Assumed wind potential (MW per km^2)	10
Indicative capacity (MW)	149.2
Assumed capacity factor	0.27
Estimated annual energy generation (MWh p.a.)	352,964
Existing wind capacity (MW) within less constrained areas	38
Remaining potential wind capacity (MW)	111.2
Estimated additional annual energy generation potential (MWh p.a.)	263,086

Table 8: Total estimated potential following constraints assessment and visual refinement using aerial imagery

Notes on indicative capacity methodology

The methodology used to estimate the MW capacity potential within the wind clusters is calculated as per the example provided in the Welsh Government (2015) Toolkit for Pembrokeshire, assuming an indicative capacity of 10 MW/km^2. As the assessment is based on 2 MW wind turbines this equates to 5 turbines per km^2.

The constraints exercise has identified land that is theoretically (at a high-level) suitable for 2 MW wind turbines. In theory, each of the clusters identified should be able to accommodate at least one 2 MW turbine. The methodology provided in the Toolkit and used in Table 8 does not assume this and some clusters are therefore estimated to have a capacity of less than 2 MW.

An additional table of indicative capacities is provided in Appendix 2 (Table 39), which calculates the indicative capacity based on the number of turbines the cluster could theoretically accommodate. This method indicates that **24.8 MW** of wind capacity is available in addition to the capacity provided in Table 8, which equates to an additional approximately **58,581 MWh p.a**.

The potential resource capacity in Table 8 is greater than the potential identified in the previous renewable energy assessments (BCBC, 2011b, 2011c). The original renewable energy assessment (BCBC, 2011b) was based on the same wind turbine typology but reduced the amount of land available by excluding land within 7 km of existing or consented wind developments as suggested by the Toolkit (Welsh Government, 2015), greatly reducing the potential resource estimated. As outlined in the method section, this has not been undertaken within this assessment, as it is considered that cumulative impacts should be considered on a site-by-site basis. Future developments may be able to be sited in such a way that they are in keeping with existing wind turbines and would therefore be considered acceptable.

Factors affecting the potential development of wind farms within the wind clusters identified are considered further in section 7.

4.1.3 Conclusions

The estimated additional annual energy generation potential available from wind energy within BCB is approximately equal to the total estimated current and proposed annual energy generation (excluding energy generated from the proposed Llynfi biomass power station). The wind clusters are located throughout the county borough, both in the upland areas in the north of the county borough and the lowland coastal areas. Existing turbines are generally located in close proximity to the identified clusters, which are of varying size; with some likely to be able to support large-scale developments (10 MW plus) and others more suitable for smaller developments of one or two turbines.

4.2 Large-scale ground-mounted solar PV resource

The UK renewable energy industry has seen large-scale deployment of solar PV, both as ground mounted arrays and building-integrated over the last decade (see Figure 13).

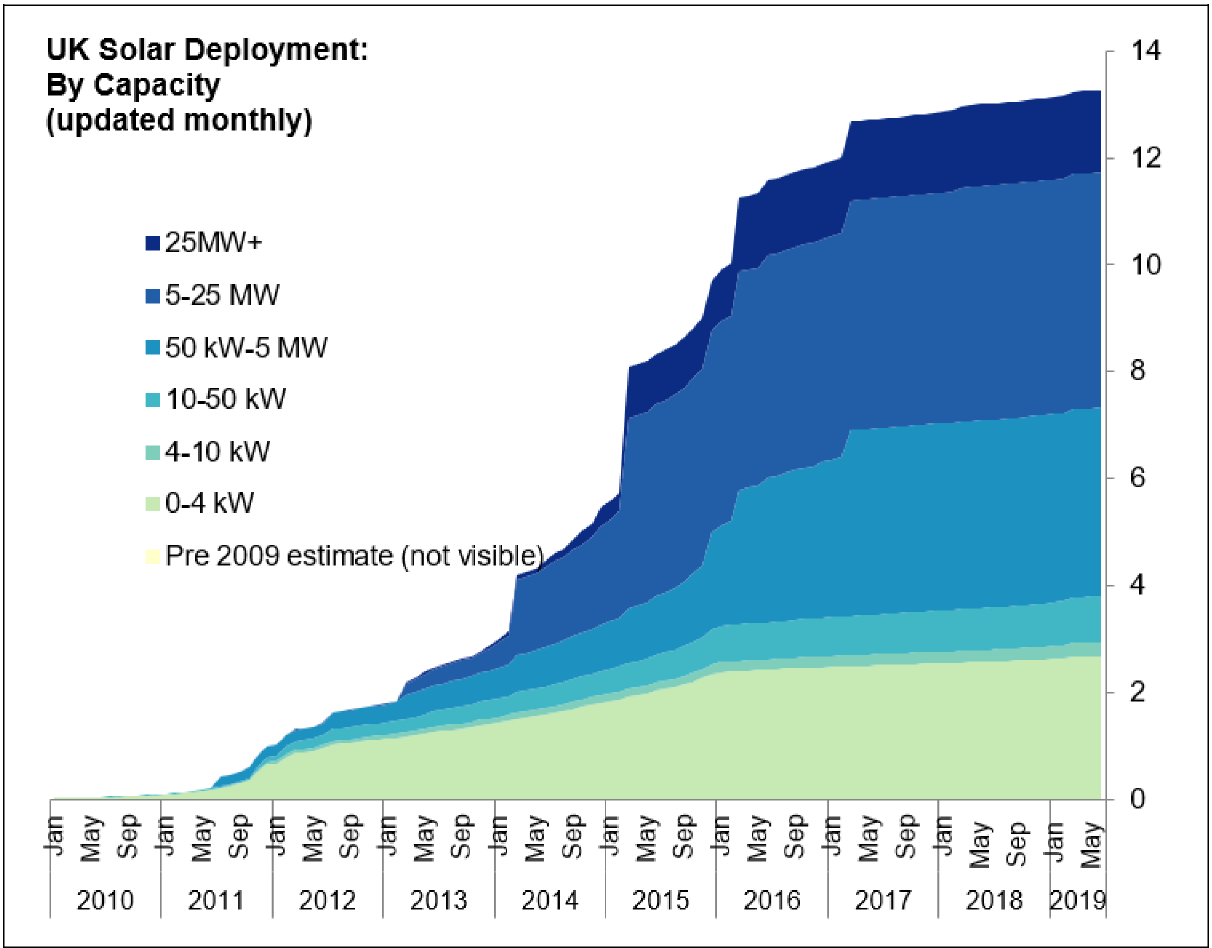


Figure 13: UK solar PV deployment since 2010

(BEIS, 2019d)

Reduction in technology costs and the benefits of a mature solar PV supply chain mean that subsidy free solar PV arrays are now being developed and deployed. As with wind developments, the suitability of a particular site for a large-scale ground mounted solar development is dependent on a number of factors, including:

- solar resource
- land use (agricultural, leisure, designated for particular land use quality or ecological features)
- ecology features
- distance to properties and access infrastructure.

4.2.1 Method

A strategic high-level assessment of accessible large-scale solar power potential within BCB has been undertaken via a constraints assessment to identify areas that are less constrained with respect to solar developments. The high-level constraints considered in this assessment are detailed in Appendix 1.

Notes with respect to high-level constraints assessment

As with the wind assessment, this assessment should not be used to automatically preclude any developments, or consent any developments. Individual site-specific studies are still necessary, but at a high-level it identifies land that is likely to be more suitable and enables an indicative resource potential to be identified.

The method undertaken is summarised in Figure 14.

Identify less constrained land outside of the areas of high-level constraints

Refine by size: Remove areas of land likely to provide insufficient space for 0.5 MW of solar PV*

Refine identified land using aerial imagery: Remove land that at a high-level appears unsuitable.

Estimate solar resource potential within the “less-constrained” areas using conversion factors provided by Welsh Government (2015)

Figure 14: Large-scale ground mounted solar PV resource assessment method

** Whilst Welsh Government (2015) suggest that the area of land required to accommodate this is 1.2 hectares, due to increases in module capacity, it is now considered that approximately 0.875 hectares is sufficient.*

Consideration of grid capacity and potential cumulative and landscape impact have not been considered within this assessment though, at the time of writing this report, grid constraints are being encountered across much of the south Wales’ electricity network. These constraints are considered too site specific to be considered within a high-level assessment.

4.2.2 Results

The results of the assessment are summarised in Table 9. With details provided regarding:

- the area of land and associated potential capacity following the initial constraints assessment (ignoring land that would accommodate less than 0.5 MW of solar PV)
- the remaining area of land following the visual inspection using aerial imagery, and removal of land considered unlikely to be developed for PV, e.g. areas used as school playing fields, graveyards, and allotments. (Areas covering car parks were retained due to the growing interest associated with solar canopies).
- the remaining potential resource capacity available once the existing capacity of ground mounted solar PV is considered.

Mapped results of the constraints exercise are provided in Appendix 3, as follows:

> Figure 34: identifies the areas of less constrained land for ground mounted solar PV following the initial constraints assessment and high-level visual review using aerial imagery.

	Total land area (hectares)	Indicative capacity (MW), assuming 1.75 hectares is required for 1 MW	Assumed capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh p.a.)
Less constrained area	6,807	3,890	0.1	3,407,390
Less constrained area following high-level visual refinement	6,711	3,835	0.1	3,359,335
	Assumed existing ground mounted PV capacity (MW)	**Indicative capacity minus existing capacity (MW)**	**Assumed capacity factor (Welsh Government, 2015)**	**Estimated annual energy generation (MWh p.a.)**
Capacity / generation (excluding existing ground mounted solar PV capacity)	14.14	3,821	0.1	3,346,951

Table 9: Calculation of indicative solar power and energy generation capacities

4.2.3 Conclusions

At a high-level, a large proportion of land in Bridgend County Borough would be considered suitable for a ground mounted PV development. In reality, only a proportion of this land would be developed due to additional considerations including cumulative impact, grid capacity and competition with other land uses, including agricultural land, recreational land and further land developments.

Due to the large land area identified as less constrained, further consideration could be given to additional constraints. Potential additional constraints, which may affect the relative suitability of the areas identified are considered in section 7.

4.3 Biomass energy resource

Energy generated from the combustion of biomass can provide a relatively flexible, renewable, low carbon fuel, if the biomass is sourced and managed in a sustainable manner. Biomass can be utilised in Combined Heat and Power (CHP) plants, large-scale boilers and smaller domestic boilers. The modelling work undertaken by ESC and the ETI for the Smart Systems and Heat programme identified a potential role for biomass in each of these areas to supply Bridgend residents with low carbon heating in the future (ETI, 2018b).

The Evidence Base for the Local Area Energy Strategy (ETI, 2018a) identifies biomass boilers as the most cost-effective decarbonisation heating system for domestic properties in off-gas, rural areas, particularly in the Ogmore and Garw valley analysis areas. It was also identified as a potential heat source for district heat networks in the county borough (ETI, 2018a).

Combustion of biomass causes emissions of particulates and gases, including carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxides and volatile organic compounds. As such, use of biomass for energy generation via combustion should be carefully managed to ensure that local air pollution issues do not arise, and that biomass is generated from sustainable sources.

The modelling work for the Local Area Energy Strategy (ETI, 2018a) limited biomass deployment within the county borough to BCB's fair share of the national resource. This study looks to assess the potential contribution that BCB could make to the national biomass fuel resource, from its own land from the following sources:

> Sustainable forestry and woodland management
> Growing of "woody" energy crops, e.g. miscanthus and short rotation coppice willow

(Welsh Government, 2015)

The potential for growing energy crops to provide liquid biofuels for transport is outside of the scope of this report.

4.3.1 Method

The method used to determine the biomass energy resource potential is based on the method set out in the Toolkit (Welsh Government, 2015), and is summarised in Figure 15 and Figure 16.

Sustainable forestry and woodland management

Estimate the land area available within Bridgend County Borough for wood fuel. Assuming woodland identified within the National Forestry Inventory (NRW, 2016) is suitable for providing wood fuel

Estimate the annual fuel yield: assuming 0.6 oven dry tonnes of fuel per hectare (Welsh Government, 2015)

Estimate the potential installed capacity if used for CHP or heat only using conversion factors provided by Welsh Government (2015)

Figure 15: Method for estimating energy resource available from wood

Growing of "woody" energy crops

Establish theoretical maximum land area available for energy crops: Assuming agricultural land other than grade 5 is suitable and excluding SSSIs, woodland and areas within 100m of scheduled monuments.

Establish practical land area available for energy crops: Assuming 10% of theoretical maximum land area would be used, due to competition with other crops and land uses and unsuitable topography (Welsh Government, 2015).

Establish the annual fuel yield: assuming 12 oven dry tonnes per hectare (Welsh Government, 2015).

Establish the potential installed capacity and energy yield if used for CHP or heat only using conversion factors provided by Welsh Government (2015).

Figure 16: Method for estimating energy resource available from "woody" energy crops

4.3.2 Results

The estimated energy resource from biomass is summarised in Table 10.

Maps identifying the theoretical land areas available are provided in Appendix 3 as follows:

- Figure 35: identifies woodland within the National Forestry Inventory in Bridgend County Borough
- Figure 36: identifies land predicted to have an agricultural land classification of 1-4 alongside land identified to be steeper than 15°.

Resource type		Sustainable forestry and woodland management	Woody energy crops	Total
Practical land area available (hectares)		4,131 hectares	854 hectares	4,985 hectares
Oven dry tonnes per hectare (Welsh Government, 2015)		0.6	12	n.a.
Amount of energy crops (oven dry tonnes per annum)		2,479	10,251	12,729
Heat only energy use	**Required oven dry tonne per 1MWth**	660	660	660
	Boiler capacity (kW_{th})	3,755	15,531	19,287
	Assumed capacity factor (Welsh Government, 2015)	30%	30%	30%
	Estimated annual useful heat yield (kWh_{th})	9,869,335	40,816,143	50,685,478
Energy used for CHP	**Assumed quantity of waste (oven dry tonnes) required per 1 MW_e, *fuel required for 1 MW_e is assumed to also produce approximately 2 MW_{th} thermal output* (Welsh Government, 2015).**	6,000	6,000	n.a.
	CHP electricity capacity (kW_e)	413	1,708	2,122
	CHP thermal capacity (kW_{th})	826	3,417	4,243
	Assumed electrical capacity factor (Welsh Government, 2015)	90%	90%	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%	50%	50%
	Estimated annual electricity yield (kWh_e)	3,256,880	13,469,327	16,726,208
	Estimated annual useful heat yield (kWh_{th})*	3,618,756	14,965,919	18,584,675

Table 10: Summary of potential biomass energy resource available within Bridgend County Borough

**The assumed thermal volume factor used to calculate the annual useful heat yield assumes that only 50% of the heat generated is used, with the remainder wasted (Welsh Government, 2015).*

The area of land available for energy crops is similar to the previous Renewable Energy Assessment (BCBC, 2011c), whereas the area of land available for sustainable forestry has increased. This has resulted in a higher overall estimate of resource availability in the current assessment. The previous Renewable Energy Assessment (BCBC, 2011c) did not consider energy crops as a heat only option, it has been included as an option in the current assessment as per the advice in the Toolkit (Welsh Government, 2015).

The CHP calculations provided in Table 10 assume that the biomass is converted into heat and power via direct combustion technologies, most likely to be a steam turbine. Biomass steam turbine CHP plants generally have capacities greater than 10 MW. The very smallest biomass steam turbine CHP units on the market have an electrical capacity of about 2 MW, which is comparable to the capacity that would be generated from all of the biomass resource within BCB. Furthermore, these smaller steam turbines are only deployed in very specialist circumstances. As such, it is considered very unlikely that the resource would be used for CHP energy use, unless additional resource was imported from outside the county borough. If the Llynfi biomass power station progresses at the proposed capacity it will require additional fuel sourced from outside the county borough.

Use in smaller scale biomass boilers dispersed throughout the county borough is considered a more likely use for the biomass resource in Bridgend County Borough, if it was exploited to its full capacity. The total thermal capacity of the resource calculated is 19,287 kW_{th} and approximately 50.7 GWh_{th} p.a. Based on the medium typical domestic consumption of gas (Ofgem, 2019) and assuming a gas boiler efficiency of 90%, the biomass energy resource in the county borough equates to the needs of approximately 4,700 homes (assuming a biomass boiler efficiency of 80%). The Bridgend Local Area Energy Strategy Evidence Base (ETI, 2018a) identifies a role for biomass in decarbonising domestic heating in the county borough, through the use of biomass boilers and as a potential district heating source.

Whilst the uptake of biomass heating across the different future scenarios modelled is found to vary, in general over 6% and 4% of domestic buildings in the Ogmore and Garw valley analysis areas, respectively, are recommended to have biomass boilers installed (ETI, 2018a). Under a future scenario with a high-level of green gas, biomass is found to be the most cost-effective decarbonisation option for 17% of the buildings located in the Ogmore Vale area (ETI, 2018a).

An issue, which should be taken into account, when considering the use of biomass resource for domestic heating, is the potential to cause air pollution. Installation of biomass boilers in higher density housing areas can lead to air quality issues. Within the modelling undertaken to inform the Local Area Energy Strategy (ETI 2018a) installation of biomass boilers is restricted from terraced houses due to practicalities of installing within these buildings, this will also help to have reduced the likelihood of the modelling suggesting that biomass boilers are installed in the more densely populated areas of BCB.

The biomass resource could be used to generate heat and power via an advanced conversion technology, for example gasification. Gasification converts biomass into a primarily gaseous product (syngas) through high-temperature thermochemical reduction in a low oxygen environment, (IEA Bioenergy, 2017). Generating heat and power from the syngas, rather than burning the biomass feedstock directly in a conventional steam boiler (for power generation via steam turbines), is potentially more efficient as it can be used in prime movers with higher electrical efficiencies such as gas turbines, gas engines and fuel cells (DECC, 2008). Smaller scale biomass gasification CHP plants are available. An example 200 kW wood power gasification plant requires 0.7 kg of wood fuel to produce 1 kWh electricity (IEA Bioenergy, 2017, p.22), this would result in an estimated annual electrical yield from biomass available in BCB to 18,185 MWh per annum; approximately 9% increase on the value calculated in table 15.

4.3.3 Conclusions

It is considered very unlikely that the identified biomass resource is of sufficient scale to be used in conventional (steam turbine) CHP applications, unless additional fuel is imported from outside the county borough. A more likely use for the resource identified is considered to be in smaller biomass boilers dispersed throughout the county borough or for generation of heat and power via advanced conversion technologies such as gasification, as the technology is more readily available for deployment at a smaller scale.

4.4 Energy from waste and anaerobic digestion

Welsh Government (2010) have set targets to achieve 70% waste recycling by 2025 and to reduce the impact of waste in Wales to within our environmental limits by 2050 – aiming to phase out residual waste and reuse or recycle any waste that is produced. Within *Prosperity for all: A low Carbon Wales*, Welsh Government (2019) introduce proposals to support the generation and recovery of energy from waste through waste management and innovation. When considering the potential for recovering energy from waste, and considering waste as a resource in these terms it is important that the Waste Hierarchy (as set out at Article 4 of the revised Waste Framework (Directive 2008/98/EC) is considered and prioritised (see Figure 17). Energy recovery from waste should be considered following measures to prevent, reuse or recycle waste, but in preference to landfill.

Energy can be generated from waste in a number of ways. Organic waste can be processed via anaerobic digestion (AD), which breaks down the organic matter in an environment without oxygen to produce:

> Biogas, which can either be burnt to produce power and/or heat or upgraded to biomethane which can be used as an alternative to natural gas
> Digestate, an organic fertiliser that can be used as an alternative to chemical fertilisers.

Residual waste can be sorted via mechanical biological treatment (MBT), so that recyclables are directed to a more appropriate conversion process and the remaining content can, similar to biomass, be converted into heat and/or power via direct combustion or advanced conversion technologies, e.g. gasification or pyrolysis to produce syngas (a gas composed of hydrogen, methane and carbon monoxide).

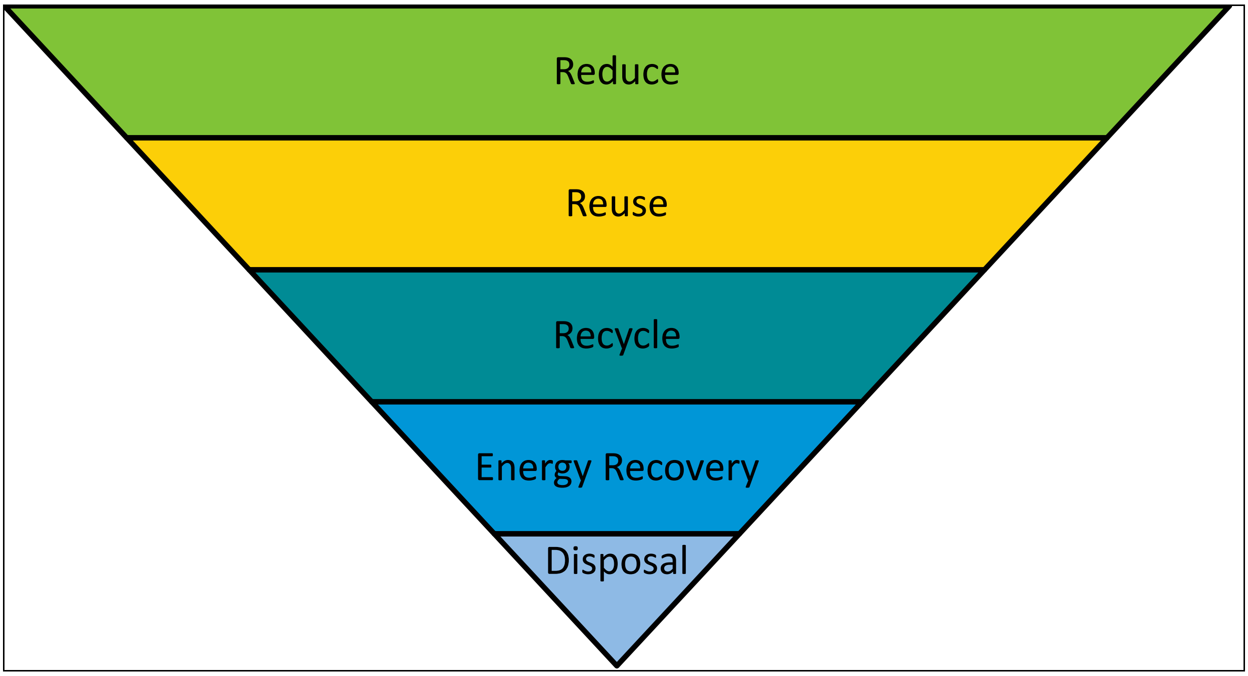


Figure 17: Waste hierarchy

4.4.1 Method

The methods used to determine the energy available from residual and organic waste within the county borough are summarised in Figure 18 and Figure 19 . With the energy estimates from residual, bulky and trade waste based on direct combustion and organic waste based on AD.

Residual, bulky and trade waste

Establish the current and 2033 projected Municipal Solid Waste and Commercial and Industrial waste management processes and amounts within the county borough from BCBC's Waste Management department

Estimate the amount of waste available for energy recovery: assuming available waste is equal to 30% of the total waste (Welsh Government, 2015)

Estimate the potential installed capacity if used for CHP or heat only using Welsh Government (2015) conversion factors

Estimate the biodegradable element (renewable energy fraction): assuming 35% is biodegradable (Welsh Government, 2015)

Figure 18: Method for estimating energy resource from residual, bulky and trade waste

Organic waste

Establish the current and 2033 projected food waste management processes and amounts within the county borough from BCBC's Waste Management department

Establish the quantity of sewage sludge available within the county borough from Welsh Water

Establish the quantity of livestock manure available within county borough from Welsh Government (2017b) data on livestock numbers and conversion factors provided in the Toolkit (Welsh Government, 2015)

Estimate the potential installed capacity if used for CHP, heat only or biomethane production.

Figure 19: Method for estimating the potential energy generation from organic waste

4.4.2 Results

Residual, bulky and trade waste

Table 11 proves the estimation of the renewable energy generation potential from residual, bulky and trade waste collected in BCB. Details regarding the current and projected waste quantities are provided in Appendix 4.

Note on current and projected waste quantities

The waste tonnage details were provided by BCBC's Waste Policy and Performance Officer and included a projection of waste increases (based on an assumption of a 1% increase in housing stock) to 2033 for all waste except food waste and trade waste. Food waste is predicted to fall during the period to 2033, as it assumed that households will waste less food in the future. Collection of trade waste was previously managed by BCBC internally, with waste collections undertaken by a contractor. Since 2017, the service has been entirely managed by an external contractor. The current figures provided in Appendix 4 relate to waste collected from BCBC's original clients. The third-party contractor is able to grow its business and its customer base, but BCBC would not receive details relating to any new contracts; for this reason, no estimations of growth to 2033 have been provided. As such Table 11 may underestimate the potential resource in the area, but still provides an indication of the resource that is controlled by the council.

Waste		Residual, bulky and trade waste
Anticipated waste quantity in 2033, residual, bulky and trade waste (tonnes p.a.)		21,500
Assumed proportion of waste that is available for energy recovery (Welsh Government, 2015)		30%
Anticipated waste quantity available for energy recovery in 2033 (tonnes p.a.)		6,450
Heat only energy use	Assumed quantity of waste (tonnes) required per 1 MW_{th} (Welsh Government, 2015)	1,790
	Boiler capacity (kW_{th})	3,603
	Assumed capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (kWh_{th})	15,782,682
	Assumed renewable proportion (Welsh Government, 2015)	35%
	Estimated renewable heating capacity (kW_{th})	1,261
	Estimated annual renewable heat yield (kWh_{th})	5,523,939
Energy used for CHP	Assumed quantity of waste (tonnes) required per 1 MW_e, *fuel required for 1 MW_e is assumed to also produce approximately 2 MW_{th} thermal output* (Welsh Government, 2015).	10,320
	CHP electricity capacity (kW_e)	625
	CHP thermal capacity (kW_{th})	1,250
	Assumed electrical capacity factor (Welsh Government, 2015)	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%
	Estimated annual electricity yield (kWh_e)	4,927,500
	Estimated annual useful heat yield (kWh_{th})*	5,475,000
	Assumed renewable proportion (Welsh Government, 2015)	35%
	Estimated renewable CHP electrical capacity (kW_e)	219
	Estimated renewable CHP thermal capacity (kW_{th})	438
	Estimated annual renewable electricity yield (kWh_e)	1,724,625
	Estimated annual renewable heat yield (kWh_{th})	1,916,250

Table 11: Estimated energy resource from residual, bulky and commercial & industrial waste

**The assumed thermal volume factor used to calculate the annual useful heat yield assumes that only 50% of the heat generated is used, with the remainder wasted (Welsh Government, 2015).*

As with the results for the biomass resource the energy yields associated with energy from waste is relatively small. Energy from waste plants are typically large-scale, centralised plants processing waste from areas outside of the immediate locality. For example, the operational energy from waste plant in Cardiff has an electrical capacity of 30 MW_e; approximately 50 times larger than the capacity calculated in Table 11. This plant processes approximately 172,000 tonnes of waste from Newport, Monmouthshire, Cardiff Vale of Glamorgan and Caerphilly.

Energy from waste would not be used to power/heat small-dispersed buildings, such as domestic properties or smaller properties, in the same way that biomass would. However, it may be possible for smaller advanced conversion generation technologies to be used to meet a smaller commercial load, or produce gas for another end use. Advanced conversion technologies tend to produce lower volumes of gas for clean-up compared to conventional waste incinerators, providing cost reductions, which could improve economic viability for processing smaller waste quantities.

BCBC's current waste management contract for residual waste is in place until 2030. As such, there may be little scope for BCBC to amend the current waste destination or process until towards the end of the LDP period, unless there are break clauses, or potential to vary existing contracts. Continuing research, testing and demonstration of advanced conversion technology energy from waste plants, may mean that a suitable technology is on the market for a more localised waste treatment at the end of the current contracts.

Organic waste

Estimates of the organic waste generated in BCB that could be processed using AD to produce energy are separated into individual waste streams in Table 12, Table 13, Table 14 and Table 15. Green waste is currently processed via composting; this is considered a more appropriate waste management technique for this sub-set of organic waste due to the high lignum (woody) content of the waste, which makes it less suitable for AD. Welsh Government (2015) provide details of the energy potential from the biogas produced if used to generate heat in a boiler with an 80% efficiency (see note below) or used in a CHP plant. The energy content of the biogas if it is upgraded to biomethane is also estimated in this assessment (assuming a 2% loss of energy during the biomethane upgrade). The final useful energy content of the biomethane will depend on the final use, e.g. if it is injected into the gas network and used in domestic boilers or compressed and used as a vehicle fuel.

Notes on heat only energy use calculation

Welsh Government (2015) only provide a method for calculating heat-only energy use for biogas generated from cattle/pig manure. The heat only energy use calculations for the other organic waste sources have been calculated from the CHP energy output calculations assuming 30% electrical efficiency and 80% biomass boiler heat efficiency (Welsh Government, 2015, p.167).

Number of cattle		6,311
Annual tonnes of manure generated per head of cattle (assuming they are housed 6 months of the year)		6
Estimate of cattle manure that is assumed available for anaerobic digestion (wet tonnes p.a.)		37,866
Number of pigs		312
Annual tonnes of manure generated per pig (assuming they are housed 6 months of the year)		0.6
Estimate of pig manure that is assumed available for anaerobic digestion (wet tonnes p.a.)*		187
Total manure available		38,053
Total manure likely to be able to be used, assuming 50% of farms use a slurry-based waste system, and 50% of waste from these farms can be collected i.e. 25% of the total		9,513
Heat only energy use	**Tonnes of manure required per 1MWth (Welsh Government, 2015)**	47,000
	Boiler capacity (kW_{th})	202
	Assumed capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (kWh_{th})	886,559
Energy used for CHP	**Assumed quantity of waste (tonnes) required per 1 MW_e, *fuel required for 1 MW_e is assumed to also produce approximately 1.5 MW_{th} thermal output* (Welsh Government, 2015)**	225,000
	CHP electricity capacity (kW_e)	42
	CHP thermal capacity (kW_{th})	63
	Assumed electrical capacity factor (Welsh Government, 2015)	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%
	Estimated annual electricity yield (kWh_e)	333,346
	Estimated annual useful heat yield (kWh_{th})	277,788
Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (kWh)**	1,086,034

Table 12: Energy generation potential from cattle and pig manure

Whilst the electrical/heating capacity provided in Table 12 is relatively small, on farm AD plants in the UK range in capacity from 3 kW_e to 14.4 MW_e (The Official Information Portal on Anaerobic Digestion, 2019). Additionally, the majority of on-farm operational AD plant listed on The Official Information Portal on Anaerobic Digestion (2019) database of operational plants use a combination of feedstocks; supplementing animal manure/slurry with crops or food waste. The addition of crops/food waste helps to stabilise the AD process and increase the energy yield, as manure has a low energy content. Anaerobic digestion of animal waste is beneficial in terms of energy production but also in terms of the treating the waste, and providing a fertiliser, which can displace the need for chemical fertilisers resulting in further carbon emissions saving.

Number of birds		13,754
Assumed annual kg of poultry litter generated per bird per year		42
Assumed proportion of litter which can be utilised for anaerobic digestion		75%
Estimate of poultry litter that is assumed available for anaerobic digestion (wet tonnes p.a.)		433
Heat only energy use	**Boiler capacity (kW_{th})**	189
	Assumed capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (kWh)	828,061
Energy used for CHP	**Assumed quantity of waste (tonnes) required per 1 MW_e, *fuel required for 1 MW_e is assumed to also produce approximately 1.5 MW_{th} thermal output* (Welsh Government, 2015)**	11,000
	CHP electrical capacity of poultry litter resource (kW_e)	39
	CHP thermal capacity of poultry litter resource (kW_{th})	59
	Assumed electrical capacity factor (Welsh Government, 2015)	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%
	CHP electrical generation per annum from poultry litter (kWh p.a.)	310,523
	CHP thermal generation per annum from poultry litter (kWh p.a.)	258,769
Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (kWh)**	1,014,375

Table 13: Estimated energy generation potential from poultry litter

Welsh Government (2015) suggest that it is unlikely that a dedicated poultry litter power plant would be built if the potential capacity is less than 10 MW_e, however the resource could go towards supporting other AD facilities. The Official Information Portal on Anaerobic Digestion (2019) database of operational plants lists one dedicated poultry litter AD plant with a capacity of 3 MW_e, the other plants that process poultry litter, do so alongside other feedstocks including food waste, energy crops and other animal manures.

Waste		Food waste
Anticipated waste quantity in 2033 (tonnes p.a.)		6,852
Heat only energy use	Boiler capacity (kW_{th})	1,644
	Assumed capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (kWh_{th})	7,202,822
Energy used for CHP	Assumed quantity of waste (tonnes) required per 1 MWe, fuel required for 1 MWe is assumed to also produce approximately 1.5 MWth thermal output (Welsh Government, 2015)	20,000
	CHP electrical capacity of available food waste	343
	CHP thermal capacity of available food waste	514
	Assumed electrical capacity factor (Welsh Government, 2015)	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%
	CHP electrical generation per annum from available food waste (kWh p.a.)	2,701,058
	CHP thermal generation per annum from available food waste (kWh p.a.)	2,250,882
Energy used as biomethane	Estimated annual energy content of biomethane, before end use (kWh)	8,823,457

Table 14: Estimated energy generation potential from food waste

Food waste in Bridgend is currently processed at the Stormy Down AD plant in the west of the county borough. The AD plant at Stormy Down processes approximately 50,000 tonnes of food waste per year (including waste that is imported from outside the county borough) and has a capacity of 3 MWe. If the ambition to reduce food waste generated is realised, it might be possible to replace the reduced food waste with the agricultural waste resource identified in Table 12 and Table 13. The biogas produced at Stormy Down is currently combusted in a CHP engine, with some of the heat used for the anaerobic digestion processes but the remaining heat is wasted. It is understood that Severn Trent (the facility owners) are investigating the possibility of upgrading the biogas to biomethane and injecting this into the gas network (BCBC, 2019).

CARBON TRUST

Sewage sludge collected at Welsh Water's sites in Bridgend County Borough (tonnes of dry solids per annum)		1,734
Heat only energy use	Boiler capacity (kW_{th})	640
	Assumed capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (kWh_{th})	2,804,990
Energy used for CHP	Assumed quantity of waste (tonnes) required per 1 MWe, fuel required for 1 MWe is assumed to also produce approximately 1.5 MWth thermal output (Welsh Government, 2015) (Welsh Government, 2015)	13,000
	CHP electrical capacity of sewage sludge in 2033	133
	CHP thermal capacity of sewage sludge in 2033	200
	Assumed electrical capacity factor (Welsh Government, 2015)	90%
	Assumed thermal capacity factor (Welsh Government, 2015)	50%
	CHP electrical generation per annum from sewage sludge in 2033	1,051,871
	CHP thermal generation per annum from sewage sludge in 2033	876,559
Energy used as biomethane	Estimated annual energy content of biomethane, before end use (kWh)	785

Table 15: Estimated energy generation potential from sewage

Welsh Water have confirmed that the sewage sludge is transported outside of the county borough to one of their anaerobic digestion plants (located near Cardiff, Port Talbot, Hereford and Wrexham), which are used to generate renewable energy. Currently ~25% of all the power that Welsh Water use is renewably generated by their own assets (including wind, solar, AD and hydro generation assets) and the remainder is renewable power, sourced from their electricity supplier (REGO backed). Whilst Welsh Water intend to expand their portfolio of renewable generation assets, they do not currently have any plans to develop any in the Bridgend County Borough area.

Whilst the sewage sludge is used to generate renewable energy, the Toolkit (Welsh Government, 2015) advises that energy generated from waste at a facility outside of the BCBC's authority area should not count as contributing to BCBC's energy targets, and therefore energy potential from this source is not considered further in this assessment.

4.4.3 Conclusions

Due to the capacity of existing plants in South Wales and the scale of waste collected in Bridgend it is considered unlikely that a traditional energy from waste plant would be able to be developed in Bridgend within the LDP period. It may be possible for smaller advanced conversion generation technologies to be used to process the waste and directly supply a small commercial electricity load, or produce gas for another end use. Current waste management contracts are due to end towards the end of the development plan period which may provide an opportunity to consider the deployment of a local advanced conversion technology generator within the county borough, rather than continue to export the residual waste to centralised plants outside of the county borough.

The operational AD plant at Stormy Down processes food waste generated within and outside of BCB. Food waste is predicted to reduce over the LDP period but it is possible that the reduction in feedstock from food waste could be offset if the existing plant is able to diversify and accept organic farm waste. Whilst the resource potential from organic farm waste is relatively small, analysis of data relating to operational on-farm AD plants show that they tend to process a mix of feedstocks (including energy crops alongside manure/slurry) and therefore there may be potential for several smaller plants to develop.

From the information provided by Welsh Water it is considered unlikely that the sewage sludge collected in BCB will be able to be processed in BCB within the LDP period, and therefore this should not be considered further as a potential resource within this assessment.

4.5 Hydropower energy resource

According to planning application data provided by BCBC (2019) there are two consented micro hydro power developments located within Bridgend County Borough; one at Evanstown, consented in 2015 and a second in Llangywnwyd consented in 2012. It is assumed that the development at Llangwynwyd progressed to installation, however it is understood that the Evanstown development did not proceed due to reduced economic viability of the scheme. The removal of the Feed-in tariff has had a big impact on the viability of onshore hydropower developments. Previously hydropower developments benefited from relatively high Feed-in Tariff rates, due to their higher capital costs. Whilst the capital costs are high, the economic life of hydropower projects are relatively long, and can be in excess of 35 years. In the absence of subsidies and incentive mechanisms, hydropower developments that are directly connected to an electricity load are going to be more likely to provide the economic returns required to enable a project to progress. The study into community scale renewable energy opportunities in rural areas of Bridgend (Gower Power and Juno Energy, 2016) looked to identify hydropower developments that met this criterion. This report identified three projects totalling 289 kW. This included the consented 39 kW development at Evanstown *(Gower Power and Juno Energy (2016) estimate the potential at Evanstown to be 39 kW, TGV Hydro (2014) suggested 36.5 kW in their original feasibility study).*

4.5.1 Method

The method used to estimate the hydropower energy resource available in the previous Renewable Energy Assessment (BCBC, 2011c) has been followed and updated to identify the consented developments in the county borough. This is summarised in Figure 20.

The method utilises the results of a study into micro hydro opportunities in England and Wales undertaken by the Environment Agency (2015). This study looked to assess the potential for micro hydropower developments at existing barriers present in rivers in Wales and England. It estimated the head height and flow at the barriers in order to estimate the potential power available. It also assessed the environmental sensitivity of each of the sites. "Win-win" opportunities were identified where the potential power capacity was estimated to be in excess of 10 kW and where the water body had been heavily modified already. There is a high-level of uncertainty associated with this data; *"There is not a level of high confidence for its current accuracy. These data are intended to provide a general national and regional overview of the potential hydropower opportunities available, their locations, and their relative environmental sensitivity to exploitation*" (DEFRA, 2019). In addition to the opportunities identified in the Environment Agency (2015) data, there will be a number of additional sites in upper catchments in locations that do not have an existing barrier, which will provide additional opportunity for hydropower development, although these are likely to be limited in terms of their individual power capacities.

Estimate likely potential for onshore micro hydro developments within Bridgend County Borough using data on "win-win" opportunities provided by the Environment Agency (2015)

Identify if any potential opportunities have been exploited from planning consent data (BCBC, 2019)

Figure 20: Method for estimating energy resource from hydropower

4.5.2 Results

The results of the assessment are provided Table 16.

Number of barriers / opportunities identified	Total power potential (MW)	Proportion of opportunities identified as "win-win"	Power potential of "win-win" opportunities (MW)	Identified opportunities already exploited (MW)	Capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh p.a.)
62	1.86	48%	0.9	*None (identified development installed, assumed to equal up to 0.05 MW is not located at opportunities identified).*	0.37	2,917

Table 16: Hydropower potential and existing generation assets within Bridgend County Borough

Figure 37 in Appendix 3 locates the identified hydropower potential and existing stations within BCB, and shows that the consented hydropower developments are not located at the site of existing barriers. Details provided in the planning applications, explain that:

> the proposed intake structure of the Evanstown project was located within Rhondda Cynon Taf County Borough at the face of the first of three man-made steps on the river Ogmore (TGV, 2014), and
> the proposal for the Llangwynwyd project was to rebuild the weir that previously diverted water to a water mill (BCBC, 2011a).

NRW were consulted during the development of this Renewable Energy Assessment and advised that, although supportive of developing renewable energy schemes, legislation and policy requires a balance with environmental protection and river restoration. In some cases, this means reconnecting fragmented river ecosystems through barrier removal rather than utilisation of existing barriers for hydropower generation, particularly in lower catchment rivers and streams.

NRW have suggested that small-scale pumped storage hydro, preferably with a closed system and minimal interference with natural hydrological systems, may be a more appropriate use for this resource in the future. Currently pumped storage plants are typically multi megawatt in capacity, but with the increased importance of energy storage this may become an emerging technology during the LDP period.

4.5.3 Conclusions

The relatively small-scale nature of the hydropower resource identified in the county borough, the current low economic viability of hydropower sites (evidenced through the lack of development of the consented Evanstown development) and the advice from NRW indicates that other renewable energy resources should be prioritised above run of river hydropower developments in Bridgend.

Due to the stage of development of small-scale pumped storage hydro the potential resource available in Bridgend associated with this technology has not been quantified but its potential could be considered when developing renewable energy planning policies.

4.6 Building-integrated solar PV uptake assessment

In addition to ground mounted solar PV, building integrated, roof-mounted solar PV has seen large-scale deployment over the last decade. Roof-mounted solar PV provides a good use of otherwise unused space, and generates electricity that can offset the need to import electricity from the electricity network. Whilst the diurnal generation profile may not match particularly well with a typical domestic diurnal demand pattern, the potential growth in storage (both electrical and thermal) and roll-out of electric vehicles, may remedy this. Roof-mounted PV on buildings that are used during the day, e.g. offices, represent a very good use of the technology.

4.6.1 Method

The simplified method provided within the Toolkit (Welsh Government, 2015) is based on a future date of 2020. As such, another method for estimating building-integrated solar PV uptake is required. As suggested by the Toolkit, the potential for future uptake is split into domestic and non-domestic sectors.

Solar PV uptake in new buildings is likely to be influenced by building regulations and planning requirements, whereas solar uptake in existing buildings is at the discretion of the building owner, which may be more related to financial viability and the desirability of solar PV installed in a domestic setting.

As detailed in section 2, National Grid ESO publish an annual Future Energy Scenarios document, which details potential future pathways for our energy system (National Grid ESO, 2019a). These scenarios are not forecasts or predictions but provide credible pathways for how the energy system may evolve over the next 30 years. As discussed in section 2, the Community Renewables scenario (National Grid ESO, 2019a) appears to best reflect the potential future described in the Bridgend Local Area Energy Strategy (ETI, 2018b), with a high deployment of low carbon heating, especially heat pumps, district heating and biofuels.

Within the detailed data provided by National Grid ESO (2019b), electricity generation capacity projections are separated into transmission capacity, distribution capacity and microgeneration. Microgeneration is defined as; *"Microgeneration is the small-scale generation of electric power by individuals, small businesses and communities to meet their own needs, as alternatives or supplements to traditional centralised grid-connected power"* (National Grid ESO, 2019a, p.164). It is considered that the majority of microgeneration in BCB will result from roof-mounted solar PV developments. Figure 21 provides the National Grid ESO (2019b) electricity generation capacity projections for the Community Renewables scenario (separated into transmission, distribution and micro capacity). The growth rates suggested for the level of micro generation across the UK, summarised in Figure 21, have been used to inform the potential uptake of solar PV in BCB in 2033, as stated in the method summarised in Figure 22.

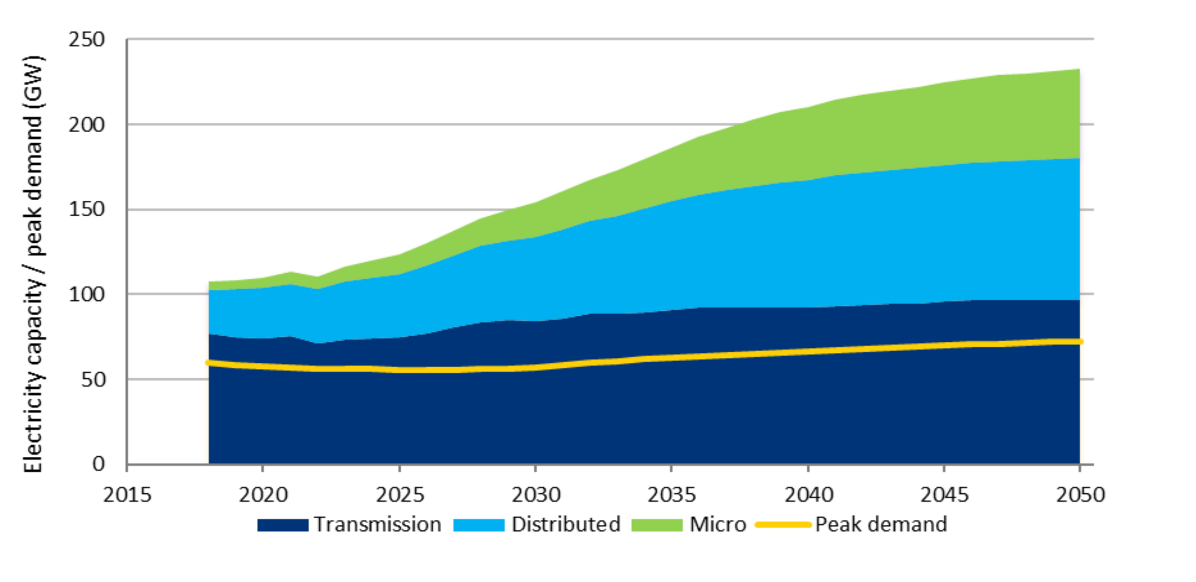


Figure 21: National Grid ESO (2019a) electricity capacity projections for the Community Renewables scenario (separated into transmission, distribution and micro capacity)

(National Grid ESO, 2019b)

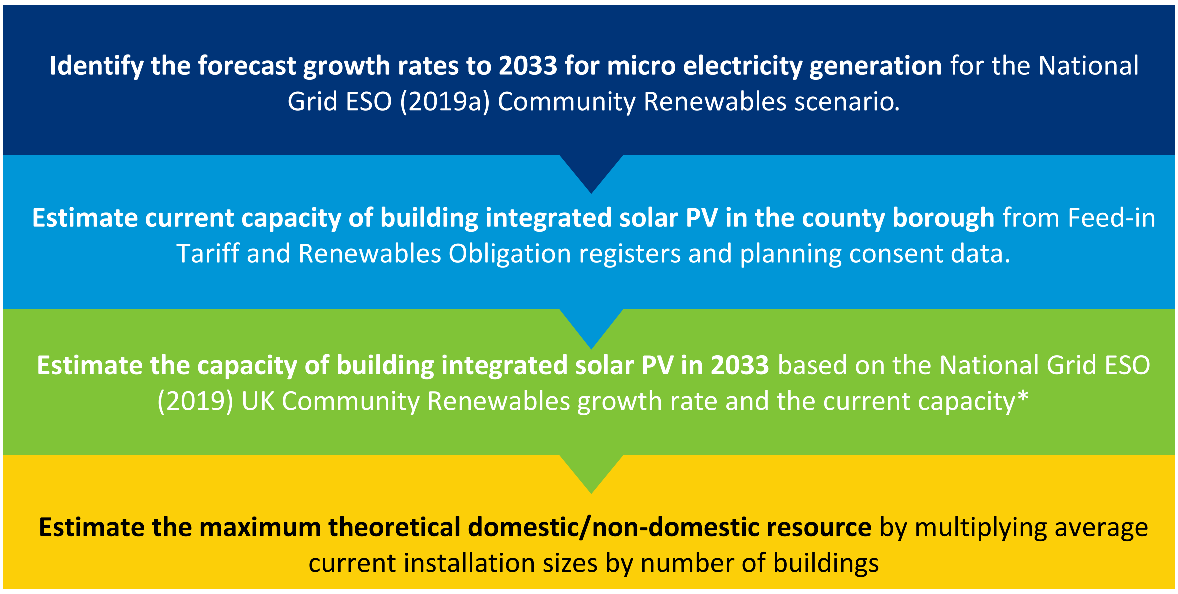


Figure 22: Method for estimating rooftop solar PV uptake

**Assumes the local rooftop solar PV growth rate will equal the projected national growth rate for all micro-generation capacity.*

4.6.2 Results

An estimate of solar PV uptake by 2033, based on the predicted growth rate in microgeneration in National Grid ESO's (2019a) Community Renewables scenario is provided in Table 17. Table 17 also provides an estimate of the maximum rooftop PV resource within the county borough, if all buildings (excluding flats) were suitable for installing the current average PV capacity on.

	Domestic	Non-Domestic	Total
Number of buildings (excluding flats, bedsits and caravans)	59,448*	6,810**	
Ground mounted capacity – estimated from planning application data (MW)		0.53	0.53
Rooftop capacity – assumes all domestic installations are roof-mounted (MW)	6.5	1.7	8.1
No. of installations	1,969	337	2,306
Mean installation capacity (kW)	3	5	
Assumed capacity factor	0.1	0.1	
Estimated maximum capacity *(Capacity if all buildings, excluding flats installed mean installation capacity of PV)* (MW)	178.3	34.1	212.4
Estimated generation if all buildings installed mean installation capacity of PV (MWh p.a.)	156,229	29,828	186,057
FES Community Renewables Distributed Solar PV Growth Rate %	502%	502%	
FES Community Renewables (MW)	32.5	8.3	40.8
FES Community Renewables (MWh p.a.)	28,458	7,292	35,751
FES Community Renewables projection proportion of estimated maximum capacity	18%	24%	19%

Table 17: Estimate of rooftop solar PV capacity installed under the National Grid ESO (2019a) Community Renewables future energy scenario

(National Grid ESO, 2019b)

**number of dwellings is based on data provided relating to existing domestic properties in Bridgend County Borough by BCBC*

***number of non-domestic buildings is based on projections used by ESC for the number of non-domestic properties at the end of the current LDP plan period (ESC, 2019a)*

4.6.3 Conclusions

The estimated roof-top PV capacity if all buildings are installed with the average capacity of current installations is five times larger than the capacity estimated from the National Grid ESO (2019b) Community Renewables growth rate. The estimated maximum capacity assumes that all buildings are suitable for PV installations, which is unlikely to be the case due to roof conditions, orientations etc. The calculation provides an indication that approximately 20% of building roof space in BCB would require installation to achieve the growth rates modelled (National Grid ESO, 2019b). It is considered realistic that this proportion of building roof-space can be utilised.

5. Comparison of potential energy generation resource and energy demand

5.1 Method

To understand the potential within Bridgend County Borough to meet its own energy demand the resource potential and existing generation capacity identified in sections 3 and 4 are compared to the energy demand estimations calculated in section 2.

5.2 Results

The results are provided in Figure 23 and Figure 24 and show that by 2033 Bridgend County Borough could theoretically generate more energy from renewable sources than it is projected to consume. However, this assumes that all of the ground mounted solar PV capacity in the county borough is installed and that resource exploitation is not mutually exclusive, e.g. that areas identified for solar PV are not used to grow woody energy crops. As discussed in section 4.2 it is unlikely that all of the solar PV capacity identified could be installed due to grid capacity, visual impact issues, and land use competition. The biomass heat generation figures are based on heat only generation from biomass.

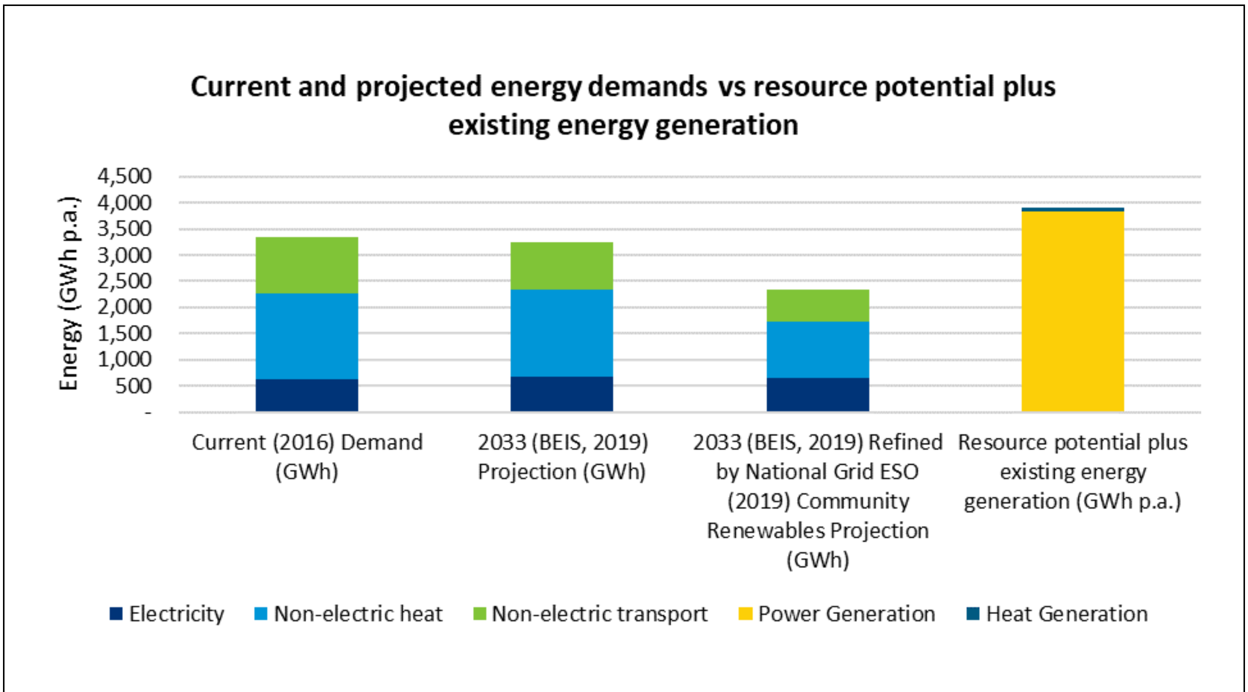


Figure 23: Summary of current and projected energy demand vs energy generation potential identified in BCB

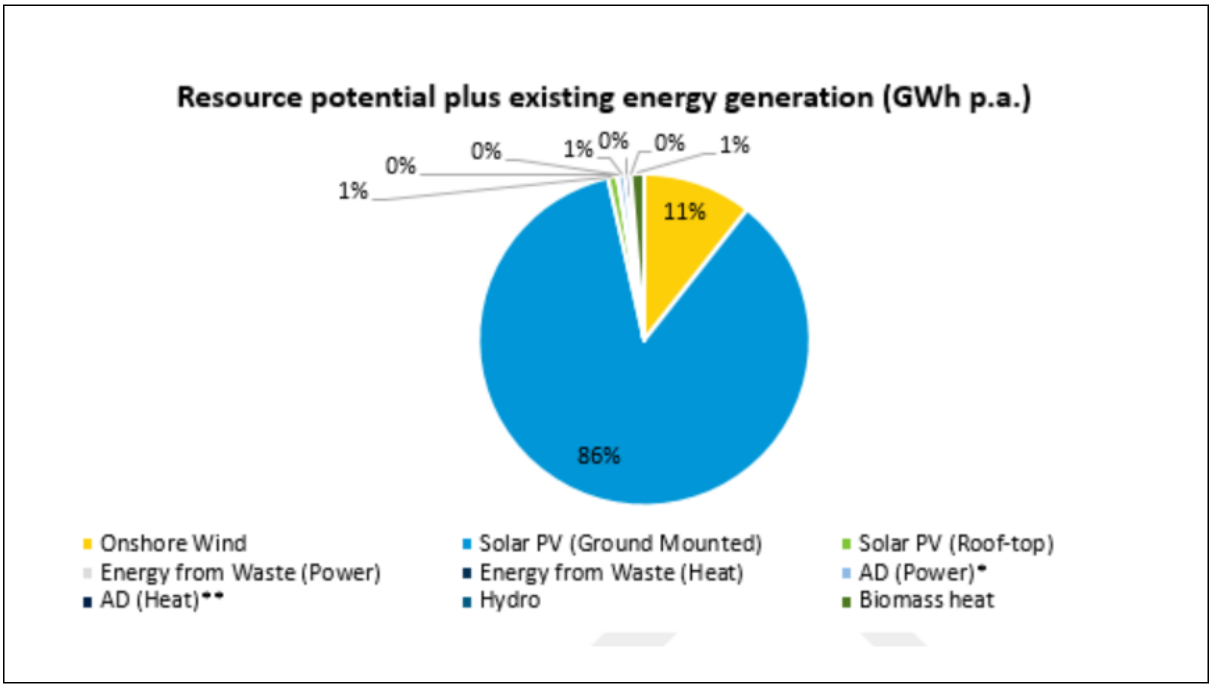


Figure 24: Summary of identified resource potential

**AD (Power): current electricity generation plus CHP potential from livestock waste*

***AD (Heat): thermal generation potential based on existing plant capacity at Stormy Down and from livestock waste produced in Bridgend*

With respect to Welsh Government's target of providing 70% of electricity demand from renewable sources by 2030, 70% of the projected 2033 electricity demand (based on the National Grid ESO refined projection) is equivalent to the total wind generation potential identified and 1% of the solar PV generation potential.

5.3 Conclusions

Whilst the estimated energy generation potential from renewable sources within BCB exceeds the projected 2033 energy demand, it is not considered possible for all the identified solar PV potential to be exploited due to grid capacity, landscape, visual and cumulative impacts, and competition with other land uses. Either a suitable proportion of the solar potential identified should be targeted or specific priority locations identified in order to ensure that developments progress in the most appropriate manner and that the resource potential, within reason, is maximised.

Energy exploitation from other resources should be maximised in order to ensure a mix of energy technologies progress so that the potential to match energy generation with demand is maximised. It is worth noting that it is unlikely that the time of generation would exactly match the time of demand and therefore energy storage and/or energy imports from elsewhere are still likely to be required to ensure security of supply.

6. Bridgend County Borough heat opportunities

Notes on Bridgend County Borough heat opportunities section

BCBC, with Energy Systems Catapult (ESC), the Energy Technologies Institute (ETI) and others, have developed a Local Area Energy Strategy for decarbonising carbon emissions associated with buildings in the county borough by 95% by 2050 from 1990 levels (ETI, 2018b). ***This section summarises the work undertaken and conclusions made when developing this Strategy and does not necessarily reflect those of The Carbon Trust.***

Decarbonisation of heating is identified as one of the greatest challenges to meeting energy sector carbon reduction targets. It will require changes to the energy system inside and outside of people's homes and upgrades to the fabric of buildings. Almost all domestic heating systems will require replacement, and the gas grid is likely to be largely scaled back or converted to alternative fuels, such as hydrogen. The Smart Systems and Heat programme was a UK public/private sector partnership programme, which ran from 2012-2019. The programme was delivered in two parts, with:

- Part 1; developing software tools to design location-specific smart energy systems and researching consumer behaviour, technology development, business modelling and supply-chain activities to support decarbonisation of domestic heating that meets consumer requirements (ESC, 2018b), and
- Part 2; bringing together all members of the energy system (from network operators and energy suppliers to technology providers and consumers) to work together to accelerate the decarbonisation of the domestic heating market (ESC, 2018b).

The Smart Systems and Heat programme worked with three local authorities; Bridgend County Borough Council, Newcastle City Council and Greater Manchester Combined Authority. The authorities were selected to partake in the programme in 2014.

During part 1 of the programme the ETI and ESC worked with BCBC to undertake local area energy planning and identify project opportunities and a Local Area Energy Strategy (the Strategy) to achieve a 95% reduction in carbon emissions from buildings by 2050 (against a 1990 baseline) in the most cost-effective manner (ETI, 2018b). Part 2 of the programme focused on developing a Smart Energy Plan (the Plan) for delivery of the first phase of the Strategy to 2025 (ESC 2018b). The Plan primarily focuses on identifying innovation opportunities to deliver on the Strategy's recommended activities for beginning to tackle potential barriers to decarbonisation of domestic heating (ESC, 2018b).

6.1 Method

Rather than follow the guidance provided by Welsh Government (2015) to identify low carbon heat opportunities within Bridgend County Borough, this evidence base summarises the methodology undertaken and the results provided by the local area energy planning undertaken and the Strategy developed through the Smart Systems and Heat programme.

The Smart Systems and Heat programme considered that decarbonisation of domestic heating required a whole systems approach to inform decisions on the most appropriate mix of building improvements, heating technologies and business models. A whole system approach considers all elements of the heating system, including fuels, distribution networks, heating technologies, market mechanisms, regulations and consumer needs and preferences (ESC, 2018a). Whole systems decision-making on future heating systems requires understanding of the local environment in terms of building stock, energy network capacity and other local characteristics. Through local area energy planning, different energy futures were investigated in order to identify the most cost-effective and promising decarbonisation options for Bridgend County Borough, to help plan and justify energy network investments and encourage market stimulation in the most appropriate manner (ETI, 2018b). The modelling considered heating system types, building fabric upgrades, and integration of controls. The seven steps followed by ESC in undertaking local area energy planning (ESC, 2018a) are summarised in Figure 26 and Figure 26. Further information is available in ESC's (2018a) publication *Local Area Energy Planning: Supporting clean growth and low carbon transition* and the *Bridgend Local Area Energy Strategy* (ETI, 2018b).

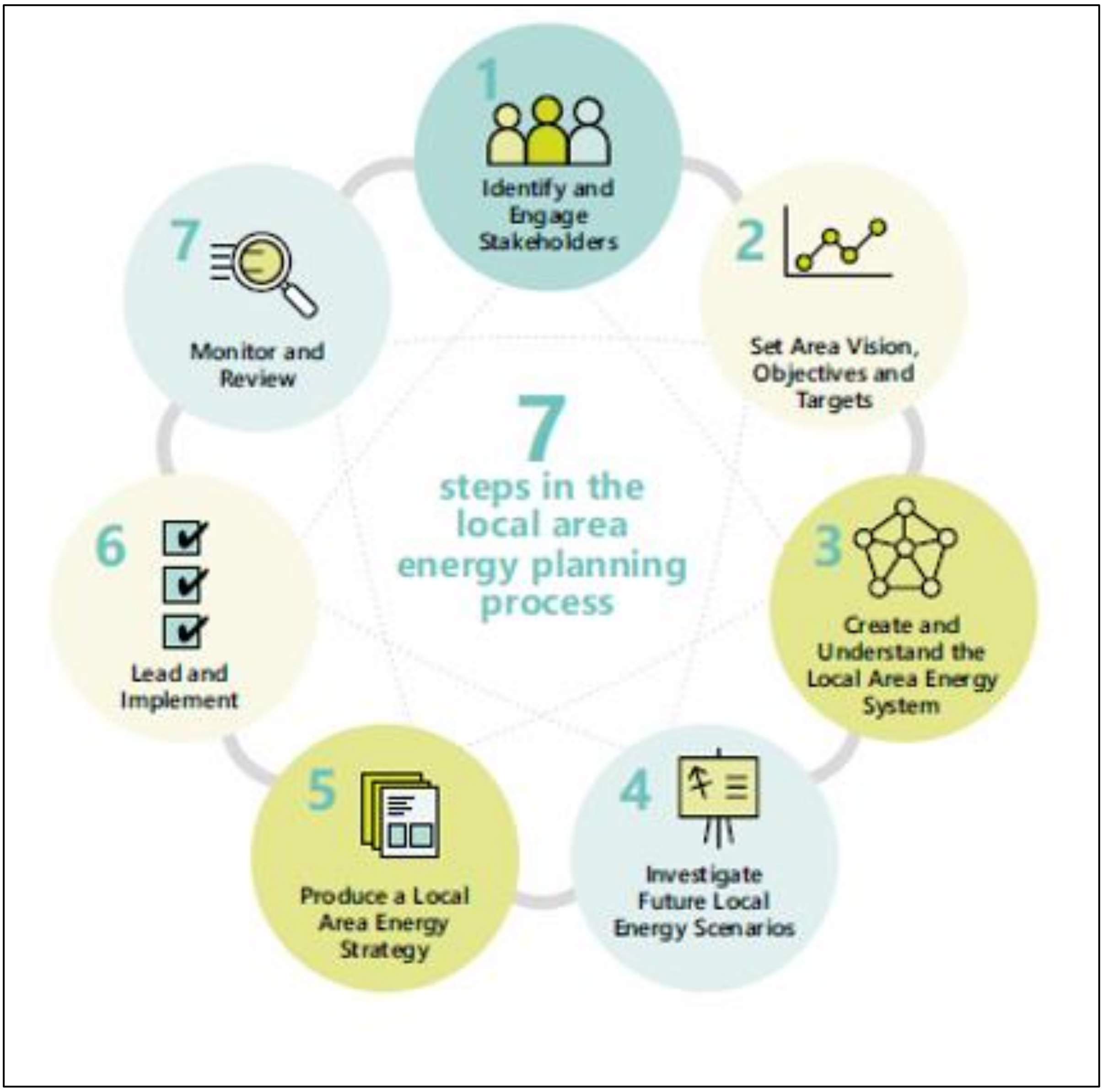


Figure 25: Energy Systems Catapult's seven steps to local area energy planning

(ESC, 2018a, p.17)

1. Identify and engage with stakeholders: A stakeholder group consisting of BCBC, Energy Systems Catapult, Welsh Government, Western Power Distribution and Wales and West Utilities helped inform the modelling and strategy development.

2. Set area vision, objectives and targets: BCBC's vision is *"…to make Bridgend a decarbonised, digitally connected smart County Borough. In doing so it will transition from the current national, centralised energy system to a future low carbon, decentralised energy system that works for its individuals, communities and businesses"* (ESC, 2018). The Local Area Energy Strategy targets a 95% reduction in carbon emissions from Bridgend's buildings by 2050.

3. Create and understand the local area energy system. The local area energy system was modelled using ESC's optimisation model, EnergyPath Networks, a sophisticated tool which uses information relating to the current local energy system and environment, future national trends in energy supply and societal influences to identify the most cost-effective route to achieving specified carbon targets (ETI, 2018a). The modelling assumes that the national electricity supply decarbonises in line with targets, and the outputs rely on these being achieved.

4. Investigate Future Local Energy Systems: Insights were drawn from over 100 different potential future energy scenarios (considering different potential future energy and technology costs, technology development, carbon factors, storage availability, etc.). An in-depth analysis of three scenarios was undertaken: Business-as-Usual, a future with high penetration of green gas and a scenario without green gas.

5. Produce a Local Area Energy Strategy: The Local Area Energy Strategy (ETI, 2018b) was developed by assessing domestic decarbonisations trends across many possible decarbonisation pathways and identifying recurring low carbon transition themes to be explored and tested further.

6. Lead and implement: BCBC are developing and implementing a pipeline of innovation and deployment decarbonisation projects, as set out in their Smart Energy Plan (ESC, 2018b), which details the first implementation stage of their Strategy.

7. Monitor and review: BCBC will use learning from innovation projects undertaken in BCB and elsewhere to review the Strategy and produce further Smart Energy Plans to ensure that the most appropriate decarbonisation routes are followed. Information from this process should inform the evidence base for future local development plans.

Figure 26: Energy Systems Catapult's seven steps to local area energy planning with Bridgend County Borough

(ESC, 2018a, 2018b, ETI, 2018a, 2018b)

Further details regarding the data included in the dynamic modelling and the ten spatial analysis areas considered are provided in Appendix 5.

Insights drawn from the results of all of the potential future scenarios modelled include:

- Predominant heating types installed in each of the analysis areas considered within the model by 2050, which were prevalent across each of the scenarios
- Building/environment characteristics that commonly resulted in certain heating types.

(ETI, 2018b)

The modelling assumed that heating systems would only be replaced at the end of their asset life, leading to two principle transition periods in the 2020s and 30s (ESC, 2019a). In reality, however, ESC (2019a) acknowledge that increases in heat network connections and heating system installations will be spread out across the study period.

In order to help inform this renewable energy assessment, ESC (2019b) provided estimations for heat network and heat pump deployment in 2030, in the predominant areas for these technologies by linearly interpolating between the 2020 average values across all model runs and 2050 average values across all model runs. To ensure that the values were representative of the whole local development plan period, the figures provided by ESC (2019b) have been further interpolated (between 2030 and 2050) to generate a corresponding figure for 2033.

In performing linear interpolation, no assumptions about how technology installations might be clustered spatially or staggered by property type, tenure, etc. have been considered, for example targeting of particular neighbourhoods for initial district heating development, due to the density of buildings and anchor heat loads (ESC, 2019a).

The Strategy acknowledges that none of the heating systems considered have been deployed at scale in the UK, and therefore significant work is required to ensure that the solutions proposed can be made commercially viable at scale, in order to achieve the deployment figures modelled (ETI, 2018b). The first phase of the Strategy (outlined in the Smart Energy Plan) is for BCBC to progress a number of innovation and deployment projects which will help to test the implementation of different technologies and inform how the Strategy progresses.

6.2 Results

The Local Area Energy Strategy identifies predominant heating types in each of the ten analysis areas considered in the modelling, as shown in Figure 27. District heating was identified as the dominant heating type in the more densely populated areas of Bridgend. Where a mixture of options emerged, with no one heating type dominant, the area in Figure 27 is identified as Electricity/District heat mix.

The electric areas identified in Figure 27 are in general areas where heat pumps dominate the electric heating system mix in 2050 (ETI, 2018b). It is suggested that further feasibility studies and research are required to decide exactly which heat pump types are most appropriate for each building, however the following insights are provided:

- Ground source heat pumps (GSHPs) have lower lifetime costs compared to air source heat pumps (ASHPs) and therefore tend to be selected in preference to air source heat pumps when possible. The model has however restricted selection of ground source heat pumps to detached buildings due to access and land restrictions.
- Hybrid heat pumps have tended to only be selected by the modelling software in buildings with poor energy efficiency ratings, where the extra cost of a gas boiler backup is necessary to meet heating requirements. This could present particular challenges, e.g. the commercial viability of

maintaining a gas network to serve less customers for a smaller proportion of the year, and does not acknowledge the potential role for hybrid heat pumps as a transition technology to move consumers from gas boiler to heat pump heating systems.

(ETI, 2018a)

Table 18 and Table 19 provides estimates for the 2033 level of heat pump/heat network installation within the areas where these technologies were identified as dominant technology types. As described above the data was derived from the average deployment rates across all the model runs interpolated to 2033. The electric/district heat mix areas are described as uncertain in the Local Area Energy Strategy (ETI, 2018b) as such numbers have not been provided for the individual technologies in these areas. As can be seen within each of the areas a mix of heating technologies are identified, as such, whilst it may be appropriate for some homes within analysis areas two, eight and nine to connect to a district heat network, it may be appropriate for others to install a heat pump or biomass system

Whilst the total values calculated in Table 18 and Table 19 do not include four of the analysis areas, the numbers are considered to provide an appropriate capacity deployable by 2033 in Bridgend in order to achieve the 2050 targets. The Smart Energy Plan (ESC, 2018b) suggested that one pathway to achieving the targeted reduction in carbon emissions from domestic buildings would be for a relatively small reduction in emission to be achieved between 2020 and 2030, and a greater emissions reduction between 2030 and 2050, by implementing the learning from innovation projects deployed in the near-term. Learning from the innovation projects, will help to determine which technologies should be deployed where, which may be particularly useful in the areas where no dominant heating technologies have been identified.

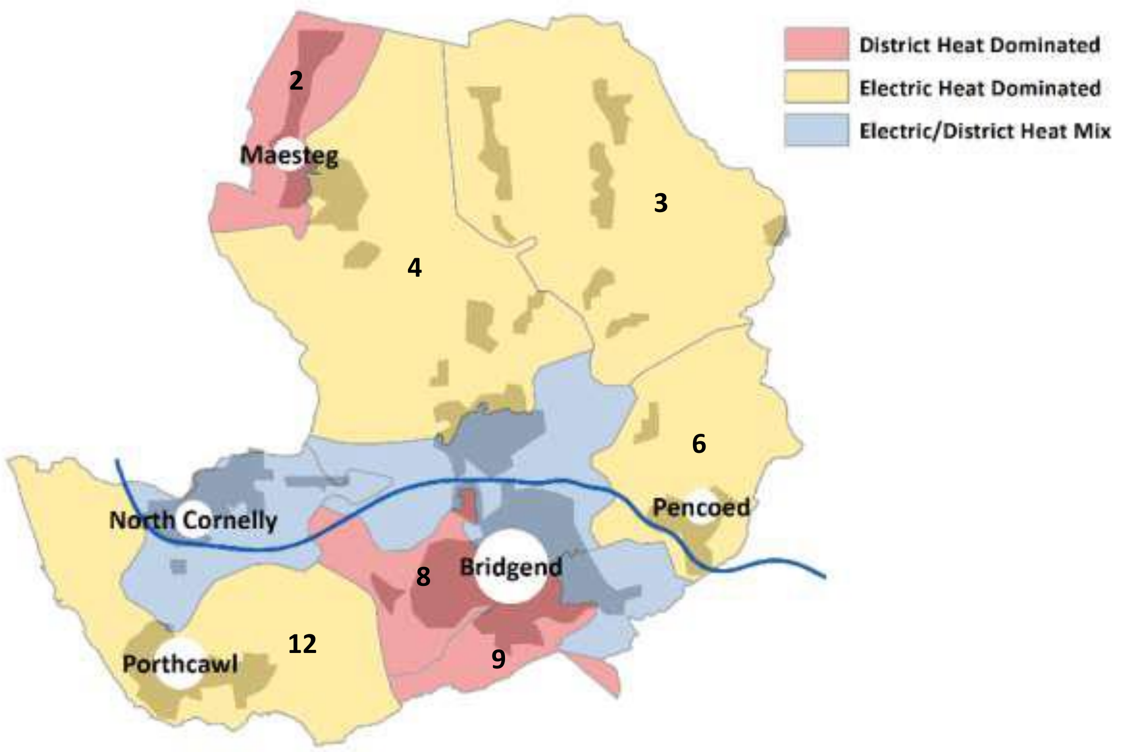


Figure 27: Dominant Heating Systems in 2050 by Area

(ESC, 2018b) (OS data © Crown copyright and database right 2018)

Analysis area	3 (Ogmore valley area)	4 (Garw valley and Lower Llynfi valley area)	6 (area around Pencoed)	12 (area around Porthcawl)	Total (based on original values, not rounded details in table)
Approximate number of ASHPs, to nearest hundred (2033)	1000	1,400	700	1,400	4,400
Percentage of domestic properties in the area(s) identified as predominantly using ASHPs (2033)	17%	19%	15%	16%	17%
Number of GSHPs (2033)	300	800	500	1500	3100
Percentage of domestic properties in the area(s) identified as predominantly using GSHPs (2033)	4%	11%	12%	17%	11%
Number of Hybrid HPs (2033)	800	700	300	600	2500
Percentage of domestic properties in the area(s) identified as predominantly using Hybrid HPs (2033)	14%	10%	7%	7%	9%

Table 18: Average number of heating systems installed across all model runs for areas with electricity identified as the dominant heating system – interpolated to be representative of 2033

Analysis area	2 (Upper Llynfi valley area)	8 (north-west of Bridgend Town area)	9 (south-west of Bridgend Town area)	Total (based on original values, not rounded details in table)
Number of domestic heat network connections (2033)	1,700	3,400	4,700	9,700
Percentage of domestic properties in the area(s) identified as predominantly connected to a heat network (2033)	32%	38%	85%	64%
2050 Energy centre capacity (MW)*	10	15	35	60

Table 19: Average district heating connections and estimated capacity installed across all model runs for areas with district heating identified as the dominant heating system – interpolated to be representative of 2033*

**The average energy centre capacities calculated for 2050 are provided as it is assumed that the energy centres will be built large enough to accommodate all future connections regardless of when they are built. In addition to the domestic heat network connections, the energy centre capacity assumes some non-domestic heat network connections.*

6.3 Conclusions

Whilst the Local Area Energy Strategy identifies predominant heating systems in key areas, the Strategy acknowledges there are uncertainties associated with large-scale deployment of each of the heating technologies considered (ESC, 2018b). As such, the first phase of the Strategy involves a period of testing, development, demonstration and evaluation, set out in the Smart Energy Plan (ESC, 2018b). The Smart Energy Plan includes a pipeline of proposed projects and activities that BCBC will pursue with partners to evaluate the potential suitability of different low carbon heating options in the county borough. The average heat pump deployment and heat connection figures to 2033 outlined in section 6.2 can be used to support BCBC in targeting the scale of the innovation and deployment projects pursued through the current Smart Energy Plan and future Smart Energy Plans (from 2025 onwards).

7. Strategic development sites

The Toolkit (Welsh Government, 2015) suggests that local authorities consider the integration of renewable energy into strategic developments within the LDP.

This could be done in a number of ways, including:

- Considering the demand at new strategic employment/residential developments and the potential for this to be met from renewable sources, and ensuring this is achieved through appropriate planning policy development.
- Identification of broad areas considered more suitable for different renewable energy technologies and support development in these areas through favourable planning policies e.g. PPW 10 states that; *"There should be a presumption in favour of development [for renewable and low carbon energy] in identified areas, including an acceptance of landscape change, with clear criteria-based policies setting out detailed locational issues to be considered at the planning application stage"* (Welsh Government, 2018, p.92).
- Identifying areas considered more suitable for different heating technologies (as considered in section 6, from the work undertaken under the Smart Systems and Heat programme)

7.1 Energy demands of strategic new development sites

BCBC have provided details of strategic development sites under consideration for the next LDP. These include:

- two confirmed strategic employment sites, and
- nine candidate strategic residential sites that are under consideration

The location and details regarding the sites are provided in Appendix 6.

7.1.1 Method

The Toolkit (Welsh Government, 2015) suggests that the energy demand at non-domestic strategic development sites is estimated using benchmarks for different use types and floor area estimates. It suggests that the energy demand for residential sites is based on the outcomes of SAP (2012) calculations for the different dwelling types and that the energy demand growth across the LDP period is calculated on an annual basis. As the residential sites provided by BCBC are currently candidate sites for consideration, an estimate for the final energy demand figures based on the potential development across the area have been calculated rather than cumulative annual growth.

The energy demands of the strategic employment sites have been estimated according to the methods provided in Figure 28. Two separate methods are used as outline planning consent has been granted for the Brocastle site and therefore there is more data already available regarding its predicted energy demand, which is used in the assessment. This detail is not available for Pencoed Technology Park and therefore energy demand benchmarks are relied upon instead.

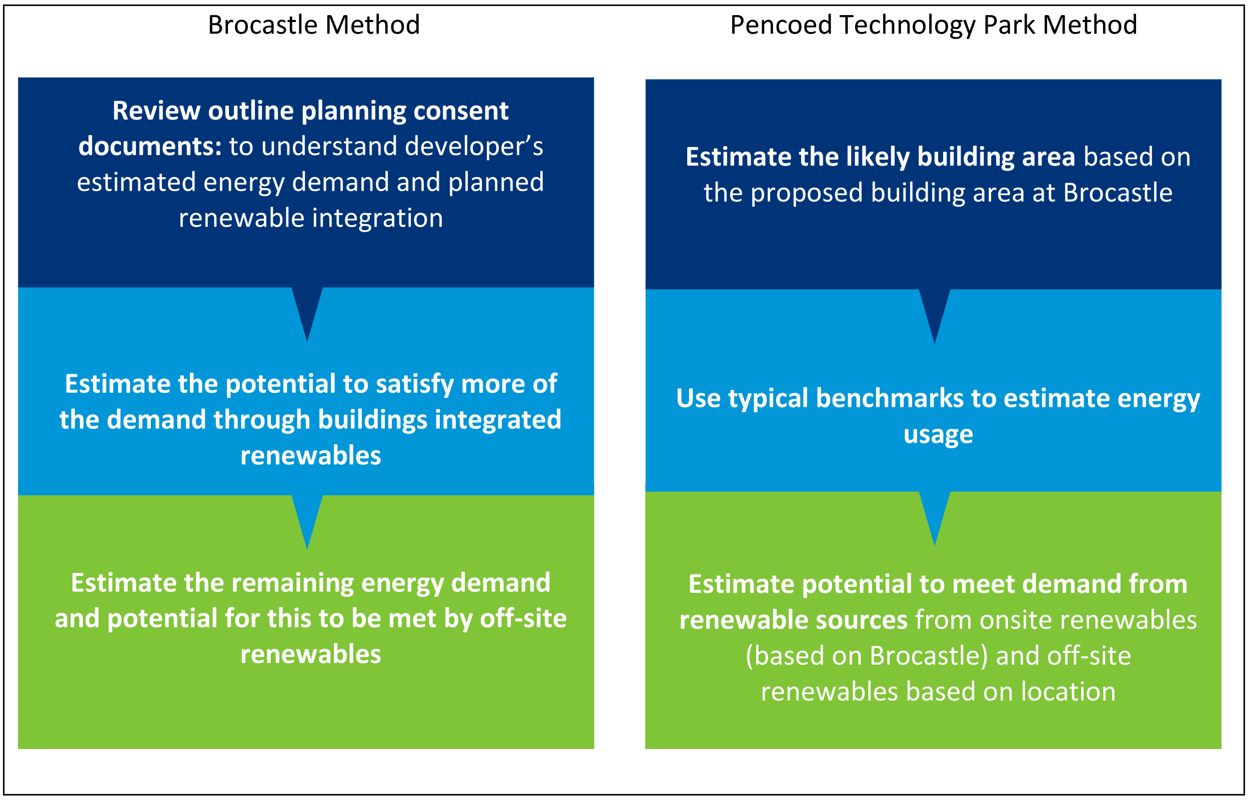


Figure 28: Method for estimating energy demand at strategic employment sites

The energy demands of the candidate residential sites have been estimated according to the method provided in Figure 29.

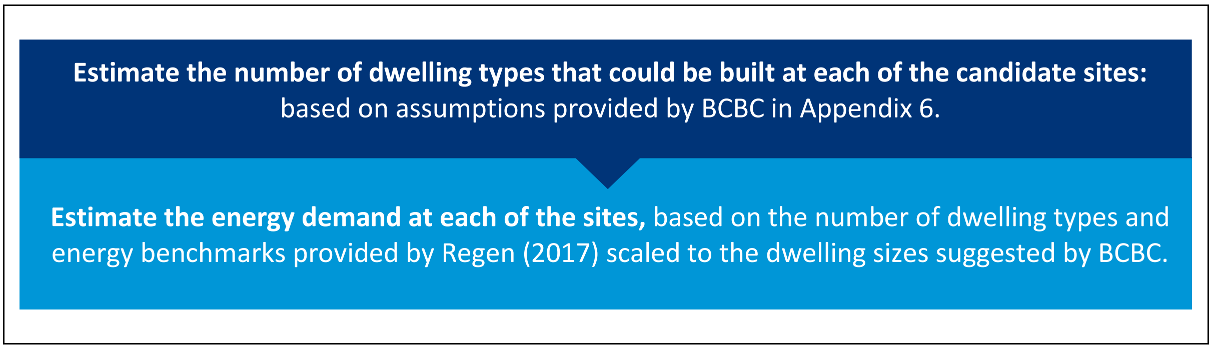


Figure 29: Method for estimating energy demand at candidate residential sites

7.1.2 Results

The results regarding the energy demand of the strategic employment and candidate residential sites are provided below.

Pencoed Technology Park

The total area of developable land at Pencoed Technology Park is 5 hectares. Not all of the land available will be translated into building space. At Brocastle up to approximately 36% (71,000 m^2) of the developable land area is proposed for building space (planning permission has been granted for a development of up to 71,000 m^2, full details suggest 62,151 m^2 is currently proposed). This factor has been applied to the Pencoed Technology Park in order to estimate the eventual floor area. Pencoed Technology Park previously had outline planning consent for B1, B2 and B8 non-domestic uses. For the purpose of this assessment, the developable land area is assumed to be split equally between the three uses, with B1 uses assumed to be two storey.

Pencoed Technology Park developable land (hectares)	5
Assumed proportion of building area	36%
Assumed building area (hectares)	1.8
Assumed developable land area for B1 offices (m^2)	6,000
Assumed floor area for B1 offices (two storeys) (m^2)	12,000
Assumed developable land area for B2 industry use buildings (m^2)	6,000
Assumed floor area for B2 industry use buildings (single storey) (m^2)	6,000
Assumed developable land area for B8 storage use buildings (m^2)	6,000
Assumed floor area for storage use buildings (single storey) (m^2)	6,000

Table 20: Assumed development parameters at Pencoed Technology Park

There are numerous benchmarks available relating to energy demand in non-domestic buildings. Appendix 7 provides details of the benchmarks considered. Benchmarks provided by BEIS (2016) have been used in this assessment as they provide a more generic energy use for each of the categories provided which seems appropriate considering the final nature of the developments at Pencoed Technology Park are unknown. The energy demand is estimated in Table 21.

	Offices	Industrial use	Storage use	Total
Assumed floor area (m^2)	12,000	6,000	6,000	24,000
Space heating and hot water energy use (kWh p.a.)	1,068,000	498,000	270,000	1,836,000
Space heating and hot water energy use assuming ASHP with a COP of 3 provides heat (kWh p.a.)	356,000	166,000	90,000	612,000
Non-heating energy demand (kWh p.a.)	1,740,000	360,000	294,000	2,394,000
Total energy demand assuming thermal energy is provided by an ASHP with a COP of 3 (kWh p.a.)	2,096,000	526,000	384,000	3,006,000

Table 21: Estimated Pencoed Technology Park energy demand

The potential to meet/offset the energy demand estimated in Table 21 from rooftop PV is calculated in Table 22.

Estimate of roof area available (m^2)	18,000
Estimate of kW per m^2 of roof area (based on Brocastle Outline Planning Consent) (kW/m^2)	0.14
Estimate of maximum roof top solar PV that could be installed (kW)*	2,466
Assumed capacity factor	0.1
Estimate of electricity generation per annum (kWh p.a.)	2,159,801
Proportion of annual energy demand	72%

Table 22: Estimated potential to meet energy demand from solar PV

* *This assumes that all the roof area would be suitable for the installation of solar PV*

In order for 72% of the annual energy demand to be met, as suggested in Table 22, integration of storage would be required, as the time of generation is unlikely to perfectly meet the time of demand, especially with respect to heating needs. Some useable energy is lost when stored so the actual energy demand met would be less than suggested by Table 22 even if storage is integrated.

With respect to meeting/offsetting the residual demand from resources near to the site, land at Pencoed Technology Park was identified as less constrained for ground mounted solar PV in the assessment undertaken for section 4.2 (refer to Appendix 3 for a map identifying the less constrained wind/solar areas and location of the strategic employment sites). A review of this land using aerial imagery shows that it is currently partially used for car parking and partially a grassed area. Solar canopies could be integrated into the car parking at the Technology Park.

A large area of land to the north of the site has also been identified as less constrained for ground mounted solar PV. This area covers approximately 40 hectares, providing space for approximately 23 MW of solar PV, which could generate approximately 20,000 MWh p.a., generating more energy than the annual estimate energy demand of Pencoed Technology Park. As above, the energy demand of the Park would only be met if storage is integrated. Other technologies that could be considered at the park to complement solar PV is biomass. Additional energy generation opportunities may also be present to the east of the site in Rhondda Cynon Taf.

Pencoed Technology Park is located in an area identified as "uncertain" in the Local Area Energy Strategy (ETI, 2018b), and Electric/District Heating mix in Figure 27. There may be opportunity over the LDP period for Pencoed Technology Park to connect into district heating networks that are being developed in the area.

Brocastle employment site

Outline planning permission has been granted for the Brocastle employment site. As part of the outline planning application an Energy Statement was provided (Encraft Ltd and Carbon Trust, 2016) which estimated the energy use of the Brocastle site and appraised different energy efficiency and low carbon energy generation measures that could be integrated into the proposal. The statement proposes that the following factors will be integrated with higher energy efficiency ratings than are required in the Part L building regulations: lighting, building control systems, appliances and equipment, design detailing, fabric efficiency, heating systems, and windows and doors. Following implementation of these measures, it is estimated that energy usage at the site will be **13,359,909**

kWh p.a. (Encraft Ltd and Carbon Trust, 2016). Low carbon generation technologies are also considered with a 520.5 kWp rooftop mounted solar PV array proposed to be installed to supply approximately 447,116 kWh p.a. to the buildings (Encraft Ltd and Carbon Trust, 2016). It is suggested that to achieve a BREAAM Excellent rating the PV provision could be approximately doubled (Encraft Ltd and Carbon Trust, 2016). With respect to heating provision it is proposed that this will be generated from gas (Encraft Ltd and Carbon Trust, 2016). Ground and air source heat pumps are considered within the report, and it is suggested that neither is suitable for the development. The following conclusion is provided with respect to air source heat pumps:

"We would not consider Air Source Heat Pumps as a low or zero carbon technology as they utilise high carbon grid electricity as the primary energy source. They are also not suitable for domestic hot water production as to heat the water to the temperatures required for Legionella prevention, they would require additional electrical energy. "

(Encraft Ltd and Carbon Trust, 2016, p.11)

This statement is considered to be outdated, and it is recommended that the heating fuel type is reconsidered at the full planning application stage. Air source heat pump technologies have improved, and are very well suited to new build energy efficient buildings designed to incorporate this heating technology. It is possible to heat water to temperatures required for Legionella prevention with heat pump technology. Whilst new gas boilers may have an efficiency of 90% (thereby providing 90% of the energy from the gas used as heat), air source heat pumps provide more heat energy than the electrical energy they consume – with a typical coefficient of performance (COP) of three (thereby providing three times as much heat energy as electrical energy consumed).

The energy demand estimates provided in the outline planning permission do not separate the energy use into heating and non-heating uses. The proportion of heat energy has been estimated to be 46% of the total energy use, this estimate is based on the proportion of electrical to non-electrical uses provided by BEIS (2016), and weighted based on the floor areas of the different building types. This assumes that the respondents to the BEIS BEES survey do not use electricity to heat their premises.

Estimated total energy demand (kWh p.a.)	13,359,909
Estimated non-heating demand (kWh p.a.)	7,220,418
Estimated heating demand (kWh p.a.)	6,139,491
Estimated electrical heating demand if heated with a heat pump (Assuming coefficient of performance of 3) (kWh p.a.)	2,046,497
Estimated total electrical demand if heated with a heat pump (kWh p.a.)	9,266,915
Proposed PV capacity (kW)	520.5
Assumed capacity factor	0.1
Estimated energy demand met by PV (kWh p.a.)*	455,958
Estimate of total roof area (m^2)	58,667
Roof area proposed for PV (m^2)	3,800
Estimate of % of roof area proposed to be covered with PV	6%
Estimate of roof area remaining (m^2)	54,867
Estimated additional potential PV capacity (kWp)	7,515
Estimated additional annual generation potential (kWh p.a.)	6,583,434
Remaining electricity demand if heated by gas (kWh p.a.)	181,027
Remaining electricity demand if heated by a heat pump (kWh p.a.)	2,227,524

Table 23: Potential to meet energy demand at Brocastle from Rooftop PV

**Note that this is a lower figure than was quoted in Encraft Ltd and Carbon Trust (2016), and is based on the solar PV capacity factor used throughout this report.*

As with Pencoed Technology Park to maximise the potential for the energy demand to be met by PV integration of storage would be required, as the time of generation is unlikely to perfectly meet the time of demand, especially with respect to heating needs. Some useable energy is lost when stored so the actual energy demand met would be less than suggested by Table 23 even if storage is integrated. Additionally, consideration of instantaneous and peak power demands would need to be considered.

With respect to meeting/offsetting the residual demand from resources near to the site less constrained land has been identified on the Brocastle site for solar PV and land to the southeast (see Appendix 3). As with the Technology Park, the land identified on site covers both car parking and grassland that is available for development. As with the Technology Park solar canopies could be installed above car parks at the new development to maximise generation at the site. The location of the site at the boundary of Bridgend and Vale of Glamorgan, means that the potential resource around the site has not been fully investigated, as there could be potential in the Vale of Glamorgan. With respect to land that is within BCBC's development control BCBC should look to maximise the energy generation potential and minimise energy use on the site itself through their development controls.

Candidate residential development sites

A summary of the number of different building types provided by BCBC the associated energy demand estimated at the sites and the potential capacity of roof-top solar PV that could be installed are provided in Table 24, Table 25, and Table 26

Whilst the energy demand has been estimated based on heat pump and non-heat pump uses, a summary of how each of the locations is considered within the local area energy strategy is provided in Table 27.

The Draft National Development Framework 2020-2040 suggests that, as a minimum, developments of at least 100 or more dwellings should consider the potential for heat networks (Welsh Government, 2019a), with the following draft spatial policy suggested to enforce this:

"Policy 15 – Master planning for District Heat Networks

Large-scale mixed-use development should, where feasible, have a District Heat Network. Planning applications for such development should prepare an Energy Masterplan to establish whether a District Heat Network is the most effective energy supply option and, for feasible projects, a plan for its implementation"

(Welsh Government, 2019a, p.43).

Number	Site name	Size (hectares)	Indicative capacity (no. of residential units)	Indicative no. detached dwellings	Indicative no. flats	Indicative No. semi-detached dwellings	Indicative no. terraced dwellings
1	Pencoed Campus	50	800	293	117	238	151
2	Land East of Pyle	100	3,500	1,281	511	1,040	662
3	Waun Bant Rd & Pen Y Castell Farm	27	1,000	366	146	297	189
4	Porthcawl Regeneration Site	53	1,650	604	241	490	312
5	Island Farm, Bridgend	54	1,000	366	146	297	189
6	Parc Afon Ewenni	16	650	238	95	193	123
7	Land West of Bridgend	229	2,000	732	292	594	378
8	Pont Rhyd-y-Cyff	14	500	183	73	149	95
9	Zig Zag Lane, Porthcawl	26	950	348	139	282	180

Table 24: Assumed building types at the candidate strategic residential sites

Site name	Indicative capacity (no. of residential units)	Indicative floor area detached dwellings (m²)	Indicative floor area flats (m²)	Indicative floor area semi-detached dwellings (m²)	Indicative floor area terraced dwellings (m²)	Indicative heating demand (MWh p.a.)	Indicative electrical heating demand if met by ASHP with a COP of 3 (MWh p.a.)	Non-heating demand (MWh p.a.)	Total energy demand (MWh p.a.)	Total energy demand (if ASHP used) (MWh p.a.)
Pencoed Campus	800	32,230	7,020	22,848	9,664	13,355	4,452	2,480	15,835	6,932
Land East of Pyle	3,500	140,910	30,660	99,840	42,368	58,392	19,464	10,850	69,242	30,314
Waun Bant Rd & Pen Y Castell Farm	1,000	40,260	8,760	28,512	12,096	16,680	5,560	3,100	19,780	8,660
Porthcawl Regeneration Site	1,650	66,440	14,460	47,040	19,968	27,526	9,175	5,115	32,641	14,290
Island Farm, Bridgend	1,000	40,260	8,760	28,512	12,096	16,680	5,560	3,100	19,780	8,660
Parc Afon Ewenni	650	26,180	5,700	18,528	7,872	10,846	3,615	2,015	12,861	5,630
Land West of Bridgend	2,000	80,520	17,520	57,024	24,192	33,360	11,120	6,200	39,560	17,320
Pont Rhyd-y-Cyff	500	20,130	4,380	14,304	6,080	8,352	2,784	1,550	9,902	4,334
Zig Zag Lane, Porthcawl	950	38,280	8,340	27,072	11,520	15,858	5,286	2,945	18,803	8,231

Table 25: Estimated energy demand at candidate strategic residential sites

Indicative heating demand is based on Regen (2017) estimation of heating demand for notional dwellings converted into a kWh per m^2 value and applied to the m^2 dwelling sizes provided by BCBC.

Site name	Potential roof-top solar PV capacity (kW)	Assumed capacity factor	Estimated annual generation (MWh p.a.)	Percentage of energy demand met/offset	Percentage of energy demand met/offset assuming ASHP installed
Pencoed Campus	2,046	0.1	1,792	11%	26%
Land East of Pyle	8,949	0.1	7,839	11%	26%
Waun Bant Rd & Pen Y Castell Farm	2,556	0.1	2,239	11%	26%
Porthcawl Regeneration Site	4,218	0.1	3,695	11%	26%
Island Farm, Bridgend	2,556	0.1	2,239	11%	26%
Parc Afon Ewenni	1,662	0.1	1,456	11%	26%
Land West of Bridgend	5,112	0.1	4,478	11%	26%
Pont Rhyd-y-Cyff	1,281	0.1	1,122	11%	26%
Zig Zag Lane, Porthcawl	2,430	0.1	2,129	11%	26%

Table 26: Estimate of potential to meet energy demand from rooftop solar PV at the candidate residential sites

Table 26 provides an indication of the capacity of roof-top PV that could be installed on the non-flat dwellings in each of the areas, assuming that the current mean domestic FIT installation capacity installed in Bridgend (~3 kW) could be installed on each of the non-flat dwellings. This shows that approximately 11% of the energy demand for the residential buildings could be offset based on conventional energy demand increasing to 26% if ASHP energy reduction is considered.

If BCBC choose to apply greater energy efficiency standards than the current building regulations the energy demand of each of the residential areas could be reduced thereby requiring less low carbon energy generation to offset the demand. The demand figures do not consider any potential demand for energy for vehicles, including electric vehicles, which is likely to grow over the plan period.

All residential areas are located near to some less constrained areas for solar with sites 1 and 4 identified to have less resource nearby (see Figure 39 in Appendix 3). Sites 2, 3, 7 and 9 are also located relatively close to areas identified as less constrained for wind. Table 27 provides detail regarding which predominant heating type area from the Local Area Energy Strategy (ETI 2018b) the sites are located in.

Residential site number	Residential site name	Predominant heating type area from Local Area Energy Strategy (ETI, 2018b)
1	Pencoed Campus	Electricity
2	Land East of Pyle	Electricity/District Heating
3	Waun Bant Rd & Pen Y Castell Farm	Electricity/District Heating
4	Porthcawl Regeneration Site	Electricity
5	Island Farm, Bridgend	District Heating
6	Parc Afon Ewenni	On the boundary of District Heating area and a District Heating/Electricity mixed area
7	Land West of Bridgend	On the boundary of District Heating area and a District Heating/Electricity mixed area
8	Pont Rhyd-y-Cyff	Electricity
9	Zig Zag Lane, Porthcawl	Electricity

Table 27: Predominant heating types identified in the Local Area Energy Strategy for each of the candidate residential sites

7.1.3 Conclusions

Both strategic employment sites are located near to areas that are less constrained for ground mounted solar PV, and both provide opportunity for development of PV on the sites themselves. BCBC could use their development controls to ensure that energy generation on the sites themselves are maximised, and energy usage is minimised through design of highly efficient buildings and energy systems.

All residential sites are located close to less constrained areas for ground mounted solar PV, with four of the residential sites located close to areas that are identified as less constrained for wind. BCBC will need to consider whether they pursue a policy, which looks to integrate these resources into the development of these sites, or whether the development types are considered mutually exclusive. As with the employment sites BCBC could use their development controls and planning policy to ensure that the energy demand of the sites is less than projected.

7.2 Summary of strategic stand-alone renewable energy development opportunities

Planning Policy Wales 10 states that; "*There should be a presumption in favour of development [for renewable and low carbon energy] in identified areas, including an acceptance of landscape change, with clear criteria-based policies setting out detailed locational issues to be considered at the planning application stage*" (Welsh Government, 2018, p.92). The Draft National Development Framework 2020-2040 (Welsh Government 2019a) identifies priority areas for the development of large-scale (over 10 MW) solar PV and wind, and district heat networks as shown in Figure 2 of this report. The draft policies relating to these areas are as follows:

"Policy 10 – Wind and Solar Energy in Priority Areas

The Welsh Government supports large-scale on-shore wind and solar energy development in the identified Priority Areas for Solar and Wind Energy. There is a presumption in favour of development for these schemes and an associated acceptance of landscape change.

When determining planning applications for large-scale on-shore wind and solar energy development in Priority Areas, significant weight will be given to the proposal's contribution to reducing Wales' greenhouse gas emissions and meeting our decarbonisation and renewable energy targets.

Planning applications must demonstrate how local social, economic and environmental benefits have been maximised and the following adverse impacts have been minimised:

- landscape and visual impacts;
- cumulative impacts;
- the setting of National Parks and Areas of Outstanding Natural Beauty;
- visual dominance, shadow flicker, reflected light or noise impacts;
- electromagnetic disturbance to existing communications systems; and
- the following identified protected assets:
    - archaeological, architectural or historic assets;
    - nature conservation sites and species;
    - natural resources or reserves.

Suitable access to the site for construction and maintenance purposes must be provided. Plans must also be in place for the end of the development's lifetime, including the removal of all infrastructure as soon as their use ceases and the appropriate after-use of the site."

(Welsh Government, 2019a, p. 38)

"Policy 11 – Wind and Solar Energy Outside of Priority Areas

Outside of the Priority Areas for Solar and Wind, planning applications for large-scale wind and solar development must demonstrate the proposal is acceptable, in accordance with the criteria below.

Planning applications must demonstrate how local social, economic and environmental benefits have been maximised and that there are no unacceptable adverse effects on, or due to, the following:

- landscape and visual impacts;
- cumulative impacts;
- the setting of National Parks and Areas of Outstanding Natural Beauty;
- visual dominance, shadow flicker, reflected light or noise impacts;

> electromagnetic disturbance to existing communications systems; and
> the following identified protected assets:

- archaeological, architectural or historic assets;
- nature conservation sites and species;
- natural resources or reserves.

Suitable access to the site for construction and maintenance purposes must be provided. Plans must also be in place for the end of the development's lifetime, including the removal of all infrastructure as soon as their use ceases and the appropriate after-use of the site."

(Welsh Government, 2019a, p. 40)

Section 4 and Appendix 3 identifies areas less constrained for wind and ground mounted solar throughout the county borough. The priority areas identified by Welsh Government (2019a), whilst provided in relatively low resolution, appear to be located in the northern parts of the county borough. As such this area should be prioritised for large-scale (over 10 MW) solar and wind developments, with the less-constrained areas identified in other parts of the county borough used for smaller scale developments, less than 10 MW in size.

Within this section, the draft priority areas for large-scale wind and solar projects have been reviewed against the less-constrained areas identified in this assessment. Following this further consideration of factors that could be considered to help shape local policy and assist in understanding the potential scale and priority of different areas for development are considered (e.g. aviation zones, wind speed, overall Landmap visual sensory classifications and predictive agricultural land classifications).

7.2.1 Method

The method for further identification of standalone renewable energy development opportunities is provided in Figure 30.

Review less constrained areas for wind and solar developments against the draft priority areas for large scale (10 MW and above) identified by Welsh Government (2019a)

Further investigate the areas of "less-constrained" land identified for wind developments and solar PV, with respect to additional constraints, in order to support identification of priority areas for development.

Figure 30: Method for identifying strategic stand-alone renewable energy areas

7.2.2 Results

Wind potential

Table 28 summarises whether the wind clusters identified in section 4.1 are considered likely to be located within the priority areas identified by Welsh Government (2019a) within the review for this assessment.

Cluster number	Considered located within a priority area?	Cluster number	Considered located within a priority area?
1	Yes	18	No
2	Yes	19	No
3	Yes	20	No
4	Yes	21	No
5	Yes	22	No
6	Yes	23	No
7	Yes	24	No
8	Yes	25	No
9	Yes	26	No
10	Yes	27	No
11	Yes	28	No
12	Yes	29	No
13	No	30	No
14	No	31	Yes
15	Yes	32	Yes
16	No	33	No
17	No	34	No

Table 28: Review of Welsh Government (2019a) priority areas against wind clusters identified in section 4

The Toolkit (Welsh Government, 2015) suggests prioritising the less-constrained wind areas identified through the constraints assessment by the average wind speed and the potential to cause interference with air traffic operations. The NATS safeguarding maps (NATS, no date) have been consulted and there are no NATS radar zones in operation in the BCB, which should lessen the potential for any of these sites to interfere with aviation. Table 29 summarises the guidance from the Civil Aviation Authority (CAA) with respect to the potential for wind turbine developments to impact upon civil aerodrome related operations.

Aerodrome type	Distance from aerodrome that wind development may be more likely to impact operations
Aerodrome with surveillance radar facility	30 km
Non-radar equipped licensed aerodrome with runway of 1100 m or more	17 km
Non-radar equipped licensed aerodrome with runway of less than 1100m	5 km
Non-radar equipped unlicensed aerodrome with runway of 800 m or more	4 km
Non-radar equipped unlicensed aerodrome with a runway of less than 800 m	3 km

Table 29: Summary of CAA guidance regarding potential impact of wind developments on aerodrome operations

(CAA, 2016)

Geographical data on aerodromes provided by the CAA (2014) was consulted and part of BCB falls within 30 km of Cardiff airport. However, there are existing wind turbines within this area, so whilst the risk to development may be greater within this distance, it is evident that there is still potential for development. Whilst landscape and visual impact is considered too site specific to consider with this assessment, Table 30 summarises the coincidence of the identified wind clusters with areas with a high/outstanding overall Landmap Visual Sensory classification, different wind speeds and Cardiff airport's potential impact zone. Clusters 8 and 9 are identified as less constrained with respect to the additional constraints. The clusters identified as being located within priority areas are denoted with an asterisk within Table 30. To further consider the policies and prioritisation of the different wind clusters other land uses designated in the previous LDP and the confirmed employment sites and candidate residential sites could be considered

Appendix 3 provides maps as follows:

> Figure 40: Clusters of areas of less constrained land for wind development, Civil Aviation Authority zone around Cardiff airport and Landmap Visual Sensory areas with overall classifications of high/outstanding

> Figure 41: Less constrained wind clusters, land uses designated in the previous LDP, and confirmed employment and candidate residential sites.

Cluster	Area (km²)	Wind resource	Within 30 km of airport?	Landmap overall Visual Sensory classification of high/outstanding?
1*	2.272	High: entirely in excess of 6.5 m/s at 45m	Yes	Yes: partially within high area, existing turbines present
2*	0.011	High: in excess of 6.5 m/s at 45m	Yes	No
3*	1.121	Medium: majority of cluster 6-6.5 m/s at 45m	Yes	Yes: entirely within high area
4*	0.041	High: almost entirely in excess of 6.5 m/s at 45m	Yes	No
5*	0.086	High: entirely in excess of 6.5 m/s at 45m	Yes	No
6*	0.256	High: entirely in excess of 6.5 m/s at 45m	No	Yes: entirely within high area
7*	5.429	High: majority in excess of 6.5 m/s at 45m	Majority	Majority within high area
8*	0.087	High: entirely in excess of 6.5 m/s at 45m	No	No
9*	0.155	High: entirely in excess of 6.5 m/s at 45m	No	No
10*	0.436	High: entirely in excess of 6.5 m/s at 45m	Yes	No
11*	0.198	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
12*	0.941	Medium: entire cluster 6-6.5 m/s at 45m	No	No
13	0.112	High: entirely in excess of 6.5 m/s at 45m	No	Yes: entirely within high area
14	1.507	Mixed: within areas of high/medium wind	Yes	Yes: almost entirely within high area
15*	0.126	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
16	0.020	Mixed: within areas of high/medium wind	Yes	No
17	0.027	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
18	0.373	High: within areas of high wind	Yes	Partially within high area
19	0.002	High: entirely in excess of 6.5 m/s at 45m	Yes	No
20	0.034	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
21	0.030	Mixed: within areas of high/medium wind	Yes	No
22	0.006	High: entirely in excess of 6.5 m/s at 45m	Yes	No
23	0.653	High: majority of cluster in excess of 6.5 m/s at 45m	Yes	No
24	0.031	High: entirely in excess of 6.5 m/s at 45m	Yes	No
25	0.210	Mixed: within areas of high/medium wind	Yes	No
26	0.075	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
27	0.545	High: entirely in excess of 6.5 m/s at 45m	Yes	No
28	0.001	High: entirely in excess of 6.5 m/s at 45m	Yes	No
29	0.004	High: entirely in excess of 6.5 m/s at 45m	Yes	No
30	0.000	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
31*	0.036	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
32*	0.029	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
33	0.070	Medium: entire cluster 6-6.5 m/s at 45m	Yes	No
34	0.002	High: entirely in excess of 6.5 m/s at 45m	No	Yes: entirely within high area

Table 30: Summary of wind resource, Landmap visual sensory overall classification and potential impact on Cardiff airport for identified wind clusters

Ground mounted solar PV

The priority areas identified by Welsh Government (2019a) for large-scale solar PV in BCB appear to be concentrated in the areas north of the M4. Approximately 60% of the less constrained land identified is located north of the M4.

It is considered best practice to site solar PV developments on non-agricultural land or lower quality agricultural land (Solar Trade Association, no date, Welsh Government, 2018). Within the county borough higher grade land (grades 1-3a) is found on the lowland areas, generally south of the M4, with lower grade areas found in the more upland areas, coinciding with Welsh Government's (2019a) identified priority areas.

The overall Landmap Visual sensory areas with an overall outstanding classification in BCB are located in coastal areas largely outside of the areas identified as less constrained for solar PV. Some areas with an overall high classification for Landmap visual sensory coincide with areas identified as less constrained for solar in the Mynydd Gaer area to the east, Mynydd Llangeinwyr area in the north, Mynydd Maes-teg in the northeast and Mynydd Baedan in the west.

Mapping provided in relation to this in Appendix 3 includes:

> Figure 42: provides a map identifying the less constrained land for ground mounted solar PV with the M4 highlighted.
> Figure 43: identifies the predictive agricultural land grade of land within the less-constrained areas.
> Figure 44: identifies land predicted to be higher-grade agricultural land, and areas with a higher overall visual sensory Landmap rating alongside the less-constrained areas for ground mounted solar PV.
> Figure 45: shows the less constrained solar areas, alongside land uses designated in the previous LDP, and confirmed employment and candidate residential sites

7.2.3 Conclusions

Some of the land identified as less constrained for wind or ground mounted solar coincides with the priority areas identified in the draft National Development Framework for large-scale (over 10 MW) solar and wind projects. Projects of this scale will be determined by policies set out in the National Development Framework. Whilst the draft NDF is not yet adopted, BCBC should consider these areas when developing policies for solar and wind projects, which will be decided at a local authority level (less than 10 MW). When developing policies BCBC could consider prioritising areas for development, which do not coincide with other classifications of designations (e.g. high/outstanding overall Landmap Visual Sensory classification, or agricultural land classifications).

Following stakeholder engagement additional maps have been added to Appendix 3 identifying the less constrained areas for wind and solar alongside the different Landscape Character Areas identified within Bridgend County Borough (BCBC, 2016).

7.3 Summary of strategic heat network opportunities

7.3.1 Method

As detailed in section 6, rather than identifying strategic heat network opportunities using the guidance provided in the Toolkit (Welsh Government, 2015), details provided in the Local Area Energy Strategy have been referred to.

7.3.2 Results

The areas around Bridgend and Maesteg were identified in the Local Area Energy Strategy as having district heating as their predominant heating technology in 2050 (ETI, 2018b) and therefore provide the most opportunity for district heat network implementation (see Figure 27).

7.3.3 Conclusions

BCBC are developing two district heat networks, in the two areas identified within the Bridgend Local Area Energy Strategy with district heating as the predominant energy technology (ETI, 2018b). The district heat networks planned are intended to be phase 1 plans, with BCBC's long-term ambitions to expand the heat networks across the two areas. These areas could be considered priority areas with respect to district heat network development, with the electricity and electricity/district heat network areas regarded as secondary priority.

The identification of Bridgend as a priority area for district heat development is also highlighted in the *Draft National Development Framework 2020-2040* (Welsh Government, 2019a). Welsh Government (2019a) states that district heat networks are supported wherever they are viable, with the priority sites identified as they are considered to have sufficiently high heat densities to make district heat networks viable. As detailed above Policy 15 of the Draft National Development Framework 2020-2040 is as follows:

"Policy 15 – Master planning for District Heat Networks

Large-scale mixed-use development should, where feasible, have and District Heat Network. Planning applications for such development should prepare an Energy Masterplan to establish whether a District Heat Network is the most effective energy supply option and, for feasible projects, a plan for its implementation"

(Welsh Government, 2019a, p.43).

Development of at least 100 or more dwellings should consider the potential for heat networks, although it is considered that there is also potential for networks within developments smaller than this (Welsh Government, 2019a).

8. Policy options and recommendations

Given Wales' and the UK's ambition to become net zero carbon by 2050, and the longevity of developments, no planning proposals should be permitted unless they can demonstrate how they fit into a net zero carbon future. This viewpoint was presented by the Royal Town Planning Institute (RTPI) 2019 in their publication: *Planning for a Smart Energy Future.* The RTPI go on to acknowledge that "smart energy" should not be considered a "bolt-on" but integral to all types of development planning – housing, employment, transport and infrastructure.

8.1 Feedback from stakeholder engagement

Following development of the evidence bases presented in section 2-7 of this document, the Toolkit (Welsh Government, 2015) has been used to assess different policy options to support BCBC's aim *"…to make Bridgend a decarbonised, digitally connected smart County Borough […transitioning] from the current national, centralised energy system to a future low carbon, decentralised energy system that works for its individuals, communities and businesses."* (ESC, 2018b, p.3). Stakeholder engagement has been undertaken in order to gather feedback to help develop policy options for BCBC to consider when drafting the replacement Local Development Plan.

Potential policy options based on the Toolkit (Welsh Government, 2015), were developed in advance of the stakeholder engagement including some example scenarios for area wide renewable energy targets, maps showing additional constraints alongside the identified unconstrained wind and solar areas, policy options for new developments and heat networks, and example policies from other local authorities.

Stakeholder engagement included the following:

- A draft of the Renewable Energy Assessment was shared with the Planning Policy Branch in Welsh Government's Planning Department
- A stakeholder workshop was held with a variety of internal BCBC stakeholders and a representative from Natural Resources Wales (with summary information regarding the evidence base and policy options circulated in advance of the workshop).
- Summary information was shared with the Solar Trade Association who provided feedback via email.

8.1.1 Welsh Government feedback

The points below summarise the feedback from Welsh Government's Planning Policy Branch.

- Welsh Government would like LPAs to consider what their "Vision" is for renewable energy, in terms of what technologies and ambition stakeholders think are 'right' for their area. Understanding the vision then helps to calculate the resource and the relative level of importance provided to renewable energy alongside other developments and constraints.
- Paragraph 5.8.4 of PPW 10 states that LPAs should assess their strategic sites for higher sustainable building standards, including zero carbon, in their development plan. These can be higher standards than the current Building Regulations (subject to viability testing).
- The REA methodology matches Welsh Government's advice to focus on <10MW schemes outside of the draft Priority Areas. Notwithstanding this, the REA may be a useful document when Bridgend is preparing responses in association with any future Development of National Significance (DNS) applications which are submitted in Priority Areas within Bridgend county borough.

The points raised by Welsh Government were covered within the wider discussion held at the stakeholder engagement workshop.

8.1.2 Stakeholder engagement workshop

Attendees to the stakeholder engagement workshop included the following:

- BCBC Council Leader
- BCBC Cabinet Member for Communities
- BCBC Group Manager for Planning and Development
- BCBC Development Planning Manager
- BCBC Sustainable Development Team Leader
- BCBC Team Leader Regeneration Projects
- BCBC Energy Contracts Manager
- Natural Resources Wales Energy Advisor (Senior Hydropower Advisor)

A summary of the topics discussed during the meeting are provided below:

General thoughts

General themes discussed during the meeting included:

- The need for the Local Development Plan to be fit for purpose for 15 years.
- The changing nature of the energy system especially with respect to the likely growth in electric vehicles and the potential for homes to act as power stations.
- The need to consider and support community-led developments, and those that provide community benefits.
- Whilst municipal food waste is currently processed at Stormy Down Anaerobic Digestion Plant it was agreed that a policy regarding food waste should be included in the LDP to ensure that it continues to be used for renewable energy generation throughout the plan period.
- In addition to additional policy options suggested prior to the workshop, the stakeholders were keen to include policies on rainwater harvesting and Sustainable Drainage Systems (SuDS), green infrastructure and a requirement for wildlife corridors and biodiversity enhancements to be considered within new developments.
- Following the meeting, it was highlighted that solar thermal had not been discussed during the meeting but as an easily deployable technology with clear benefits for new developments and retrofitting it should also be considered.

Low carbon heating and new build developments

With respect to low carbon heating, the current innovative and leading work being undertaken by BCBC through their local area energy strategy was discussed. It was acknowledged that the challenge to transition the current housing stock to low carbon is already large and shouldn't be added to by allowing new housing developments to be built based on higher carbon heating systems. If this were allowed it would negate the positive steps that BCBC are making with the existing housing stock in the area.

It was agreed that a policy that required a hierarchy of heating solutions to be considered was required. It was reported that in the past the response from house builders to a policy that tried to encourage development of district heat networks was that their developments were too small to attract a district heating operator to adopt and manage a new heat network. The council are planning to set up an Energy Service Company (ESCO) to manage their two heat networks currently under development, this ESCO would be well placed to take on and manage additional networks developed to meet the heating needs of new housing developments. It was suggested that whilst the LDP should reference the predominant heating map identified in the Local Area Energy Strategy, the policy wording should allow the individual house builder to consider all low carbon heating options to determine the most appropriate solution for their development.

Targets

A long discussion was held around targets, and how these should be set. It was considered that an overall renewable power deployment target would be useful within the overarching policy, but that this could be broken down into individual technology targets within the monitoring framework.

It was suggested that a lot of wind turbines already exist in and around the north of the county borough and that therefore there should perhaps be a greater emphasis on development of roof-mounted and ground mounted solar PV.

With respect to heating targets, it was decided that it would be useful to base these on the proportion of buildings in an area to have low carbon heating systems installed rather than the number of connections or capacity. It was also suggested that there shouldn't be a standalone biomass target.

In general, it was concluded that more consideration to the targets to be set was required before making a firm decision on the targets to be set.

Local Search Areas

PPW 10 requires local authorities to identify areas for less than 10 MW capacity renewable energy developments, where there is an acceptance of landscape change (generally referred to as "Local Search Areas"). These could be located within the NDF areas for large-scale developments, but smaller developments should not impact the potential for larger-scale projects to be developed.

It was felt that the north of the county borough is home to a lot of wind developments – this could mean that the landscape has already been changed with respect to these developments, or mean that this area should not be prioritised for further developments. The north-east of the county borough sits within a priority wind area in the Draft National Development Framework (Welsh Government, 2019a), which means it may already be targeted for larger scale wind developments. SPG20: Renewables in the Landscape Supplementary Planning Guidance (BCBC, 2016) was highlighted as a resource which should be referred to when prioritising the unconstrained wind and solar areas identified. It also provides some best practice advice to developers to consider when siting and designing wind and solar farms.

Energy efficiency and new build developments

It was highlighted throughout the meeting that there should be a strong focus on energy efficiency and integration of renewable energy development in new (and existing) buildings.

There was a general consensus that BCBC should aim to achieve greater energy efficiency than building regulations and include integration of renewable energy generation into new developments including single wind turbines, roof top solar PV and solar canopies over car parks, which could also be integrated with EV charging. It was suggested that if a developer cannot install low carbon generation then they should be required to prove that they have achieved a further increase in energy efficiency measures as compensation.

8.1.3 Solar Trade Association engagement

The Solar Trade Association (STA) reviewed the summary information prepared for the Stakeholder Engagement Workshop. A summary of their feedback is provided below (Solar Trade Association, 2019a).

Area wide renewable energy targets

> Using BEIS and National Grid scenarios to inform deployment targets is sensible and results in a good level of ambition.
> It is right to recognise that Grid Constraints are a major issue in South Wales. As such, where solar is deployed it will be important to maximise the output from these sites. A solar PV development that looks to supply Warrington Borough Council (Solar Power Portal, 2019) with energy is maximising energy generation by using bifacial modules and single-axis tracking – providing a forecast generation enhancement of 20%.

(Solar Trade Association, 2019a)

New developments

> In the STA's recent report on local authorities and building regulations (Solar Trade Association, 2019b) they found Milton Keynes had the most favourable policies towards New Build development and has now begun successful implementation of its new Local Plan. The STA suggest reviewing their report as it also identifies other leading councils; each with slightly different policy wordings/structures.
> Some councils (e.g. Greater London Authority) have set up offsetting funds for developments that may miss carbon reduction targets. These funds can then be reinvested in council-led renewables projects and/or clean technologies.

(Solar Trade Association, 2019a)

Local Search Areas

> The STA recommend looking at their Natural Capital Value of Solar report (Solar Trade Association, 2019c), which highlights how well-managed solar sites can restore the ecological health of brownfield sites and contribute to biodiversity net gain. They suggest that solar is quite unique in this respect, and the ecological benefits of solar sites can be enjoyed by the wider community.

(Solar Trade Association, 2019a)

Policy mechanisms to support district heating networks

> With respect to heat networks the STA point out the importance of considering that heat networks are not intrinsically 'low carbon', however acknowledge that they are well suited to integration with large scale renewables (which has been widely tested elsewhere, e.g. Denmark).
> Development of low carbon heat networks requires foundational design considerations, with STA members highlighting that most existing heat networks have a feed-in temperature of 70°C, which excludes solar thermal from contributing, due to its lower operational temperature of 50-60°C.

(Solar Trade Association, 2019a)

Other actions that BCBC and wider stakeholders could undertake

> STA identified some actions that are being undertaken by other councils and suggested reviewing their report on local authorities (Solar Trade Association, 2019b) for more actions:

- Energiesprong (Energiesprong, no date): a pioneering approach to retrofitting homes to improve energy efficiency and reduce bills, involving innovative procurement and business models to stimulate the retrofit market at a very low cost to the tenant/homeowner – initially being explored in the UK in Nottingham.
- Solar Together (Solar Together, 2019): a solar PV bulk purchasing programme via local councils, designed to help multiple homeowners to install solar PV at a reduced cost, and to offer tenders to local installer businesses
- Flexi carports for council fleets: Installing flexible car parking facilities with EV infrastructure.

(Solar Trade Association, 2019a)

8.2 Policy options

The Toolkit (Welsh Government, 2015) provides guidance on how the evidence base established in sections 2 to 7 of this document can be translated into energy policy within the LDP, by exploring a range of policy themes, as outlined in the following sections. The feedback from the stakeholder engagement has been incorporated into the details below.

8.2.1 Area wide renewable energy targets

Policy objectives

It is a requirement in PPW 10 for local authorities to set targets for renewable energy deployment in their LDPs:

"To assist in the achievement of [national] targets, local authorities must take an active, leadership approach at the local or regional level, by identifying challenging, but achievable targets for renewable energy in development plans. In order to identify a measurable target, which can be assessed and monitored, it should be expressed as an absolute energy installed capacity figure. This should be calculated from the resource potential of the area and should not relate to a local need for energy.

Planning authorities should consider the renewable energy resource they have available in their areas when formulating their renewable energy target, informed by an appropriate evidence base, and use the full range of policy options available, including developing spatial policies in their development plans. Targets must not be seen as maximum limits, but rather used as a tool to maximise available resource, and where proposals exceed the target they should not be refused."

(Welsh Government, 2018, p.)

Section 5 shows that without installing a large proportion of the identified potential of solar PV in the county borough (which is not considered realistic or even feasible) there is insufficient renewable or low carbon resource within BCB to meet its future energy needs. Energy generated in other parts of the UK and offshore will help to ensure that energy used in BCB is generated from low carbon and renewable sources. However, in order to reduce reliance on external resources BCBC should consider setting ambitious targets for renewable energy deployment in the LDP.

Existing policy

Rather than set targets, the previous renewable energy assessment identified "Preferred Assessment Totals" (BCBC, 2011c) for the level of electricity and heat generation resource within the county borough. It compared the percentage heat and electricity demand that could be met from renewable energy resources with the UK targets under the EU Directive, and found that the potential electricity generation exceeded the relevant target but the heat generation potential was substantially below the EU Directive target for the UK (BCBC, 2011c). Within the Local Development Plan (2006-2018), BCBC (2013b) refer to the results of the assessment as follows:

"In preparing the LDP, the Council has prepared a Renewable Energy Assessment (REA) to indicate the potential level of energy generation from renewable sources. This assessment followed a toolkit provided by the Welsh Government and examines a wide variety of renewable energy sources. Development allocations which will make a significant contribution to meeting this potential are highlighted in Policy ENV17. The REA acknowledges that, in the generation of renewable heat sources in particular, the potential for heat energy generation in the County Borough falls below the national targets set out in the UK Renewable Energy Strategy. Therefore, there is a case for requiring closer scrutiny of proposals to assess their potential for the receipt or generation of renewable energy generation over the requirements set out in national policy on sustainable buildings."

(BCBC, 2013b, p. 43)

An overall policy is provided relating to national targets which is as follows:

"***Strategic Policy SP8 Renewable Energy***

Development proposals which contribute to meeting national renewable energy and energy efficiency targets will be permitted where it can be demonstrated that there will be no significant adverse impacts on the environment and local communities".

(BCBC, 2013b, p. 42)

Evidence base for future policy

The evidence base generated in sections 4 and 5 of the report were drawn on and considered alongside information relating to local factors and the National Grid ESO (2019a) Future Energy Scenarios to suggest potential targets that could be adopted by BCBC – these potential targets were shared with the stakeholders during the engagement exercise. Tables 31 and 32 provide the initial suggested targets and revised suggestions following the engagement exercise (following the engagement exercise all targets provided have been rounded to the nearest MW/GWh). Low and high target scenarios for each generation technology were developed.

The evidence base found that the predominant renewable energy resources within BCB are wind and solar. The high and low target scenarios for wind and solar were calculated based on:

- Low target: National Grid ESO (2019b) projected growth in national onshore wind/solar capacity to 2033 for the Two Degrees scenario (this scenario is based on a centralised energy system that meets the 80% carbon reduction targets)
- High target: National Grid ESO (2019b) projected growth in national onshore wind capacity to 2033 for the Community Renewables scenario.

The Solar Trade Association provided positive feedback regarding the use of the future energy scenarios in developing the targets. During the stakeholder engagement workshop, it was suggested that a lot of wind turbines already exist in and around the north of the county borough and that there should be a greater emphasis on development of solar PV – this has been reflected in the updated target suggestion. The revised wind target has been informed by the potential capacity identified within the Landscape Character Areas identified as having moderate sensitivity to large wind turbine developments of 76-110 m tip height (as opposed to high sensitivity) (BCBC, 2016). Whilst this is smaller than the tip height used in this assessment it provides an indication of the areas most likely to be acceptable for development of future wind farms. Figure 31 provides the power generation target against the power demand projections estimated in section 2.

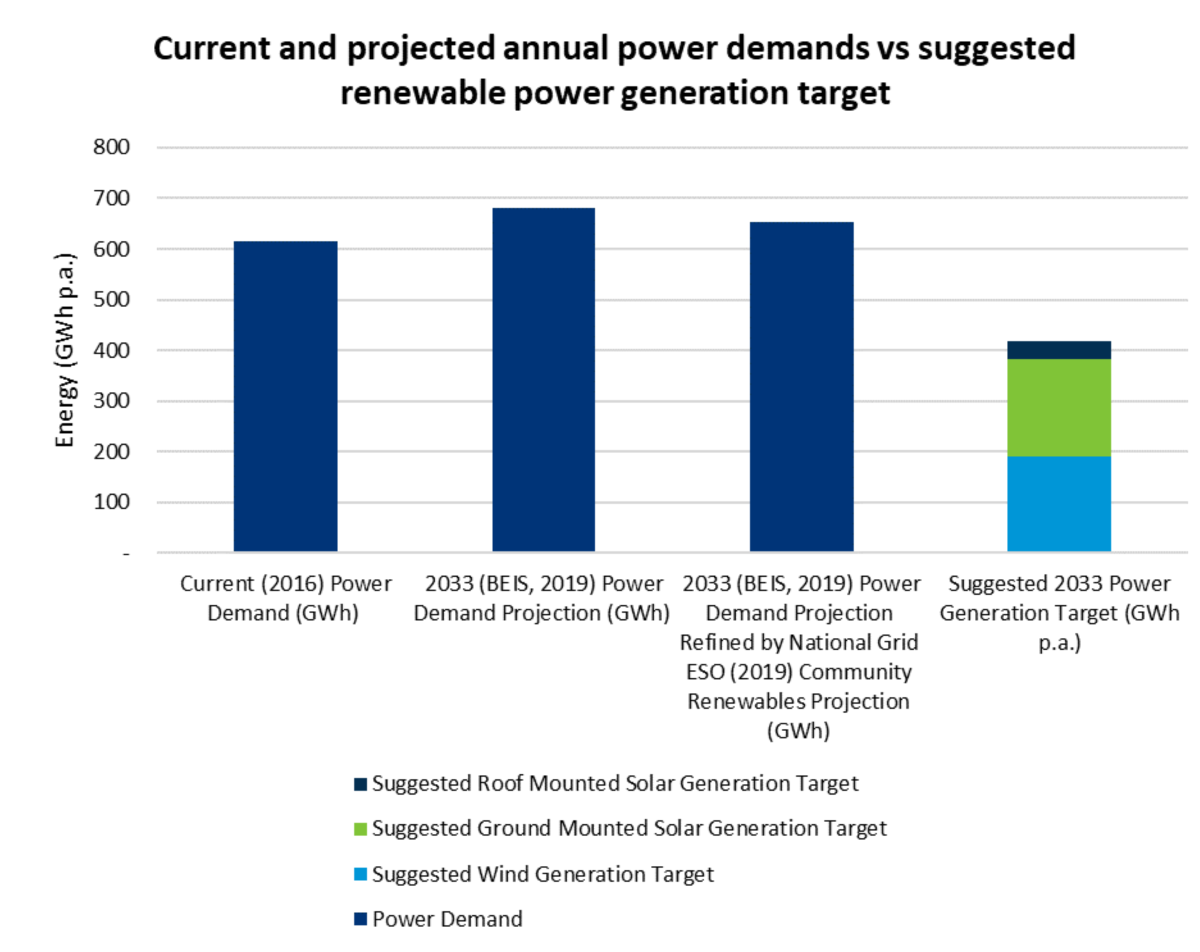


Figure 31: Bridgend County Borough current (2016) and future (2033) power demand estimations and suggested power generation target

Energy technology	Estimated maximum accessible resource		Current installed capacity		Target scenarios					
					Low		High		Suggested target following feedback	
	MW	MWh p.a.	MW	MWh p.a.	MW	MWh p.a.	MW	MWh p.a.	MW	MWh p.a.
Wind*	176 MW_e *(includes installed)*	416 GWh_e	64 MW_e	151 GWh_e	84 MW_e	199 GWh_e	148 MW_e	351 GWh_e	81 MW_e*	191 GWh_e
					Based on National Grid ESO (2019b) projected growth in national onshore wind capacity to 2033 for the Two Degrees scenario		*Based on National Grid ESO (2019b) projected growth in national onshore wind capacity to 2033 for the Community Renewables scenario*		*Based on the estimated remaining wind capacity potential within Landscape Character Areas: LCA1: Llangynwyd Rolling Uplands & Forestry and LCA8: Ogmore Forest and Surrounding Uplands (clusters 1, 2, 4, 5, 13, 14, and 34) and the current installed capacity*	
Ground mounted solar PV	3,835 MW_e *(includes installed)*	3,359 GWh_e	13 MW_e	11 GWh_e	29 MW_e	25 GWh_e	35 MW_e	31 GWh_e	218 MW_e	191 GWh_e
					Based on National Grid ESO (2019b) projected growth in national solar PV capacity to 2033 for the Two Degrees scenario		*Based on National Grid ESO (2019b) projected growth in national solar PV capacity to 2033 for the Community Renewables scenario*		*Based on transferring the remaining wind energy generation potential under the high target scenario to solar PV (following stakeholder feedback to focus more on solar PV than wind). This translates to ~400 hectares of land.*	
Building integrated solar PV	212 MW_e	186 GWh_e	8 MW_e	7 GWh_e	16 MW_e	14 GWh_e	41 MW_e	36 GWh_e	41 MW_e	36 GWh_e
					Capacity based on the National Grid ESO (2019b) Two Degrees scenario growth rate		*Capacity based on the National Grid ESO (2019b) Community Renewables scenario growth rate*		*The discussion at the stakeholder engagement workshop highlighted rooftop solar PV as a priority technology for BCBC to promote. If the 7500-8000 new houses projected to be built during the plan period integrate ~ 3 kW of solar PV, this will equate to 22.5-24 MW of solar PV. The estimated PV capacity at Brocastle and Pencoed Technology Park in section 7 is 10.5 MW. This provides a total potential capacity from new developments of 33-34.5 MW, when added to the current installed capacity this equates to 41-42.5 MW.*	
Hydro	1 MW_e	3 GWh_e	0.05 MWe	0.2 GWh_e	*None*		0.3 MW_e	1 GWh_e	***No target*** *Due to the low level of resource identified it is suggested that no specific target for hydropower is included, however a positive planning policy should be included to enable development, where there is resource and the developments would not have a negative impact. It was suggested in the stakeholder workshop that community developments should be supported which could enable the opportunities identified by Juno Energy and Gower Power (2017) to be developed*	
					Prioritise other renewable energy resources due to relatively small-scale nature of the resource available in the county borough, current low economic viability of hydropower sites and advice from NRW.		*As per the community-scale resource identified by Juno Energy and Gower Power (2017)*			

Biomass	19 MW$_{th}$	51 GWh$_{th}$	7 MW	17 GWh$_{th}$	10 MW$_{th}$	27 GWh$_{th}$	19 MW$_{th}$	51 GWh$_{th}$	***No target*** *It was suggested in the stakeholder engagement workshop that there should not be a standalone biomass target.*	
					Represents an additional capacity equivalent to the estimated needs of 6% and 4% of domestic buildings in the Ogmore and Garw valley analysis areas, as suggested by the SSH modelling (ETI, 2018b).		*BCBC target the maximum biomass resource available, through promoting biomass use in district heating, and as a retrofit option for homes where this is a more cost-effective option than heat pumps or district heating.*			
Energy from Waste (Power)	0.2 MW$_{e}$	2 GWh$_{e}$	*None – waste is transported out of the county*		*None*		0.2 MW$_{e}$	2 GWh$_{e}$	***No targets.*** *Due to the small amount of resource available it is suggested that there is not a specific energy from waste target. However, following the feedback at the Stakeholder Engagement Workshop, it is suggested that BCBC adopt a policy to ensure that waste management at new development sites and all waste management operations/contracts that BCBC engage with comply with the Waste Hierarchy (Welsh Government, 2010) to ensure that where waste cannot be prevented, reused or recycled it is used for energy generation.*	
					Existing contracts and small amount of waste generated will make it difficult to exploit this resource within the LDP period.		*BCBC attract innovative companies to introduce Advanced Conversion Technologies to process waste in the County Borough, at the end of existing waste contracts.*			
Energy from Waste (Thermal)	0.4 MWth	2 GWh$_{th}$	*None – waste is transported out of the county*		*None*		0.4 MW$_{th}$	2 GWh$_{th}$		
					Existing contracts and small amount of waste generated will make it difficult to exploit this resource within the LDP period		*BCBC attract innovative companies to introduce Advanced Conversion Technologies to process waste in the County Borough, at the end of existing waste contracts.*			
Anaerobic digestion (Power)	0.4 MW$_{e}$	3 GWh$_{e}$	3 MW$_{e}$	24 GWh$_{e}$	*None*		3 MW$_{e}$	24 GWh$_{e}$		
					Target to support Severn Trent to transition to a biomethane-to-grid plant, injecting biomethane into the gas network		*Target to ensure that existing energy generation is maintained, with any reductions in food waste feedstock offset by utilising other feedstocks*			
Anaerobic digestion (Thermal)	0.6 MW$_{th}$	3 GWh$_{th}$	*n/a (heat generated is understood to be currently used for plant's parasitic load only)*		*None*		27 MW$_{th}$	70 GWh$_{th}$		
					Target to support current operation of Stormy Down AD plant		*Target to support Severn Trent to transition to a biomethane-to-grid plant, utilising injecting biomethane into the gas network for use in domestic boilers (assumed efficiency 90%)*			
Total power generation	**4,225 MW$_{e}$**	**3,970 GWhe**	**88 MW$_{e}$**	**193 GWh$_{e}$**	**129 MW$_{e}$**	**238 GWh$_{e}$**	**228 MW$_{e}$**	**444 GWh$_{e}$**	**340 MW$_{e}$**	**418 GWh$_{e}$**
Total heat generation	**20 MW$_{th}$**	**55 GWh$_{th}$**	**7 MW$_{th}$**	**17 GWh$_{th}$**	**10 MW$_{th}$**	**27 GWh$_{th}$**	**46 MW$_{th}$**	**122 GWh$_{th}$**	***No target.*** *It was decided that it would be useful to base these on the proportion of buildings in an area to have low carbon heating systems installed rather than the number of connections or capacity*	

Table 31: Suggested high and low targets for area-based resource use

Wind targets provided are based on the Toolkit's (Welsh Government, 2015) indicative capacity of 10 MW per km^2. The suggested target following feedback increases to 87 MW per km^2 if using the Carbon Trust's suggested indicative capacity of five 2 MW turbines per km^2.

Energy technology	Target scenarios					
	Low		**High**		**Suggested following feedback**	
	No. of dwellings*		**No. of dwellings***		**Percentage of dwellings in Bridgend County Borough fitted with low carbon heating systems**	
ASHP	4,400	*As per the values provided in section 6, interpolating the average modelling results for the four predominant electricity areas between 2030 and 2050.*	9,600	*Higher values calculated by interpolating the average modelling results for the four predominant electricity areas between 2014 and 2050.*	*30%*	*During the Stakeholder Workshop it was discussed that a policy providing a hierarchy of lower carbon heating systems should be introduced. Whilst the Strategy map should be referred to it should be up to developers/homeowners to decide on the most appropriate heating system. It was also decided that targets should be based on a proportion of dwellings that have low carbon heating installed rather than a target consisting of the number of connections/capacities.* *The suggested target is based on the values provided in section 6 (i.e. low heat pump targets and high district heating target) but as a percentage of the current housing stock in Bridgend County Borough. This cannot be met by new build housing alone, therefore, to maximise the likelihood of meeting this target all new build developments should be fitted with low carbon heating systems.*
GSHP	3,100		3,400			
Hybrid HP	2,500		3,100			
District heat network connections	8,000	*Lower target calculated by interpolating the average modelling results for the three predominant district heating areas between 2014 and 2050.*	9,700	*As per the values provided in section 6, interpolating the average modelling results for the four predominant electricity areas between 2030 and 2050.*		
Biomass boilers	700 (additional dwellings)	*Represents an additional capacity equivalent to the estimated needs of 6% and 4% of domestic buildings in the Ogmore and Garw valley analysis areas, which were generally recommended to have biomass boilers installed in the SSH modelling (ETI, 2018b), thereby assuming these dwellings do not already have biomass installed.*	4,700	*Represents equivalent number of homes to the maximum accessible resource available minus the current installed values, based on an assumed home heating requirement from Ofgem's typical domestic gas consumption values (Ofgem, 2019c) and a gas boiler efficiency of 90% and biomass boiler efficiency of 80%.*	***No target*** *It was suggested in the stakeholder engagement workshop that there should not be a standalone biomass target.*	

Table 32: Suggested high and low targets for low carbon domestic heating

**Following feedback, the number of dwellings was rounded to the nearest one hundred dwellings.*

Example policy wording

Merthyr Tydfil County Borough Council, (MTCBC) has included a local contribution target towards renewable energy production within their proposed LDP monitoring framework (MTCBC, 2018). They have divided up the target across three time periods in order to monitor progress to achieving targets.

MTCBC (2018) proposed monitoring framework for proposed *LDP Objective 16: To promote renewable and low carbon energy*

Relevant Policies / SA Objectives	*Ref no.*	*Indicator Core / Local*	*Monitoring Target*	*Trigger Point*	*Data Source*
LDP Policies: EcW8: Renewable Energy. EcW9: District Heating. SA Objectives: 4: To improve human health and wellbeing and reduce inequalities. 6: To improve the overall quality and energy efficiency of the housing stock. 9: To ensure essential utilities and infrastructure are available to meet the needs of all. 10: To minimise energy use and optimise opportunities for renewable energy generation. 11: To minimise the contribution to climate change whilst maximising resilience to it.	*15.1*	*Local* The capacity of renewable energy developments (electricity) permitted (MWe).*	*To secure planning permissions for 12.5 MWe of electricity generation by 2021. To secure planning permissions for 25 MWe of electricity generation by 2026. To secure planning permissions for 37.4 MWe of electricity generation by 2031.*	*Failure to meet monitoring targets associated with Policies EcW8 and EcW9 by 10% or more.*	*MTCBC Development Management Monitoring*
	15.2	*Local* The capacity of renewable energy developments (heat) permitted (MWth).*	*To secure planning permissions for 6.5 MWth of [heat] generation by 2021. To secure planning permissions for 13 MWth of [heat] generation by 2026. To secure planning permissions for 19.4 MWth of [heat] generation by 2031.*	*Failure to meet monitoring targets associated with Policies EcW8 and EcW9 by 10% or more.*	*MTCBC Planning & Countryside Department*

(MTCBC, 2018, p.128)

Recommendations

Following the stakeholder engagement exercise, it is recommended that BCBC adopt the suggested overall power capacity target provided in table 31 and a percentage of dwellings fitted with low carbon heating systems target provided in table 32.

It is recommended that an overall target is adopted within the LDP, with the technology breakdown provided in the monitoring framework. It is also recommended that the target is broken down within the monitoring framework across three time periods as per MTCBC's (2018) monitoring framework.

In order to retain the existing renewable energy deployment within the county borough, it is recommended that supportive policies are adopted in relation to:

> Repowering existing assets at the end of their current planning consent period
> Continuing to process food waste collected on behalf of BCBC for the generation of energy.

8.2.2 Areas for stand-alone renewable energy development

Policy objectives

The National Development Framework will identify areas for solar PV and onshore wind projects greater than 10 MW, which will look to replace the previous Strategic Search Areas (SSAs) for large-scale wind developments set out in TAN8. The NDF is currently in draft form with the final document expected to be published in September 2020.

PPW 10 (Welsh Government, 2018) requires Local Authorities to identify areas for renewable energy developments ("Local Search Areas") within their LDPs. Within these areas there should be a presumption in favour of development, including an acceptance of landscape change, with clear criteria-based policies setting out detailed locational issues to be considered at the planning application stage.

If the local authorities' Local Search Areas coincide with the NDF areas identifying priority areas for large-scale developments Welsh Government would not want smaller developments to prevent larger developments progressing – and planning policy should be adopted which prevents this.

According to PPW 10 development plans should, where relevant, provide policies to clarify where in the SSAs large scale wind energy developments are likely to be permitted. For example, by identifying local micro-siting criteria or identifying specific preferred locations. It is not clear how this will be updated to reflect the areas in the NDF, but Welsh Government have advised that they will be updating PPW 10 in line with the NDF, therefore it is likely to be worth BCBC considering if there are areas which would be more acceptable within the new NDF areas for development.

Existing policy

Current policy identifies the Llynfi Power Station as a site allocated for renewable generation:

*"**Policy ENV17 Renewable Energy and Low/Zero Carbon Technology***

The Council will encourage major development proposals to incorporate schemes, which generate energy from renewable and low/zero carbon technologies. These technologies include onshore wind, landfill gas, energy crops, energy from waste, anaerobic digestion, sewage gas, hydropower, biomass, combined heat and power and buildings with integrated renewable sources.

In achieving this, all development proposals of 10 or more residential dwellings or with a total floor space of 1,000 sq metres or more should, where viable, be able to connect to district supply networks of heat and energy. In addition, energy assessments should be submitted with applications to investigate incorporating on-site zero and low carbon equipment or connecting to existing sources of renewable energy. Such investigations should also examine the potential for heat and electricity generated by the development to power/fuel nearby receptive buildings.

The Council's Energy Opportunities Plan will inform consideration of these issues.

The following site is allocated for renewable energy generation:

ENV17(1) Former Llynfi Power Station: Biomass"

(BCBC, 2013b, p.43)

There is no formal policy regarding prioritising other sites for standalone renewable energy generation although the LDP does include the following statement:

"…the Council will take a proactive, corporate role in not only seeking to make its own buildings more energy efficient and generators of renewable energy generation, but will produce an Energy Opportunities Plan (EOP) as SPG to the LDP. The EOP will assist the development industry by spatially identifying possible sources of renewable energy including suitable areas for smaller scale wind, hydropower generation and district heating networks. Such networks utilise a single source of energy to provide heating to a number of different buildings and can help to minimise carbon emissions and energy costs. The Council will expect major developments to be designed to enable connection to such networks where they exist or are proposed, where viable."

(BCBC, 2013b, p.43)

The Energy Opportunities Plan is included in the second edition of the Renewable Energy Assessment published in November 2011 (BCBC, 2011c). The Energy Opportunities Plan section of the document identifies opportunities for district heat networks, with the resource evidence base for other energy generation technologies covered elsewhere in the document (BCBC, 2011c).

The overall renewable energy policy is as follows:

"***Policy ENV18 Renewable Energy Developments***

Proposals for renewable energy developments will be permitted provided that:

1) In the case of wind farm developments of 25MW or more, the preference will be for them to be located within the boundary of the refined Strategic Search Area;

2) The availability of identified mineral resources or reserves will not be sterilised;

3) Appropriate monitoring and investigation can demonstrate that the development will not have any significant impacts on nature conservation;

4) Appropriate arrangements have been made for the preservation and/or recording of features of local archaeological, architectural or historic interest;

5) They can be safely accessed to permit regular maintenance without detriment to the environment or the public rights of way network;

6) They will not detrimentally affect local amenity by reason of noise emission, visual dominance, shadow flicker, reflected light, the emission of smoke, fumes, harmful gases, dust, nor otherwise cause pollution to the local environment;

7) They will not lead to electromagnetic disturbance to existing transmitting and receiving systems (which includes navigation and emergency services), thereby prejudicing public safety;

8) Local receptors of heat and energy from the proposal are identified and, where appropriate, are connected to/benefit from the facility; and

9) Provision has been made for the removal of all infrastructure from, and reinstatement of the site following termination of the use."

(BCBC, 2013b, p.43)

Evidence base for future policy

Section 7 and Appendix 3 reviewed the less constrained areas for wind and solar identified in section 4 against additional constraints to help support a prioritisation of areas to target for development. Following the stakeholder engagement workshop, additional maps have been added to Appendix 3 which identify how the less constrained land areas coincide with the landscape sensitivity assessment set out in *SPG20: Renewables in the Landscape Supplementary Planning Guidance* (BCBC, 2016).

SPG20 draws on the details provided in the Landscape Character Assessment for Bridgend County Borough (BCBC, 2013a), which splits the county borough into fifteen Landscape Character Areas (LCAs) and assesses the areas' sensitivity to wind turbines greater than 15m to tip and solar PV greater than 1 hectare. The results are summarised inTable 33.

The SPG states that BCBC will favour proposals which demonstrate understanding of how they would impact landscape character, protect/enhance key features, and mitigate negative impacts and provides guidance on how to site and design wind and solar farms (BCBC, 2013a).

The assessment finds that all BCB's landscapes are particularly sensitive to large scale solar and wind developments.

With respect to wind developments, the majority of the county borough is considered to have moderate-high or high sensitivity to turbines greater than 75 m in height. Two Landscape Character Areas (1: Llangynwyd Rolling Uplands & Forestry and 8: Ogmore Forest and Surrounding Uplands) are assessed to have 'moderate' sensitivity to large wind turbine developments (76-110 m to blade tip) and moderate-high sensitivity to turbines over 110 m, all other areas are considered to have moderate-high or high sensitivity for turbines greater than 75 m in height (the assumed tip height used for this assessment was 120 m). Landscape Character Area 8: Ogmore Forest and Surrounding Uplands is located within the draft NDF Priority Area for Wind, therefore any policy referring to this area will need to ensure that the intention of the Priority area designation is not compromised.

For solar PV developments, the entire county borough is considered to have high sensitivity to solar schemes greater than 15 hectares (~8.5 MW). LCA 12: Newton Down Limestone Plateau is considered to have 'moderate-high' landscape sensitivity assessment for developments within the 10-15 hectares size and moderate sensitivity to developments of 5-10 hectares. All other areas are considered to have high sensitivity to developments of 10-15 hectares, as such, on the basis of the assessment provided in the SPG, it is suggested that the Newton Down LCA is prioritised for solar PV developments as a Local Search Area.

The five urban areas within Bridgend are not included in the landscape character or sensitivity assessment. They are considered within the SPG to be unlikely to be targeted for renewable energy developments (BCBC, 2013a), however some areas have been identified as less constrained and providing potential for solar PV development within the work undertaken in section 4. It is therefore considered that positive policy could be included around integrating renewable energy development in these locations (e.g. solar canopies over car parks).

Whilst the Landscape Sensitivity Assessment provides an indication of landscape sensitivities, the document states that it should not be considered as a definitive statement of the suitability of a certain location for development (BCBC, 2013a), as such there may be sites which are found to be suitable for development within areas considered to have high sensitivity.

Landscape Character Area	Sensitivity to Wind Farms	Sensitivity to Solar Farms
1. Llangynwyd Rolling Uplands and Forestry	Very Small 15-25 m: Low Small 26-50 m: Low-Moderate Medium 51-75 m: Moderate Large 76-110 m: Moderate Very Large 111-150 m: Moderate-High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High
2. Llynfi Valley Floor and Lower Slopes	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
3. Llynfi and Garw Uplands and Forestry	Very Small 15-25m: Low Small 26-50 m: Low-Moderate Medium 51-75 m: Moderate Large 76-110 m: Moderate-High Very Large 111-150 m: High	Very Small <1 ha: Moderate-High Small 1-5 ha: High Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
4. Bettws Settled Farmland	Very Small 15-25m: Low Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High
5. Garw Valley Floor and Lower Slopes	Very Small 15-25m: Low-Moderate Small 26-50 m: Medium 51-75 m: High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
6. Mynydd Llangeinwyr Uplands	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Moderate-High Small 1-5 ha: High Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
7. Ogmore Valley Floor and Lower Slopes	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High
8. Ogmore Forest and Surrounding Uplands	Very Small 15-25m: Low Small 26-50 m: Low-Moderate Medium 51-75 m: Moderate Large 76-110 m: Moderate Very Large 111-150 m: Moderate-High	Very Small <1 ha: Moderate-High Small 1-5 ha: High Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
9. Hirwaun Common and Surrounding Ridges	Very Small 15-25m: Low-Moderate	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate

	Small 26-50 m: Moderate Medium 51-75 m: Moderate Large 76-110 m: Moderate-High Very Large 111-150 m: High	Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High
10. Coity Rural Hinterland	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Moderate Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
11. Merthyr Mawr Farmland, Warren and Coastline	Very Small 15-25m: Moderate-High Small 26-50 m: High Medium 51-75 m: High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Moderate Small 1-5 ha: Moderate-High Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
12. Newton Down Limestone Plateau	Very Small 15-25m: Low-Moderate Small 26-50 m: Low-Moderate Medium 51-75 m: Moderate Large 76-110 m: Moderate-High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Low-Moderate Medium 5-10 ha: Moderate Large 10-15 ha: Moderate-High Very Large >15 ha: High
13. Porthcawl Coastline and Settled Farmland	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Low-Moderate Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High
14. Kenfig Dunes and Coastline	Very Small 15-25m: Moderate-High Small 26-50 m: High Medium 51-75 m: High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: High Small 1-5 ha: High Medium 5-10 ha: High Large 10-15 ha: High Very Large >15 ha: High
15. Cefn Cribwr Ridge and Settled Farmland	Very Small 15-25m: Low-Moderate Small 26-50 m: Moderate Medium 51-75 m: Moderate-High Large 76-110 m: High Very Large 111-150 m: High	Very Small <1 ha: Low-Moderate Small 1-5 ha: Low-Moderate Medium 5-10 ha: Moderate-High Large 10-15 ha: High Very Large >15 ha: High

Table 33: Summary of Sensitivity Assessment of Landscape Character Areas

(BCBC, 2016)

Example policy wording

MTCBC has included reference to Local Search Areas for solar PV within their proposed Replacement Local Development Plan Deposit Plan June 2018 (MTCBC, 2018)

Example policy wording based on wording included in *Policy EcW8* of MTCBC's (2018) Local Development Plan:

"We will support the use of renewable energy as a tangible means of reducing our local carbon footprint, where appropriate to do so.

Development proposals for renewable energy will be permitted where:

- *They do not have an unacceptable landscape and visual impact, including on the setting of the Brecon Beacons National Park.*
- *There would be no unacceptable cumulative impacts in combination with existing or consented development. ·*
- *Satisfactory mitigation can be put in place to minimise the impacts of the renewable energy proposal and its associated infrastructure.*
- *Proposals make provision for the appropriate restoration and after-care of the land for its beneficial future re-use.*

Within the Local Search Areas (LSA), proposals for solar energy generation will be permitted subject to the above criteria. ***Proposals for other development within these areas will only be permitted where they can demonstrate that they would not unacceptably prejudice the renewable energy generation potential of the LSA."***

(MTCBC, 2018, p.71)

Recommendations

Following a review of SPG20 it is recommended that:

> LCA1: Llangynwyd Rolling Uplands & Forestry and LCA8: Ogmore Forest and Surrounding Uplands are defined as Local Search Areas for wind developments, and
> LCA 12: Newton Down Limestone Plateau is defined as a Local Search Area for solar developments.

Whilst it is recommended that LCA12 is designated as a Local Search Area in order to meet the proposed target set out in table 31 and avoid cumulative impact issues, it is anticipated that solar PV developments will be required in additional areas outside of LCA12. Smaller less constrained areas for solar PV have been identified within each of the urban areas within the county borough, which may provide good opportunities for development in less sensitive areas, in light of the following advice provided in SPG20: *"Since PV panels introduce a new land cover (of built structures) , landscapes containing existing hard surfacing or built elements (e.g. urban areas, brownfield sites or large-scale horticulture) are likely to be less sensitive to field-scale solar PV development than highly rural or naturalistic landscapes".* (BCBC, 2016, p. 18).

If either Local Search Area coincides with the final NDF priority areas for wind/solar, a clause should be included in any policy wording that smaller developments should not impact the potential for larger-scale projects to be developed.

In addition to these local search areas, positive policy regarding siting solar PV assets within built-up and urban areas should be adopted, including a requirement for the integration of roof-top PV on all new buildings.

To provide strength to the Local Search Area designation, BCBC could include similar wording to MTCBC that "*Proposals for other development within these areas will only be permitted where they can demonstrate that they would not unacceptably prejudice the renewable energy generation potential of the LSA*" (MTCBC, 2018, p.71).

8.2.3 Site allocations for new development and opportunities and requirements for renewable or low carbon energy generation linked to strategic new build development sites

Policy objectives

Sites located close to less constrained solar/wind areas may provide an electricity load which could be connected to a generation asset via a private wire. Welsh Government (2015) identify that residential candidate sites may conflict with potential wind developments if they are located within approximately 500 m due to potential noise concerns. If there appears to be significant potential to integrate renewable energy generation into strategic new build development sites, Welsh Government (2015) suggest that local authorities could encourage this by setting a carbon reduction target for the strategic site that developers are required to meet. It is suggested that these targets are framed in terms of a reduction in CO_2 emissions compared to Part L Building regulations and that the local authority will need to demonstrate that the level of carbon saving is achievable, and that the cost will not represent an undue burden to a developer.

Existing policy

Current policy encourages use of the renewable energy assessment to help encourage integration of renewable energy generation into development proposals:

*"**Policy ENV17 Renewable Energy and Low/Zero Carbon Technology***

The Council will encourage major development proposals to incorporate schemes, which generate energy from renewable and low/zero carbon technologies. These technologies include onshore wind, landfill gas, energy crops, energy from waste, anaerobic digestion, sewage gas, hydropower, biomass, combined heat and power and buildings with integrated renewable sources.

In achieving this, all development proposals of 10 or more residential dwellings or with a total floor space of 1,000 sq metres or more should, where viable, be able to connect to district supply networks of heat and energy. In addition, energy assessments should be submitted with applications to investigate incorporating on-site zero and low carbon equipment or connecting to existing sources of renewable energy. Such investigations should also examine the potential for heat and electricity generated by the development to power/fuel nearby receptive buildings.

The Council's Energy Opportunities Plan will inform consideration of these issues.

The following site is allocated for renewable energy generation:

ENV17(1) Former Llynfi Power Station: Biomass"

(BCBC, 2013b, p.43)

Evidence base for future policy

Section 7.1 and Table 34 have demonstrated that all the considered sites are located within or near areas of high resource. Furthermore, as stated by the RTPI (2019), due to the longevity of developments all new proposed developments should be able to demonstrate that they are suitable for a net-zero carbon energy system, otherwise costly retrofits will be required in the future to ensure that carbon targets are met. Table 34 summarises the results from the assessment, which were initially provided in section 7.1. It gives details on the proximity of the confirmed employment sites and candidate residential sites to areas of less constrained wind resource and solar resource and the area of predominant heat technology within which they are located. This information is provided to support BCBC when reviewing the candidate sites and establishing supportive policies for the integration of renewables into the employment sites.

Following a review of SPG20 integration of wind/ground mounted solar PV will need to be considered from a landscape perspective. Integrating generation technology into the built form of the development, e.g. providing solar canopies over car parks, may help to increase the acceptability of the development from a landscape perspective.

In addition to the considerations provided in Table 34 consideration of building design with respect to potential impacts of climate change including hotter summers, should be considered in development proposals. Whilst buildings may be designed to be energy efficient, the performance does not necessarily always deliver on the designs. Monitoring provision within development controls may help to ensure that building design continues to improve to ensure that actual performance is as energy efficient as possible.

Site	Proximity to less constrained solar/wind areas and predominant heating area	Policy considerations
Employment site: Pencoed Technology Park	**Solar:** identified onsite and immediately to the north **Wind:** over 1.5 km north–west **Predominant heating area:** Electric	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and solar canopies > review potential for private wire wind/solar developments offsite > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies
Employment site: Brocastle	**Solar:** identified onsite and immediately to the north-west **Wind:** no less constrained wind resource identified nearby within BCB boundary **Predominant heating area:** District heating	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and solar canopies > require integration of energy storage to provide load flexibility > require a review of district heating potential for development
Residential site 1: Pencoed Campus	**Solar:** identified onsite (site to the north of Pencoed Technology Park) **Wind:** ~1.5 km to the north-east **Predominant heating area:** Electric	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require consideration of integration of private wire to an off-site wind development > require installation of heat pump heating technologies
Residential site 2: Land east of Pyle	**Solar:** identified onsite, and to the south, east and west **Wind:** located onsite **Predominant heating area:** Electric/district heating	Consider whether to prioritise area for housing development or wind development. Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > integrate wind/ground mounted solar PV generation into development plans > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies, or assessment of district heat network viability
Residential site 3: Waun Bant Road and Pen y Castell Farm	**Solar:** identified onsite, and to the south and east **Wind:** located ~500 m south **Predominant heating area:** Electric/district heating	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require consideration of integration of private wire to an off-site wind/solar development > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies, or assessment of district heat network viability

Residential site 4: Porthcawl regeneration site	**Solar:** Less constrained solar resource identified in the eastern section of the site **Wind:** located ~2 km north **Predominant heating area:** Electric	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies, or assessment of district heat network viability
Residential site 5: Island Farm	**Solar:** Onsite and immediately south-east/south-west **Wind:** Small area located on-site **Predominant heating area:** District heating	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > integrate wind/ground mounted solar PV generation into development plans > require integration of energy storage to provide load flexibility > require a review of district heating potential for development
Residential site 6: Parc Afon Ewenni	**Solar:** Areas located nearby but within industrial sites **Wind:** ~2 km west **Predominant heating area:** Electric/district heating	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies, or assessment of district heat network viability
Residential site 7: Land west of Bridgend	**Solar:** Onsite and to the north and west of the site **Wind:** Onsite and ~500 m west **Predominant heating area:** District heating	Consider whether to prioritise area for housing development or wind development. Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > integrate wind/ground mounted solar PV generation into development plans > require consideration of integration of private wire to an off-site wind/solar development > require integration of energy storage to provide load flexibility > require a review of district heating potential for development
Residential site 8: Pont Rhyd y Cyff	**Solar:** Small area onsite and large area to the south, east, and west of the site **Wind:** ~1 km south-west **Predominant heating area:** Electric	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design > maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require consideration of integration of private wire to an off-site wind/solar development > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies
Residential site 9: Zig Zag	**Solar:** Onsite and to the north-west **Wind:** ~1 km north	Consider using development controls to: > reduce energy demand by maximising energy efficiency in fabric design

Lane, Porthcawl	**Predominant heating area:** Electric	> maximise onsite electricity generation from roof top solar PV and smaller ground arrays > require consideration of integration of private wire to an off-site wind/solar development > require integration of energy storage to provide load flexibility > require installation of heat pump heating technologies

Table 34: Policy considerations for integration of renewable/low carbon energy technologies at candidate residential and confirmed employment sites

Example policy wording

Milton Keynes Council has included a comprehensive policy within their local plan which requires a 19% carbon reduction improvement compared to Part L Building regulations and integration of onsite renewable energy generation, alongside additional requirements to ensure that all new buildings are built to a high standard and perform as they are intended to. The policy wording is provided below.

Example policy wording based on proposed Policy SC1: Sustainable Construction of Milton Keynes Council's *Plan: MK 2016-2031:*

"Development proposals will be required to demonstrate how they have implemented the principles and requirements set out below. With the exception of requirements K.2/3/5, non-residential development of 1000 sq.m or more that is demonstrated to achieve a BREEAM Outstanding rating will not be required to meet the requirements below.

[…]

Energy and Climate

- *Implement the Energy Hierarchy within the design of new buildings by prioritising fabric first, passive design and landscaping measures to minimise energy demand for heating, lighting and cooling.*
- *Review the opportunities to provide energy storage and demand management so as to tie in with local and national energy security priorities.*
- *The design of buildings and the wider built environment is resilient to the ongoing and predicted impacts of climate change.*
- *Development proposals for 11 or more dwellings and non-residential development with a floor space of 1000 sq.m or more will be required to submit an Energy and Climate Statement that demonstrates how the proposal will achieve the applicable requirements below:*
    1. *Achieve a 19% carbon reduction improvement upon the requirements within Building Regulations Approved Document Part L 2013, or achieve any higher standard than this that is required under new national planning policy or Building Regulations.*
    2. *Provide on-site renewable energy generation, or connection to a renewable or low carbon community energy scheme, that contributes to a further 20% reduction in the residual carbon emissions subsequent to 1) above.*
    3. *Make financial contributions to the Council's carbon offset fund to enable the residual carbon emissions subsequent to the 1) and 2) above to be offset by other local initiatives.*
    4. *Calculate Indoor Air Quality and Overheating Risk performance for proposed new dwellings.*
    5. *Implement a recognised quality regime that ensures the 'as built' performance (energy use, carbon emissions, indoor air quality, and overheating risk) matches the calculated design performance of dwellings in d) above.*
    6. *Put in place a recognised monitoring regime to allow the assessment of energy use, indoor air quality, and overheating risk for 10% of the proposed dwellings for the first five years of their occupancy, and ensure that the information recovered is provided to the applicable occupiers and the planning authority."*

(Milton Keynes Council, 2019)

In addition to planning policies relating to energy generation and use in buildings, BCBC should consider implementing policies which consider sustainable transport, including integration with pedestrian transport routes, the public transport network and expanding the electric vehicle network. BCBC could consider implementing requirements relating to integrating solar canopies and electric vehicle charging infrastructure into all new car-parking developments.

Brighton and Hove City Council has included provision for sustainable transport links within the policies relating to their designated development areas.

Example policy wording based on Policy DA3: Lewes Road of Brighton and Hove City Council's *Development Plan (2016)*:

"DA3 Lewes Road
The strategy for the development area is to further develop and enhance the role of Lewes Road as the city's academic corridor by supporting proposals which:

> improve further and higher education provision in the Lewes Road area;
> facilitate improved sustainable transport infrastructure that provides choice, including travel by bus, walking and cycling;
> secure improvements to the townscape and public realm;
> deliver inter-connected green infrastructure and biodiversity improvements, contributing to Biosphere objectives (see policy CP10);
> improve air quality in the Lewes Road area; and
> deliver the amounts of development set out in part B below.

…"

(Brighton and Hove City Council, 2016, p.49)

Recommendations

Following stakeholder feedback, it is recommended that BCBC requires new build developments to;

> achieve higher building fabric efficiencies than building regulations,
> integrate renewable energy generation technology (in particular solar PV and solar thermal), and
> include low carbon heating systems.

It is recommended that these requirements are framed in terms of a reduction in CO_2 emissions compared to Part L Building regulations as suggested by Welsh Government (2015). Welsh Government (2015) require the local authority to demonstrate that the level of carbon saving is achievable, and that the cost will not represent an undue burden to a developer. Previously it has been argued that requiring improvements on building regulations will result in housing developers building properties in other areas with lower regulations. Climate emergency declarations, an intention to raise building standards by Welsh Government (Welsh Government, 2019b) and the announcement in the 2019 Spring Budget Statement that a Future Homes Standard would be introduced which would require all new builds from 2025 to have low carbon heating systems in place of gas boilers, may help to reduce the likelihood of this. BCBC should engage with Welsh Government's current review of building regulations, when details are published and use the evidence provided to help determine the level of ambition to set in policy.

The Committee on Climate Change (2019, p.112) reports that *"New and existing homes often do not perform in line with the minimum standards of performance expected of them by law"*, therefore in addition to requiring higher standards than building regulations to be designed into a property, BCBC could require developers to provide a monitoring system that demonstrates compliance with the approved designs.

As above, it is recommended that new developments are required to enable sustainable travel, with infrastructure designed to encourage walking, cycling, public transport use and electric vehicles.

8.2.4 Policy mechanisms to support district heating networks for strategic new development sites

Policy objectives

Welsh Government (2015) suggest that encouraging district heat networks within new developments can provide a catalyst for wider district heat networks to develop and connect to existing buildings. It is suggested that local authorities will need to take a strong lead in developing these networks.

The UK government announced in the 2019 Spring Budget Statement that a Future Homes Standard would be introduced which would require all new builds from 2025 to have low carbon heating systems in place of gas boilers. In order to pursue the Local Area Energy Strategy (ETI 2018b) BCBC could consider implementing this sooner within the development controls of the LDP.

Existing policy

Current policy supports connection of new developments to district heat networks, where viable:

*"**Policy ENV17 Renewable Energy and Low/Zero Carbon Technology***

<u>The Council will encourage major development proposals to incorporate schemes, which generate energy from renewable and low/zero carbon technologies. These technologies include onshore wind, landfill gas, energy crops, energy from waste, anaerobic digestion, sewage gas, hydropower, biomass, combined heat and power and buildings with integrated renewable sources</u>.

<u>In achieving this, all development proposals of 10 or more residential dwellings or with a total floor space of 1,000 sq metres or more should, where viable, be able to connect to district supply networks of heat and energy.</u> In addition, energy assessments should be submitted with applications to investigate incorporating on-site zero and low carbon equipment or connecting to existing sources of renewable energy. Such investigations should also examine the potential for heat and electricity generated by the development to power/fuel nearby receptive buildings.

The Council's Energy Opportunities Plan will inform consideration of these issues.

The following site is allocated for renewable energy generation:

ENV17(1) Former Llynfi Power Station: Biomass"

(BCBC, 2013b, p.43)

Evidence base for future policy

An example policy suggested in the toolkit is to designate areas as strategic (or priority) district heat areas. BCBC are already showing strong leadership with respect to district heat networks by developing two council-owned district heat networks in Bridgend town and the Upper Llynfi Valley. The Local Area Energy Strategy (ETI, 2018b) identifies these areas as areas that are anticipated to be predominantly served by district heating in 2050. It was discussed at the Stakeholder Workshop whether BCBC should consider designating these areas as strategic district heating areas within the LDP, however it was decided that whilst the predominant technology map provided within the Strategy should be referred to, it should be for the developer to decide which **low carbon** heating system is most appropriate for their development and the policy should allow for this.

Example policy wording

Bristol City Council has included a policy, which sets a hierarchy of consideration of heating systems within development proposals. Connection to existing or new "Classified heat networks" is at the top of the hierarchy and these are defined as follows:

"Classified heat networks' include those being developed by Bristol City Council and third-party networks that meet certain requirements including:

- *Compliance with appropriate technical standards (presently the CIBSE code of practice);*
- *They are powered by renewable/low carbon sources or are on a clear timeline and technology pathway towards decarbonising the heat provided by the energy centre in line with the council's aspiration for the city to be run on entirely clean energy by 2050 and carbon neutral by 2050;*
- *They offer heat and/or cooling services at a fair and affordable price to the consumer;*
- *They provide annual reporting on their performance and carbon content."*

(Bristol City Council, 2019, p.112-113)

Example policy wording from proposed Policy CCS2: Towards zero carbon development from Bristol City Council's *Local Plan Review, Draft Policies and Development Allocations Consultation (March 2019):*

"Heating and Cooling Systems

New development will be expected to demonstrate through its Energy Strategy that the most sustainable heating and cooling systems have been selected. This should include consideration of the proposed system as a whole, including the impact of its component materials on greenhouse gas emissions.

New development will be expected to demonstrate that heating systems have been selected in accordance with the following approach:

> *Where possible, connection to an existing classified heat network or a new classified heat network from the point of occupation;*
> *Where it is likely that existing or proposed heat networks will grow, designing development with a communal heating system which could connect in the future;*
> *Elsewhere, employing sustainable alternatives to heat networks such as individual renewable heat or communal renewable/low-carbon heat.*

New development will be expected to demonstrate that cooling systems have been designed in accordance with the following steps:

> *Minimise excessive solar gain through orientation, built form, massing, fixed, mobile and seasonal shading and green infrastructure; then*
> *Maximise passive cooling through natural ventilation, diurnal cooling, placement of thermal mass and green and blue infrastructure; and then*
> *Meet residual cooling load renewably, and consider opportunities for seasonal cooling/heating."*

(Bristol City Council, 2019, p.109)

Recommendations

It was agreed in the stakeholder workshop that new developments should not be allowed to connect to the gas network. Instead a policy should be implemented which requires a hierarchy of low carbon heating solutions to be considered. Where district heat networks are considered too small to be managed by a traditional district heating operator, housing developers should be encouraged to engage with BCBC's ESCO which is due to be set-up to manage the two BCBC owned heat networks currently in development.

Whilst the LDP should reference the predominant heating map identified in the Local Area Energy Strategy (ETI 2018b), the policy wording should allow the individual house builder to consider all low carbon heating options to determine the most appropriate solution for their development. As per the feedback from the Solar Trade Association (2019a) the policy wording should require district heat networks to be designed so that they are suitable for integration with lower temperature heat generation systems (e.g. solar thermal and heat pumps).

8.3 Further actions for local authority, public sector and wider stakeholders

In addition to developing and implementing supportive and ambitious planning policies, local authorities and other stakeholders can undertake additional actions to ensure delivery of renewable energy opportunities and attainment of climate change targets. Table 35 summarises some additional actions that could be undertaken, including those identified through the stakeholder engagement exercises.

Category	Actions
Resilience and adaptation	Ensure resilience to climate change is considered in all new development Commit to building any new developments to the highest energy and environmental standards
Energy system transition	Consider supportive policies for new additional energy system infrastructure including electric vehicle charging infrastructure and battery storage Continue to act as an enabler for energy systems innovation Share learning from decarbonisation projects with others (private and public sector)
Water conservation and management	Ensure that all new developments incorporate sustainable drainage systems and rainwater harvesting
Grid infrastructure	Consider supportive policies for development of new grid connection infrastructure
Smart development	Develop supportive policies around smart development that devotes attention to energy issues in relation to building orientation and site layout, e.g. considering solar gain and solar generation. Consider integration of heat mains and digital infrastructure in new roads
Community energy	Support energy systems that are developed for the benefit of the community
Sustainable transport	Ensure developments maximise the use of active, public and shared transport over private transport and expand the existing cycle network
Green infrastructure	Incorporate green infrastructure in new development, with sufficient tree planting, green space or other techniques, such as green walls or roofs, to mitigate increasing temperatures and limit the Urban Heat island effect Require new developments to integrate wildlife corridors and biodiversity enhancements
Increase renewable energy deployment	Develop additional renewable energy generation projects on BCBC's (or other stakeholders') own estate Invest in renewable energy generation technologies (joint venture or sole investor) Ensure that renewable energy generation from waste is secured through any new waste management contracts
Waste management	Ensure that all waste management processes comply with the Waste Management hierarchy (Welsh Government, 2010)
Lead by example	Commit to building any new developments to the highest energy efficiency and environmental standards Implement energy efficiency measures on BCBC's (and other stakeholders') own estate Manage organisation operations in the most energy efficient manner (train staff) Ensure that climate change impact and sustainable development is considered throughout all procurement activities

Table 35: Additional actions that BCBC could undertake to achieve renewable energy and carbon targets

9. Conclusions

In order for Bridgend to achieve the energy targets set out in the Local Area Energy Strategy (ETI 2018b) and support the achievement of national energy targets, there is a need to decarbonise at a faster rate than the current reference projection set out by the UK Government (BEIS, 2019g). This requires increased electrification of heat and transport and large increases in energy efficiency (both with respect to electrical appliances and building fabric efficiency) in order to maintain electricity demands at a similar level as today.

An approximately ten-fold increase in local renewable energy generation would be required to meet/offset the proposed future energy demand of Bridgend County Borough from local sources. The assessment of resource potential has indicated that whilst theoretically possible, it would not be practically possible to achieve this from resources within the county borough alone, and some reliance on energy/resource imports from other areas will be required.

With respect to resource potential within the county borough, wind and solar resource have been identified as the predominant energy resources available.

The estimated additional annual energy generation potential available from wind energy within BCB is approximately 1.4 times the estimated current annual renewable electricity energy generation within the county borough. Areas of potential have been identified throughout the county borough, both in the upland areas in the north of the county borough, which are included in the Welsh Government's draft priority areas for large-scale (over 10 MW) wind developments and in the lowland coastal areas.

At a high-level, a large proportion of land in Bridgend County Borough would be considered suitable for a ground mounted PV development. In reality, only a proportion of this land would be developed due to additional considerations including cumulative impact, grid capacity and competition with other land uses, including agricultural land, recreational land, land used for other renewable energy sources and further land developments.

Wind and solar developments could be encouraged within the county borough by adopting policies, which:

> set an overall target for renewable energy deployment within the LDP, broken down within the monitoring framework into individual wind and solar deployment targets,
> identify the least sensitive landscape character areas for wind and solar developments (LCA1: Llangynwyd Rolling Uplands & Forestry/LCA8: Ogmore Forest and Surrounding Uplands, and LCA 12: Newton Down Limestone Plateau respectively) as Local Search Areas where developments would be favoured, and
> requiring new developments to directly integrate renewable generation technologies.

An assessment of the confirmed LDP strategic employment sites and candidate residential sites has shown that they provide potential for roof top solar PV installations, are all located close to areas less constrained for ground mounted solar and some are located close to areas less constrained for wind – providing ample opportunity for integration of renewable electricity generation.

To minimise reliance on energy generation in new developments, it is recommended that BCBC use their development controls to ensure that the energy demand from the sites is minimised through fabric efficiency and energy system design as well as encouraging on site energy generation.

Energy generation potential from renewable energy sources, other than wind and solar within the county borough is much lower, although their use could still be encouraged and maximised by adopting favourable policies. Energy generation from hydropower is particularly small, but additional resource may become available if the viability of small-scale pumped hydropower improves.

Without importing additional fuel, it is considered very unlikely that the identified biomass resource is of sufficient scale to be used in conventional (steam turbine) CHP/electricity generation applications. Another potential use for the resource would be in smaller biomass boilers dispersed throughout the county borough or for generation of heat and power via advanced conversion technologies, such as gasification.

Similarly, the amount of residual waste generated within the county borough and the existing capacity of waste processing plants means it is unlikely that a traditional energy from waste plant would be able to be developed in Bridgend within the LDP period. Some potential for smaller advanced conversion generation technologies is identified and these could be deployed towards the end of the development plan period when current waste management contracts end.

The operational AD plant at Stormy Down processes food waste generated within and outside of BCB. Food waste is predicted to reduce over the LDP period, but it is possible that the reduction in feedstock from food waste could be offset if the existing plant is able to diversify and accept organic farm waste. Whilst the resource potential from organic farm waste is relatively small, there may also be potential for several smaller on-farm mixed feedstock plants to develop.

The Local Area Energy Strategy identifies predominant heating systems in key areas, but acknowledges that there are uncertainties associated with large-scale deployment of each of the heating technologies considered (ESC, 2018b).

The first phase of the Strategy, outlined in the Smart Energy Plan (ESC, 2018b), involves a period of testing, development, demonstration and evaluation through a pipeline of proposed innovation and deployment projects and other activities. BCBC will pursue these projects and activities with partners to confirm the potential suitability of different low carbon heating options in the county borough.

The projected deployment figures provided within this document and based on the Local Area Energy Strategy modelling, for heat pumps and heat network connections, could be used to help determine the scale of innovation and deployment projects to be delivered by the end of the LDP period. Delivery of low carbon heating systems could be encouraged in new development proposals by adopting policies, which prohibit connection to the gas network and require a low carbon heating system hierarchy to be adhered to.

Whilst it is unlikely that Bridgend will be able to meet/offset their entire energy needs by 2033, positive development policies and targets could be adopted to aim to maximise the resource available alongside other land uses and considerations.

Policies could be adopted to ensure that any new building developments are suited to a zero-carbon future, by ensuring high-energy efficiency, integrating sustainable transport connections, providing renewable energy generation and implementing high-quality design.

BCBC has been at the forefront of energy systems innovation, through their involvement in the Smart Systems and Heat programme, the FREEDOM project and their own innovative energy projects.

BCBC can continue to lead the decarbonisation agenda by:

- Continuing to pursue their own innovation projects and enabling others to deliver innovation projects within the county borough, through delivery of the BCBC Smart Energy Plan
- Delivering and facilitating deployment of proven low carbon projects, e.g. by extending the fleet of wind and solar farms in the county borough,

- Introducing sustainable, low carbon transport policies and initiatives, and
- Improving the energy efficiency of the Council's own estate.

Undertaking these action points will assist BCBC in achieving their aim of making *"…Bridgend a decarbonised, digitally connected smart County Borough"* (ESC, 2018b, p.7).

Appendices

Appendix 1: Wind and ground mounted solar constraints

Constraint	Exclusion zone/Comment
Wind resource: Areas with estimated wind speeds less than 6.0 m/s at 45 m were excluded.	Wind speeds greater than 6.0 m/s at 45 m height are considered more likely to result in an economically viable wind scheme. Data used for the assessment is based on data provided by the Met Office to Welsh Government, which contains 1.5 km resolution average wind speed data at 45m height for the period 1984-2014. Whilst this data provides an indication of wind speed, the low geographic resolution means that site specific wind assessments are required to understand the energy potential and associated viability of individual sites. Ideally, sites for wind developments will experience wind speeds much greater than 6.0 m/s at 45 m height, but given the resolution of the wind data used, 6.0 m/s is considered an appropriate cut-off for this high-level assessment.
Environmental/Landscape Designations: Land designated as follows was removed > Special Area of Conservations > National Nature Reserves > Sites of Special Scientific Interest > Local Nature Reserves	Whilst it may be possible to install wind turbines within designated areas, depending on the nature of the individual site and designation, for a high-level assessment, these areas are considered less suitable. NRW's latest datasets (NRW, 2019c, 2019d, no date, no date) available were used, however it was noted that Newton Burrows was not included within the Local Nature Reserve dataset – so this area was added from BCBC spatial data. Areas of Outstanding Natural Beauty, National Parks, Special Protection Areas, RAMSAR sites and Marine Nature Reserves were originally considered, however there are none present in Bridgend County Borough.
Heritage Designations: Land designated as follows was removed > Scheduled Monuments	An additional exclusion zone of tip height plus 10% (132m) was included around Scheduled Monuments (Cadw, no date), due to their small footprint and to provide further protection from construction. Country Parks and World Heritage Sites were originally considered, however there are none present in Bridgend County Borough.
Domestic properties	An exclusion zone of 500m around domestic property point location data provided by BCBC was included. Whilst it may be possible to install wind turbines closer than 500m to domestic properties, Welsh Government's (2015) suggested exclusion zone for providing protection from noise and visual impact was used for this assessment.
Other infrastructure: > Other buildings > Secondary road network	Ordnance Survey Vector Map District (Ordnance Survey, 2019c) data for buildings and the Ordnance Survey Open Roads (Ordnance Survey, 2019a) data for the secondary road network was used with an exclusion zone of tip height plus 10% (132m) applied.

Other infrastructure: > Railway Tracks > Primary roads	Vector Map District (Ordnance Survey, 2019c) data for railway lines and Ordnance Survey Open Roads (Ordnance Survey, 2019a) data for the primary road network was used with the Welsh Government (2015) suggested exclusion zone of tip height plus 50m (170m)
Other environmental data: > Woodland > Surface Water	Ordnance Survey Vector Map District (Ordnance Survey, 2019c) data for woodland and surface water and NRW's National Forestry Inventory (NRW, 2016) data was used with a 50m exclusion zone applied.

Table 36: High-level wind constraints included in assessment

Constraint	Comment
Slope/Aspect: **Inclinations of 0-3°:** All orientations considered suitable **Inclinations between 3-15°:** Exclude areas outside of south-west to south-east facing **Inclinations above 15°:** Exclude all areas (Welsh Government, 2015)	Ordnance Survey Terrain 50 (Ordnance Survey, 2019b) data was used to determine the slope and aspect of the terrain.
Flood warning areas	NRW's flood warning areas and development advice zones were used (NRW, 2019a, 2019b).
Environmental/Landscape Designations: Land designated as follows was removed > Special Area of Conservations > National Nature Reserves > Sites of Special Scientific Interest > Local Nature Reserves	Whilst it may be possible to install solar farms within designated areas, depending on the nature of the individual site and designation, for a high-level assessment, these areas are considered less suitable. NRW (2019c, 2019d, no date, no date) data was used, however it was noted that Newton Burrows was not included within the Local Nature Reserve dataset, so this area was added from BCBC's own data. Areas of Outstanding Natural Beauty, National Parks, Special Protection Areas, RAMSAR sites and Marine Nature Reserves were originally considered, however there are none present in Bridgend County Borough.
Heritage Designations: > Scheduled Monuments	An additional exclusion zone of 100m was included around Scheduled Monuments (Cadw, 2019), due to their small footprint and to provide further protection from construction. Country Parks and World Heritage Sites were originally considered, however there are none present in Bridgend County Borough.
Infrastructure/Environmental constraints: > Railway Tracks	Ordnance Survey Open Roads (Ordnance Survey, 2019a) and Vector Map District (Ordnance Survey, 2019c) data was used and a 10 m exclusion zone applied.

> Primary/secondary road network > Buildings > Surface water	
Environmental constraints: > Woodland	Ordnance Survey Vector Map District (Ordnance Survey, 2019c) data for woodland and surface water and NRW's National Forestry Inventory (NRW, 2016) was used.

Table 37: High-level solar PV constraints included in assessment

Appendix 2: Wind clusters

Cluster	Area (km^2)	Indicative capacity (MW), assuming 10 MW per km^2 (Welsh Government, 2015)	Assumed capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh p.a.)
1	2.272	22.72	0.27	53,741
2	0.011	0.11	0.27	262
3	1.121	11.21	0.27	26,502
4	0.041	0.41	0.27	969
5	0.086	0.86	0.27	2,026
6	0.256	2.56	0.27	6,063
7	5.429	54.29	0.27	128,411
8	0.087	0.87	0.27	2,065
9	0.155	1.55	0.27	3,665
10	0.436	4.36	0.27	10,304
11	0.198	1.98	0.27	4,682
12	0.941	9.41	0.27	22,261
13	0.112	1.12	0.27	2,639
14	1.507	15.07	0.27	35,651
15	0.126	1.26	0.27	2,972
16	0.020	0.20	0.27	464
17	0.027	0.27	0.27	628
18	0.373	3.73	0.27	8,827
19	0.002	0.02	0.27	38
20	0.034	0.34	0.27	815
21	0.030	0.30	0.27	716
22	0.006	0.06	0.27	131
23	0.653	6.53	0.27	15,447
24	0.031	0.31	0.27	730
25	0.210	2.10	0.27	4,957
26	0.075	0.75	0.27	1,765
27	0.545	5.45	0.27	12,879
28	0.001	0.01	0.27	20
29	0.004	0.04	0.27	101
30	0.000	0.00	0.27	9
31	0.036	0.36	0.27	842
32	0.029	0.29	0.27	682
33	0.070	0.70	0.27	1,647
34	0.002	0.02	0.27	52
TOTAL	14.92	149.23	0.27	352,964

Table 38: Estimated power and energy generation capacity within the identified wind clusters based on Welsh Government (2015) assumption of 10 MW/km^2

Cluster	Area (km^2)	Indicative no. of turbines	Indicative capacity (MW)	Assumed capacity factor (Welsh Government, 2015)	Estimated annual energy generation (MWh p.a.)
1	2.272	11	22	0.27	52,034
2	0.011	1	2	0.27	4,730
3	1.121	5	10	0.27	23,652
4	0.041	1	2	0.27	4,730
5	0.086	1	2	0.27	4,730
6	0.256	1	2	0.27	4,730
7	5.429	27	54	0.27	127,721
8	0.087	1	2	0.27	4,730
9	0.155	1	2	0.27	4,730
10	0.436	2	4	0.27	9,461
11	0.198	1	2	0.27	4,730
12	0.941	4	8	0.27	18,922
13	0.112	1	2	0.27	4,730
14	1.507	7	14	0.27	33,113
15	0.126	1	2	0.27	4,730
16	0.020	1	2	0.27	4,730
17	0.027	1	2	0.27	4,730
18	0.373	1	2	0.27	4,730
19	0.002	1	2	0.27	4,730
20	0.034	1	2	0.27	4,730
21	0.030	1	2	0.27	4,730
22	0.006	1	2	0.27	4,730
23	0.653	3	6	0.27	14,191
24	0.031	1	2	0.27	4,730
25	0.210	1	2	0.27	4,730
26	0.075	1	2	0.27	4,730
27	0.545	2	4	0.27	9,461
28	0.001	1	2	0.27	4,730
29	0.004	1	2	0.27	4,730
30	0.000	1	2	0.27	4,730
31	0.036	1	2	0.27	4,730
32	0.029	1	2	0.27	4,730
33	0.070	1	2	0.27	4,730
34	0.002	1	2	0.27	4,730
TOTAL	14.92	87	174	0.27	411,545

Table 39: Estimated power and energy generation capacity within the identified wind clusters considering number of turbines per cluster

Appendix 3: Resource maps

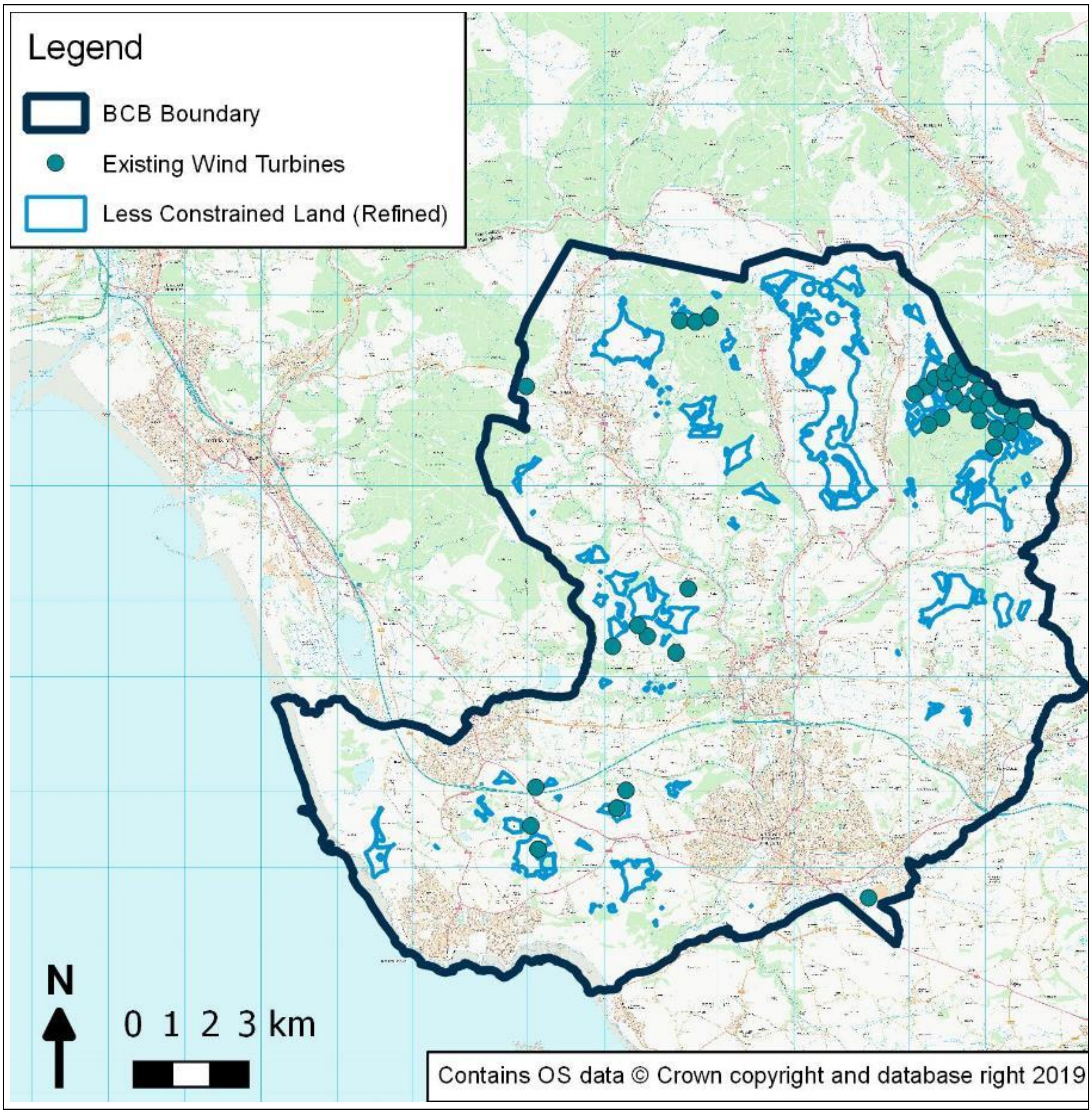


Figure 32: Areas of less constrained land for wind developments and existing wind turbines

(Blaenau Gwent County Borough Council, 2019)

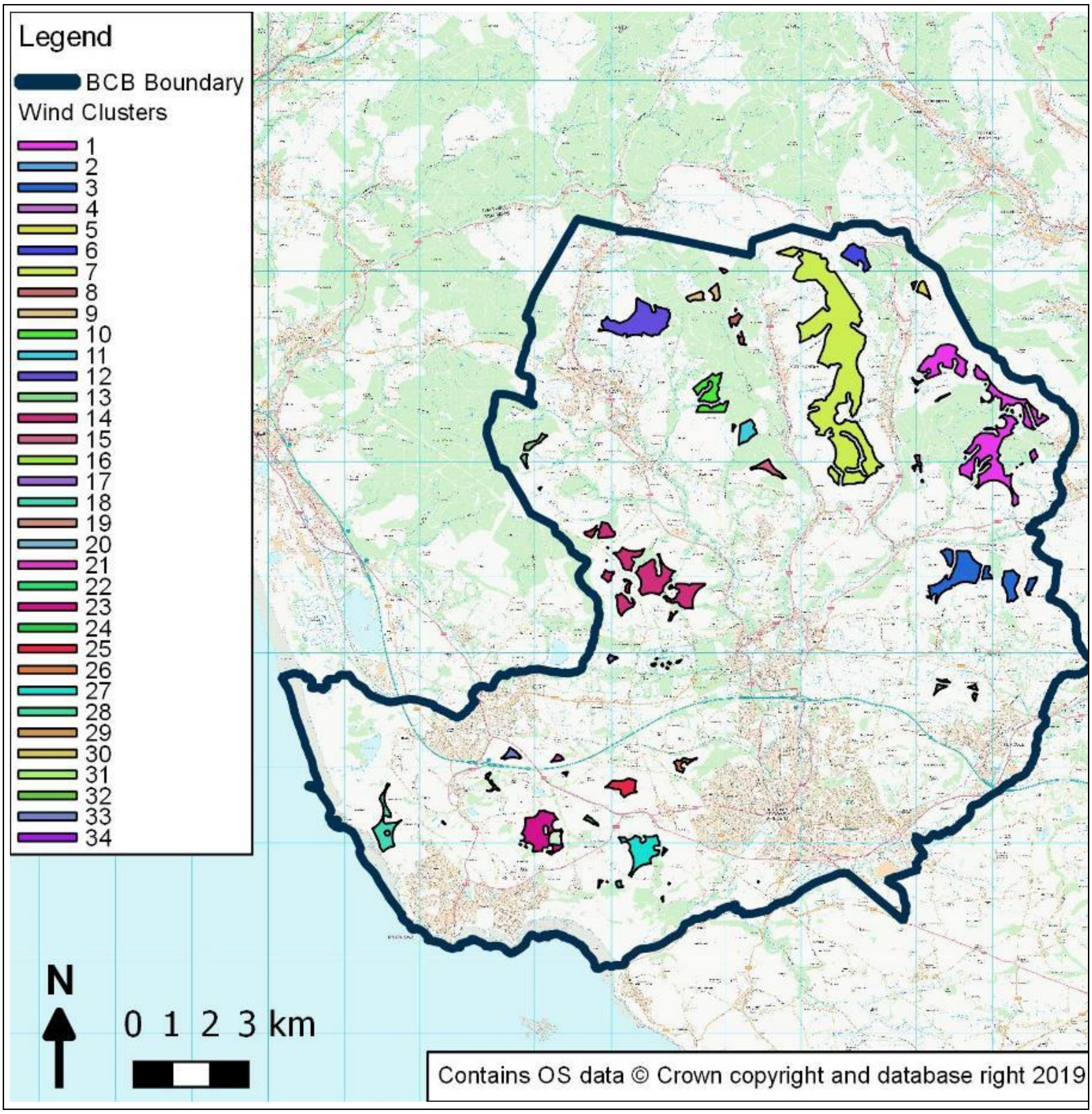


Figure 33: Clusters of areas of less constrained land for wind development – following a refinement of the less constrained areas using aerial imagery

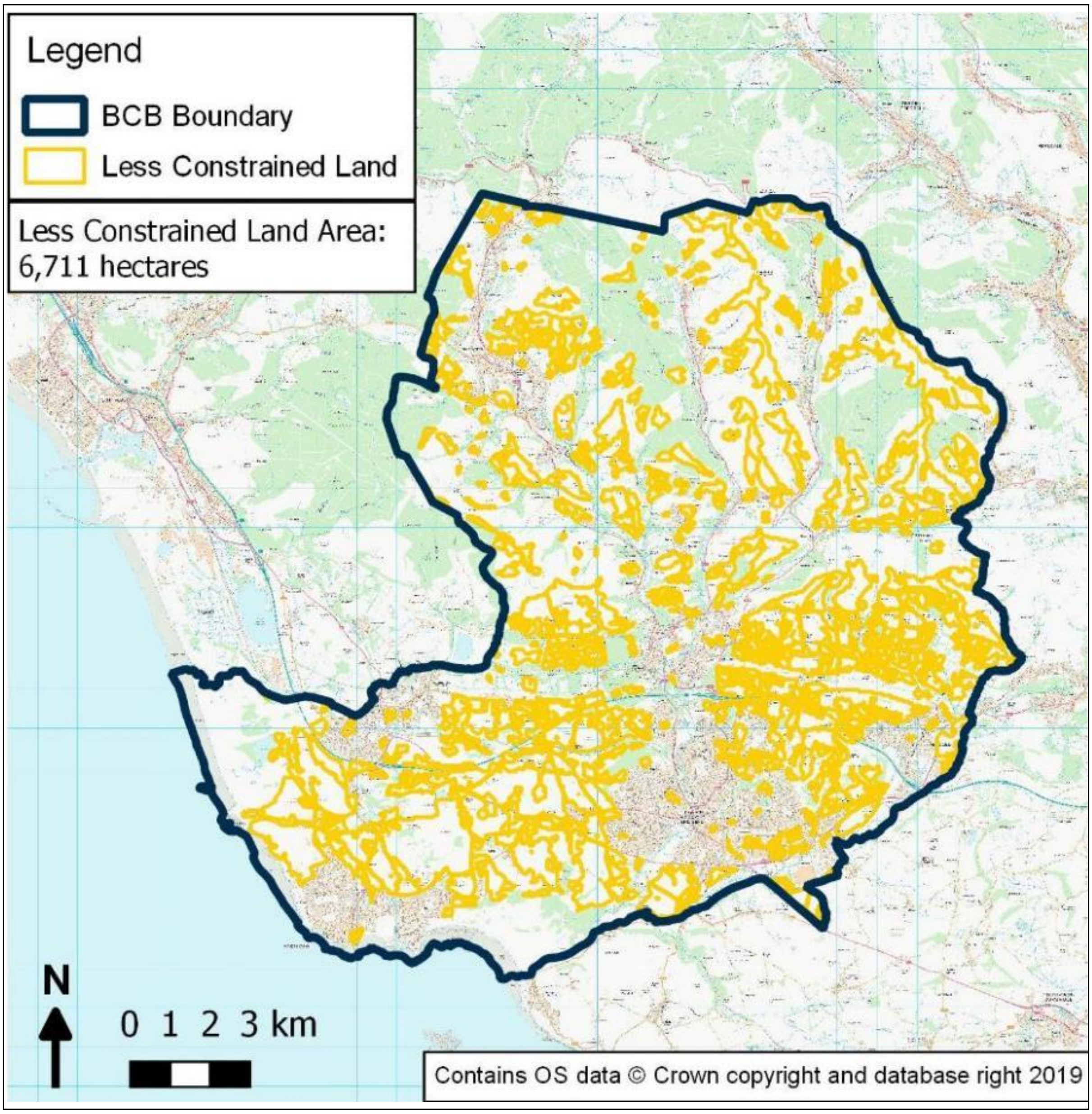


Figure 34: Less constrained land available for ground mounted solar PV following the high-level constraints assessment and visual inspection

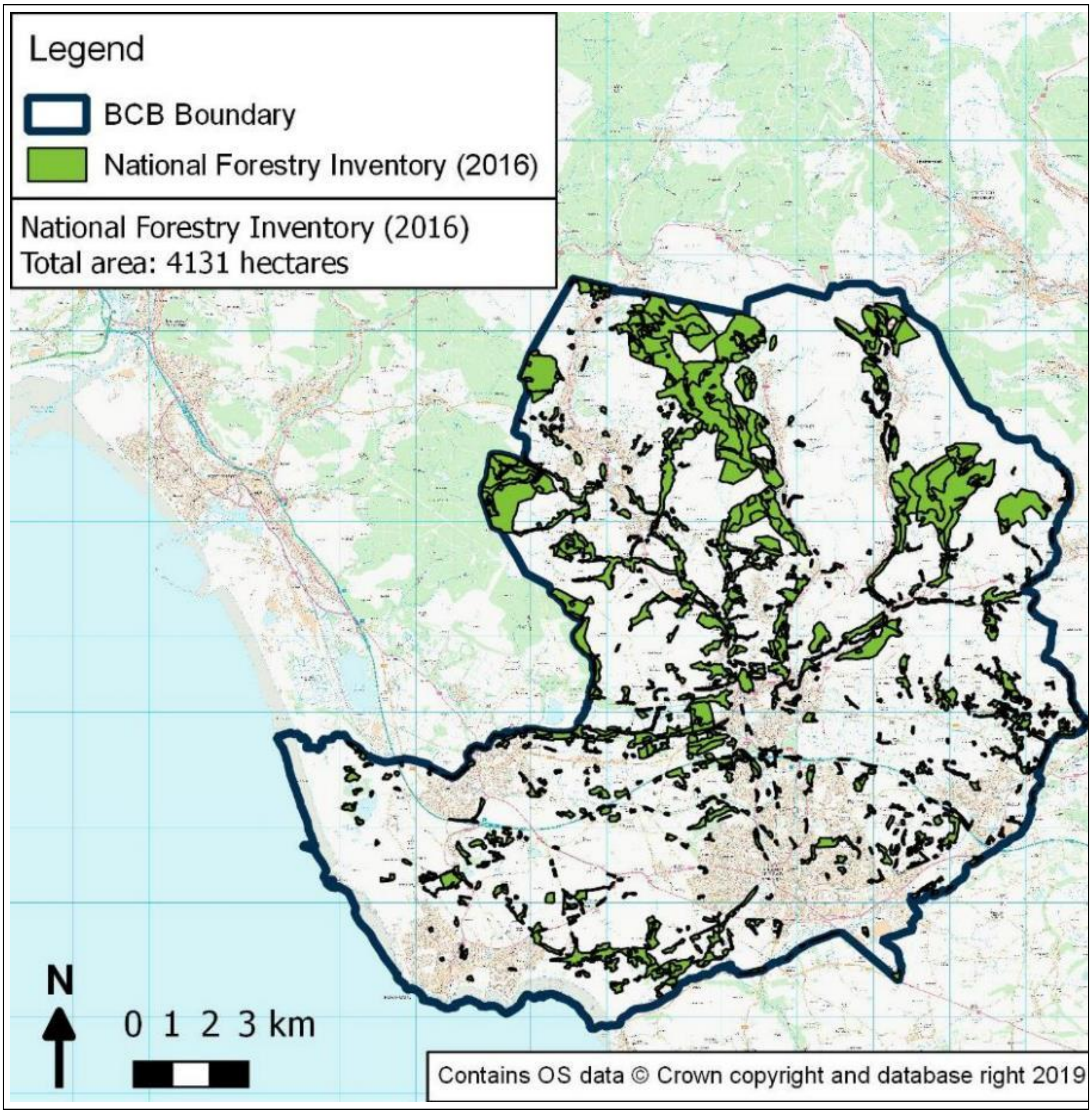


Figure 35: Woodland within the National Forestry Inventory in Bridgend County Borough

(NRW, 2016)

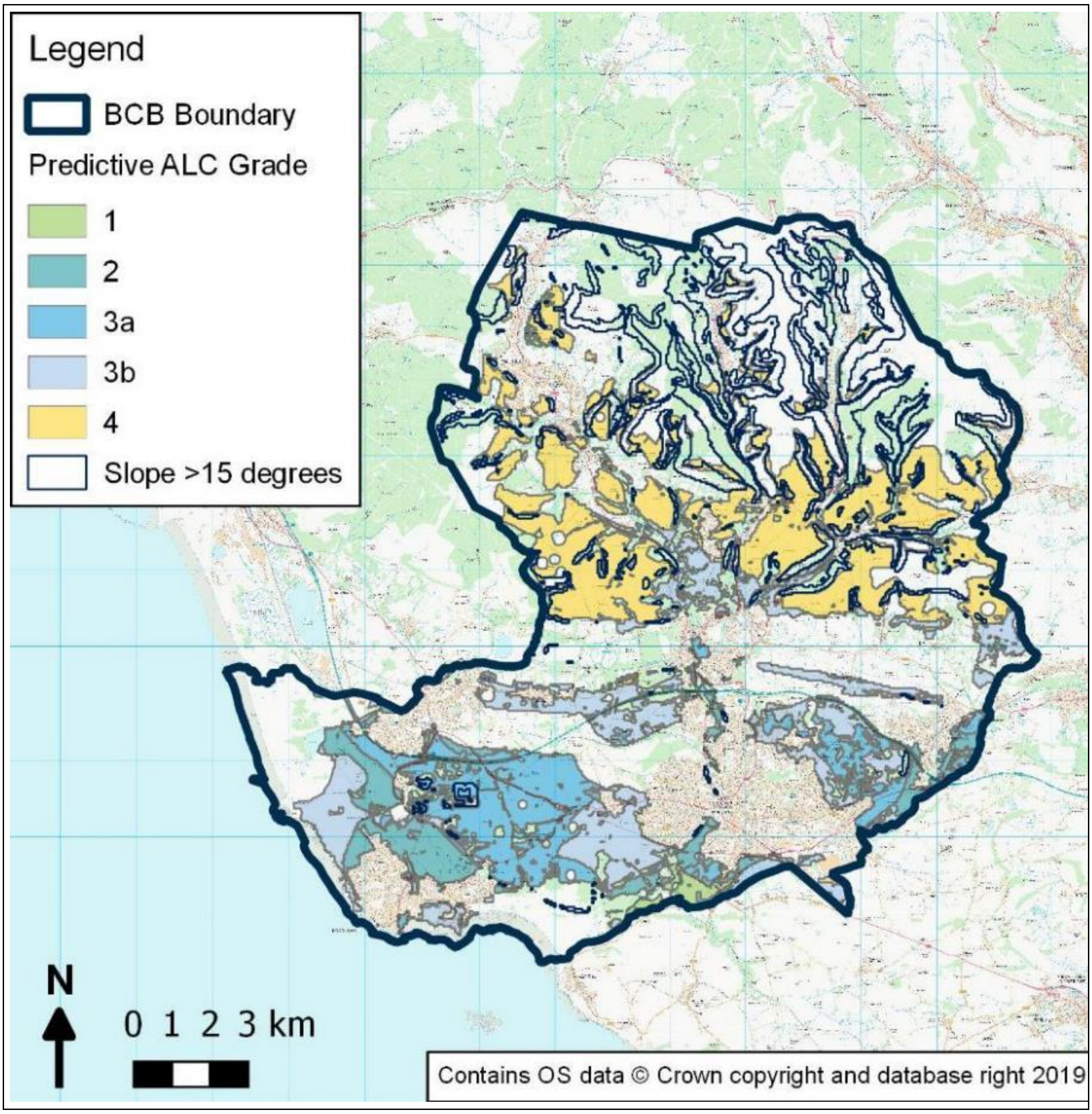


Figure 36: Theoretical land available for energy crops

(Welsh Government, 2017a)

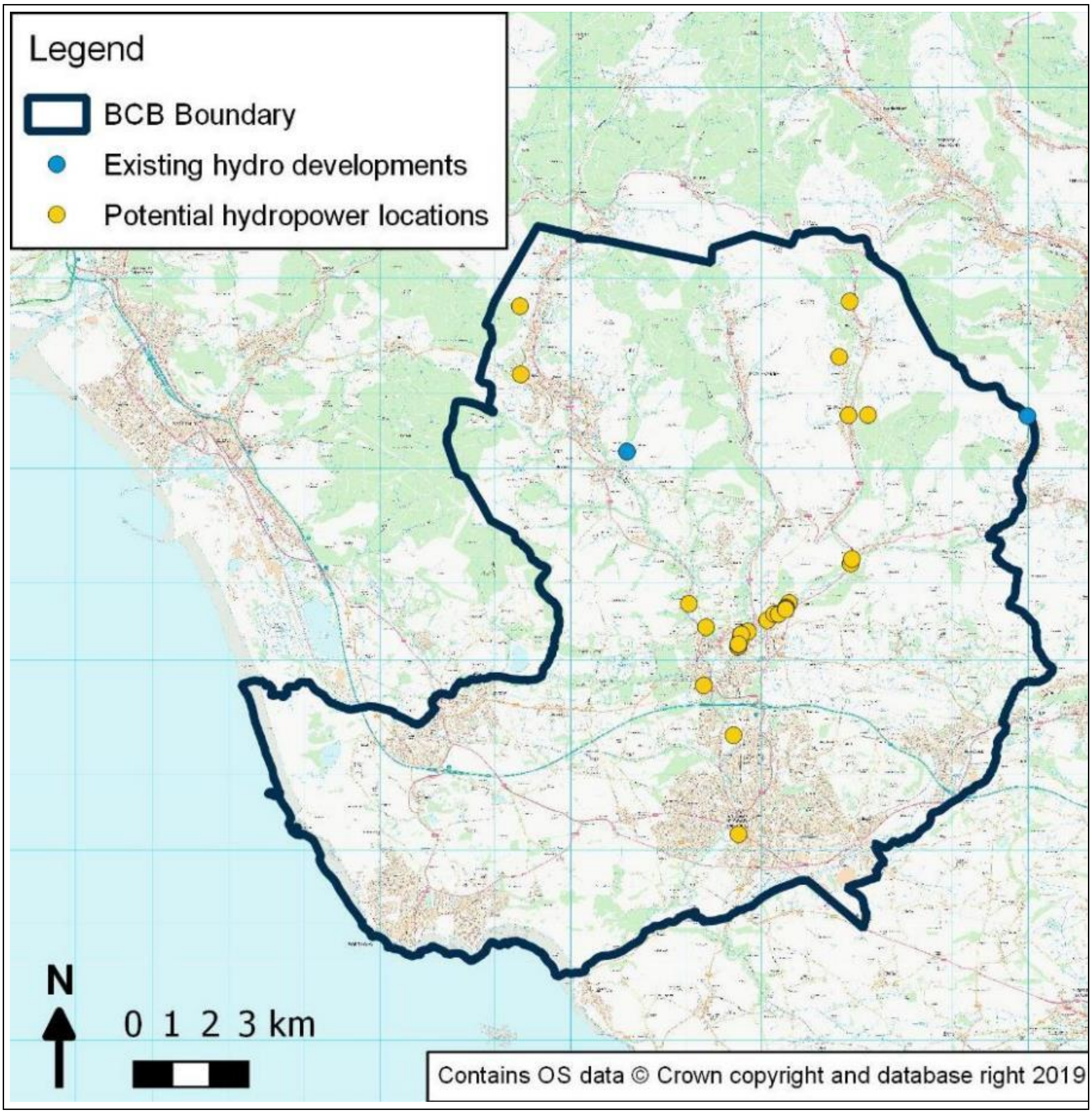


Figure 37: Map of identified hydropower potential and existing stations within Bridgend County Borough

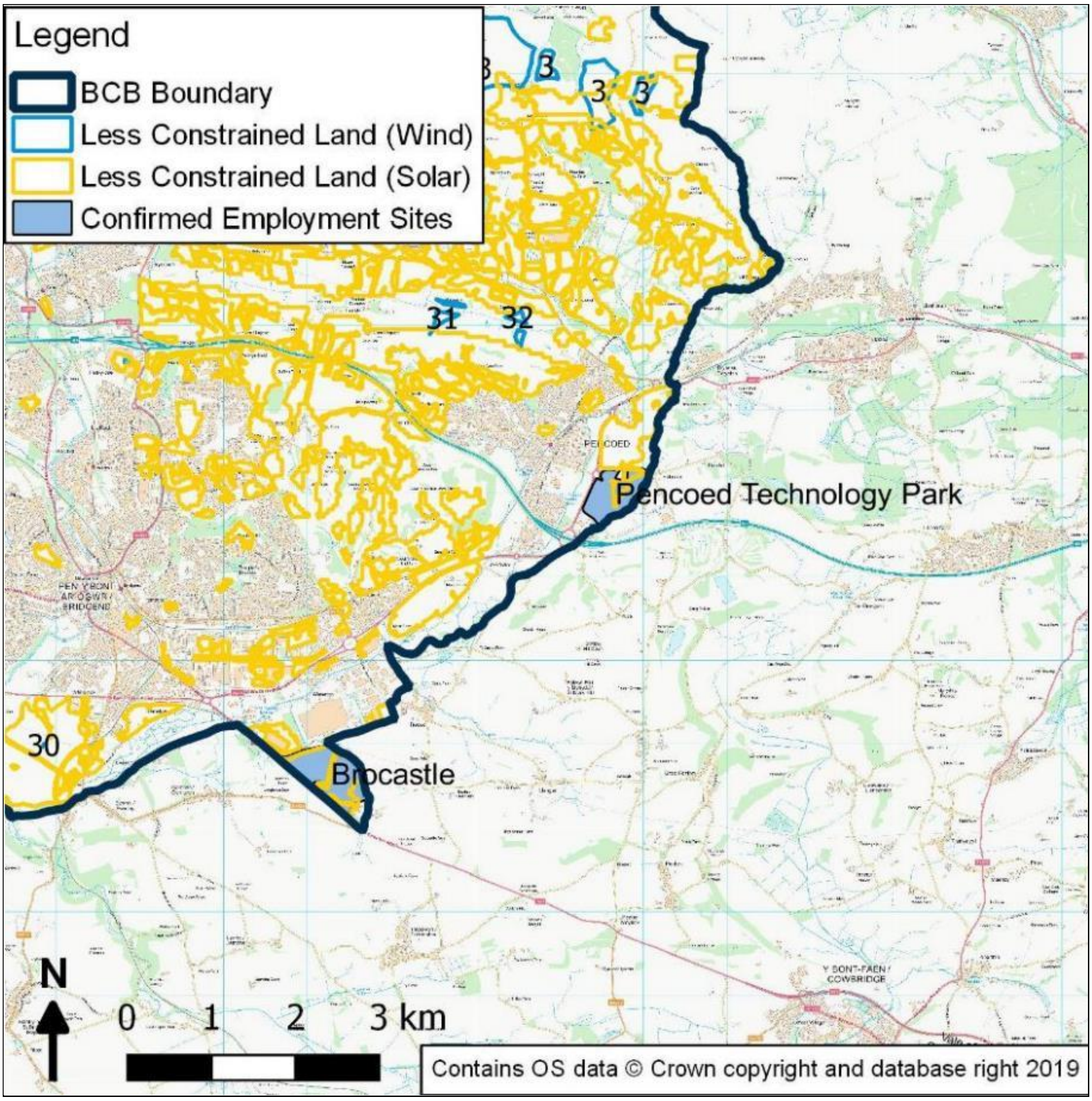


Figure 38: Location of strategic employment sites and less constrained areas for wind/solar

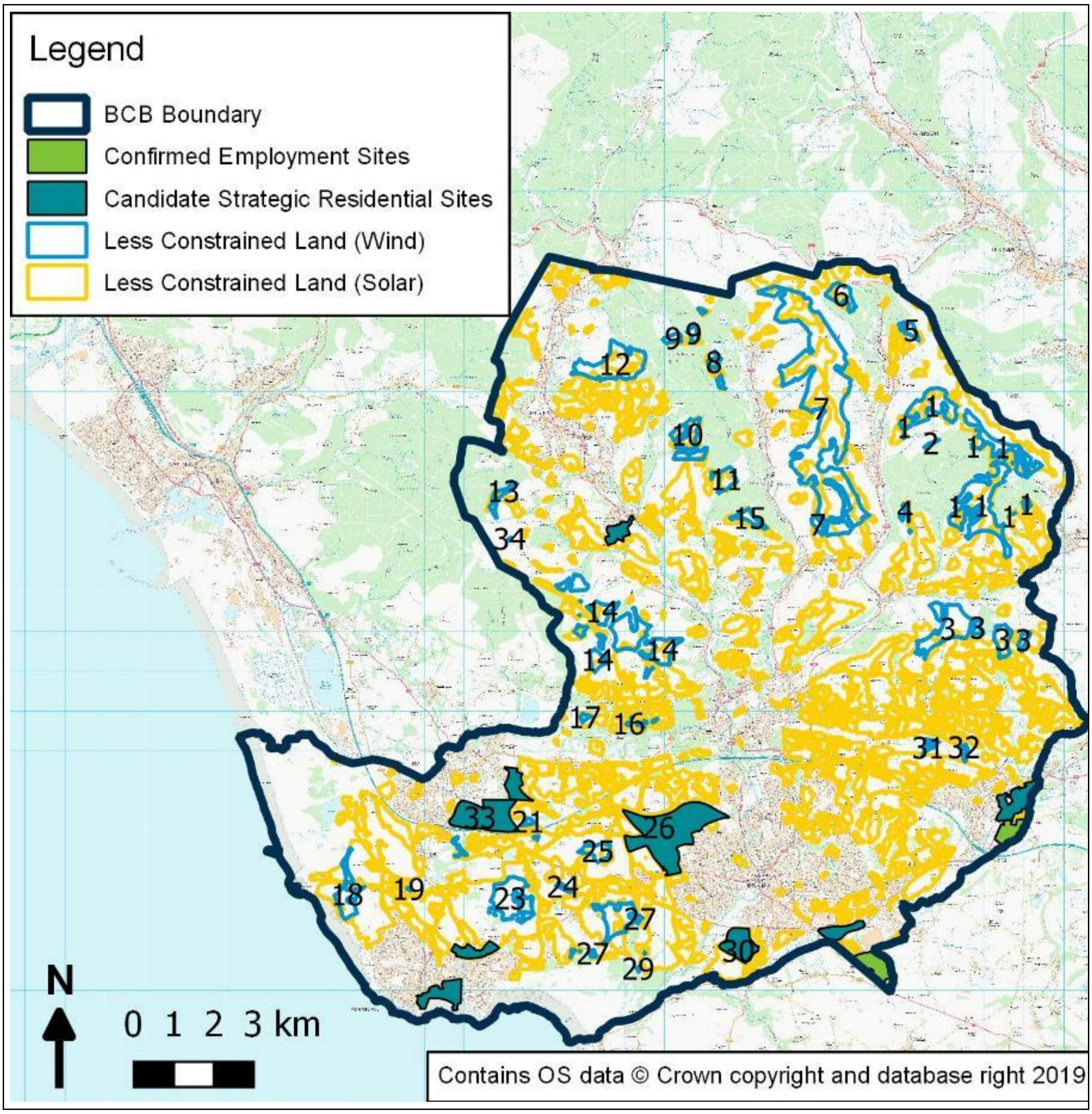


Figure 39: Location of candidate residential sites and areas less constrained for wind/solar

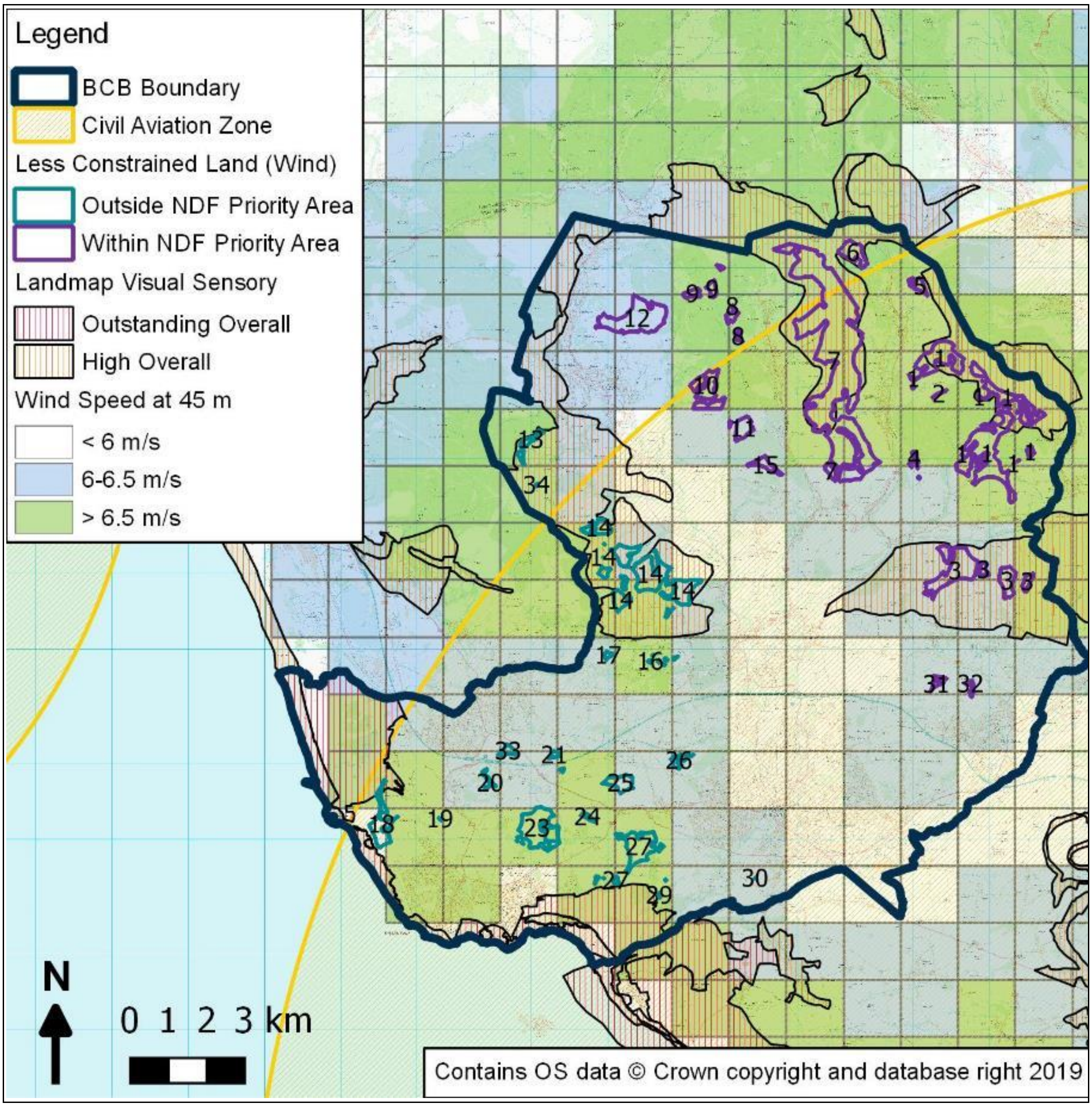


Figure 40: Clusters of areas of less constrained land for wind development, Civil Aviation Authority zone around Cardiff airport and Landmap Visual Sensory areas with overall classifications of high/outstanding

(NRW, 2019b, CAA, 2014)

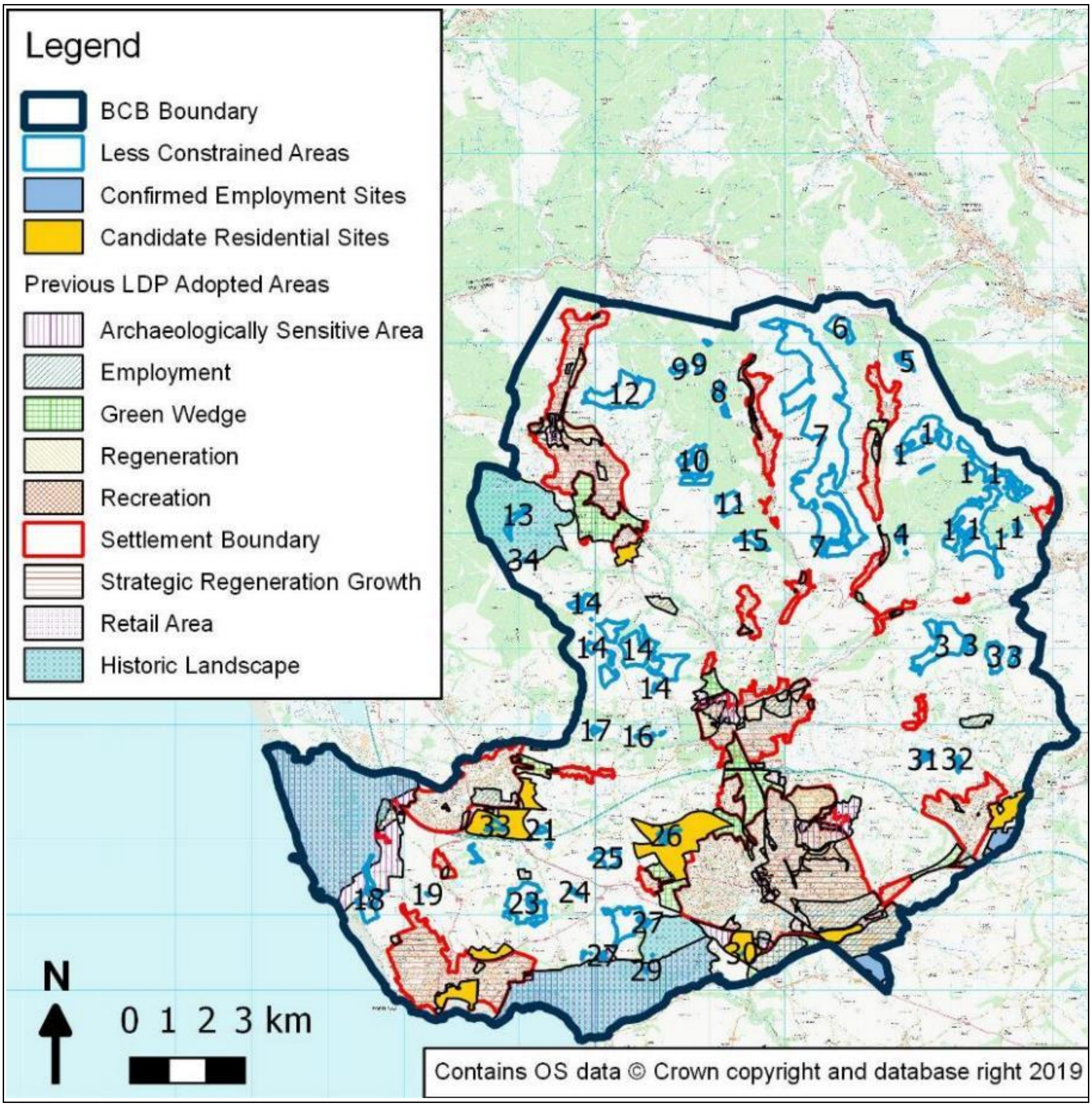


Figure 41: Less constrained wind clusters, land uses designated in the previous LDP, and confirmed employment and candidate residential sites

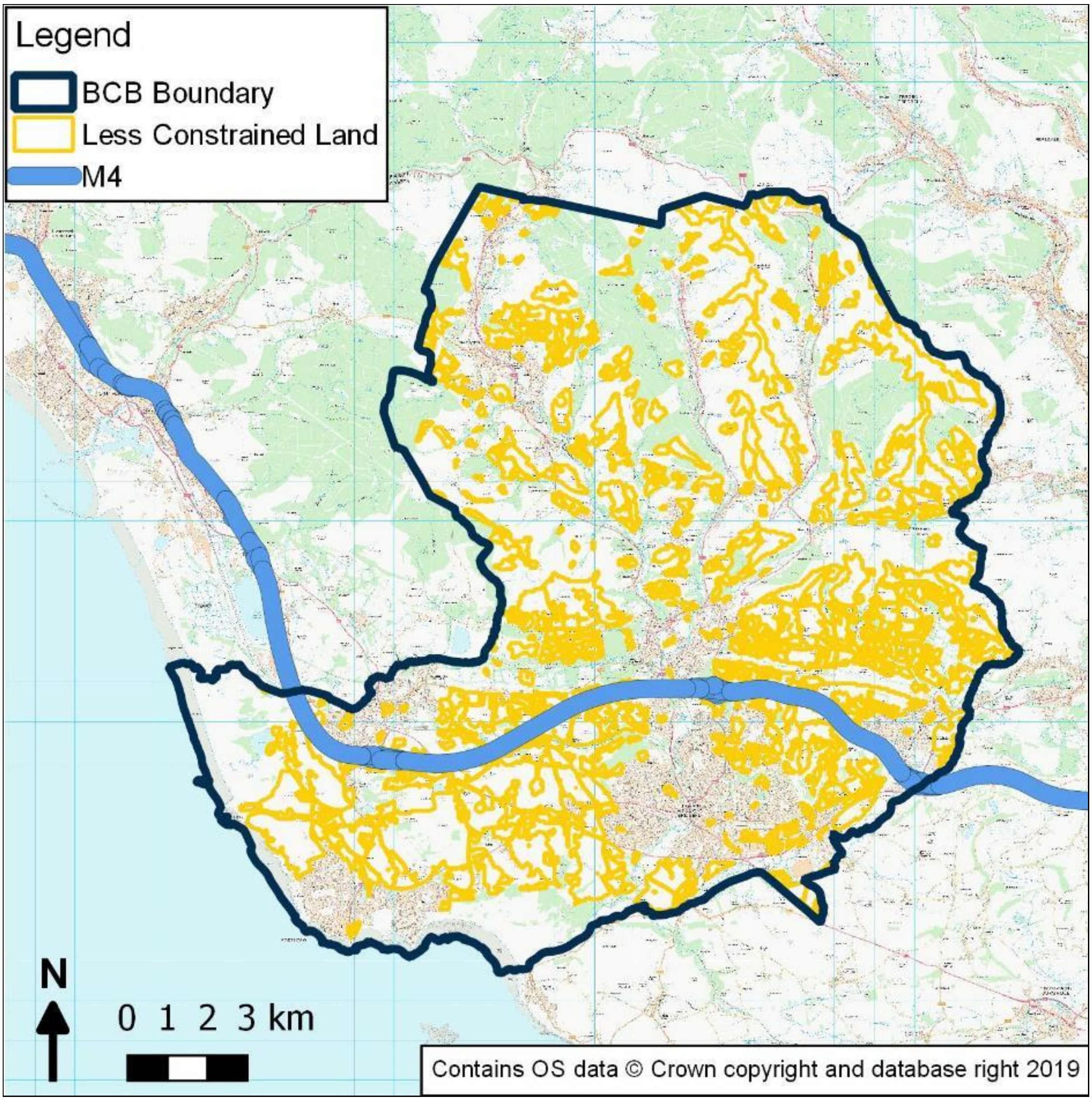


Figure 42: Refined less constrained solar areas with M4 highlighted to ease identification of Welsh Government (2019a) priority areas for large-scale solar

(Ordnance Survey, 2019a)

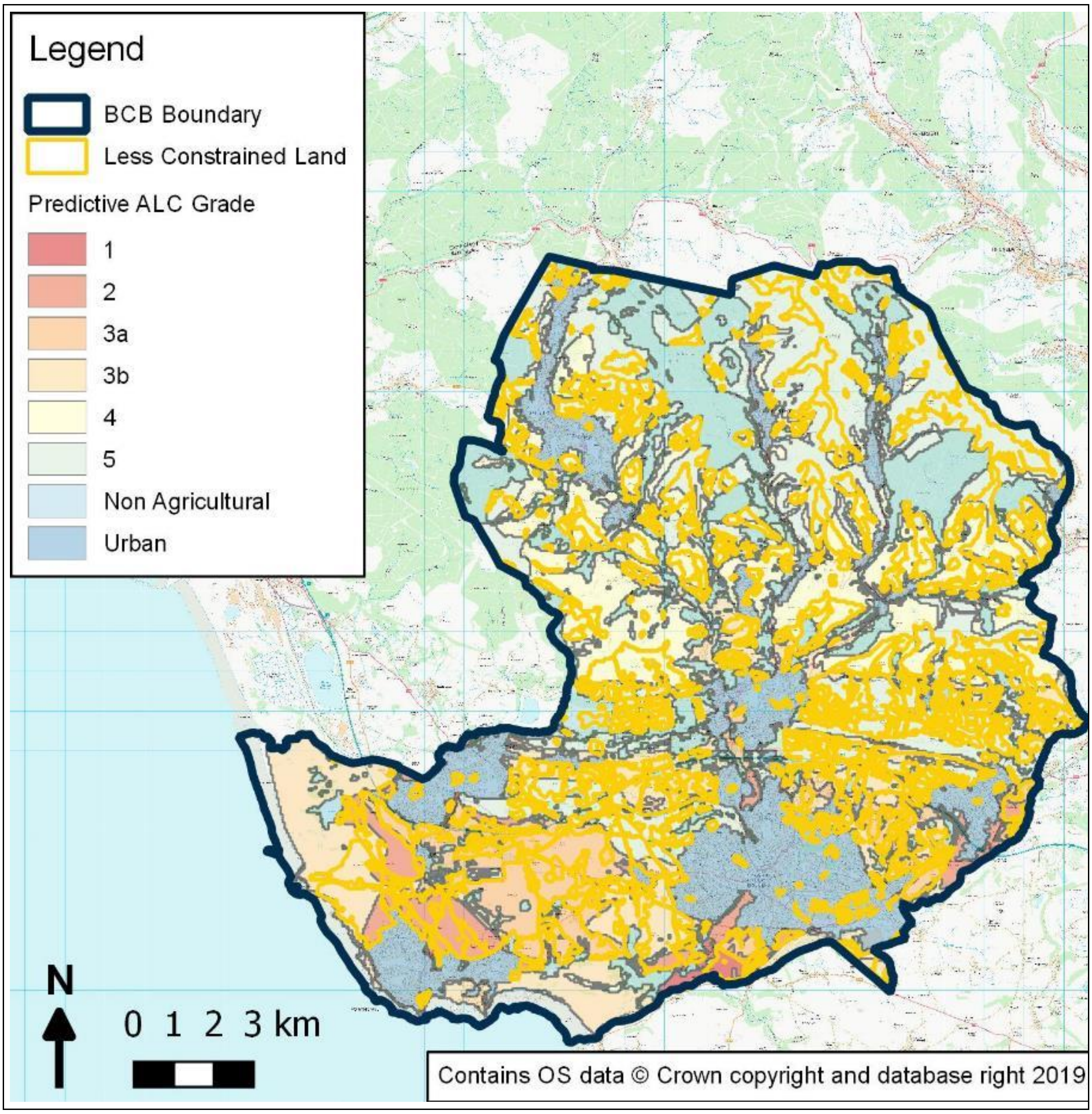


Figure 43: Less constrained land available following a visual inspection and predictive agricultural land classification (ALC)

(Welsh Government, 2017a)

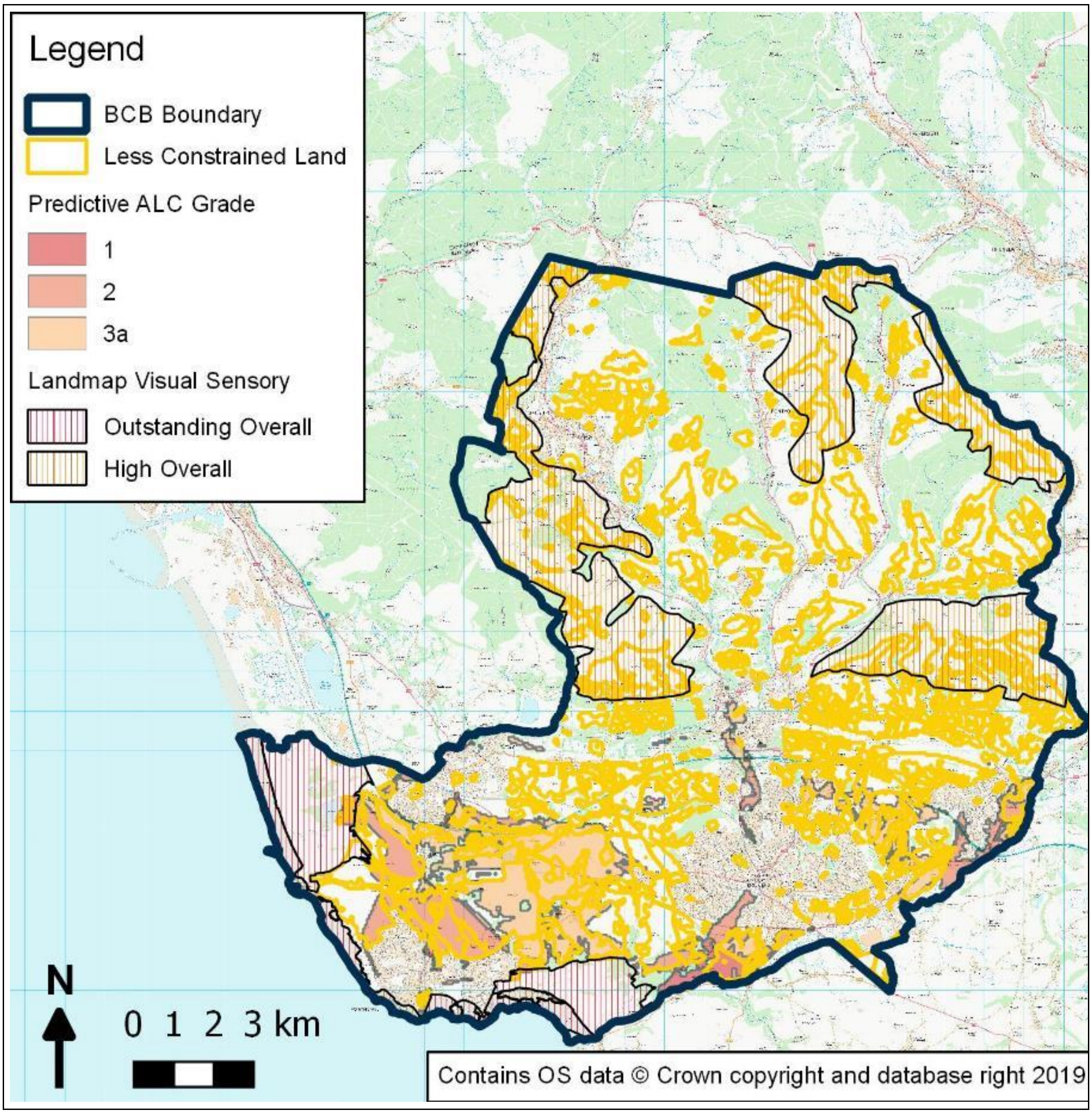


Figure 443: Less constrained land available following a visual inspection, predictive agricultural land classifications 1-3a and areas with an overall classification of high/outstanding for Landmap Visual Sensory

(Welsh Government, 2017a, NRW, 2019c)

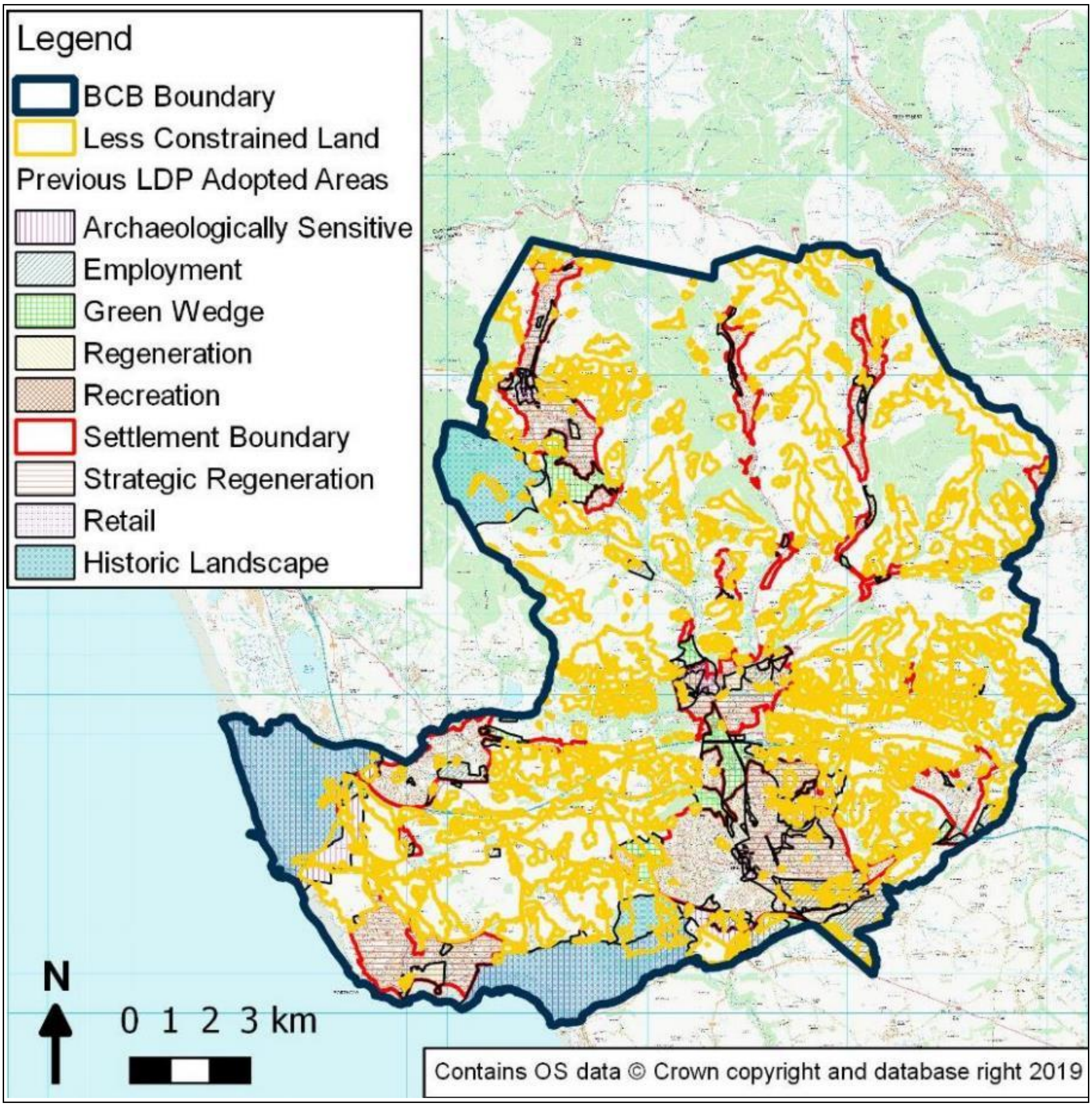


Figure 45: Less constrained solar areas, land uses designated in the previous LDP, and confirmed employment and candidate residential sites

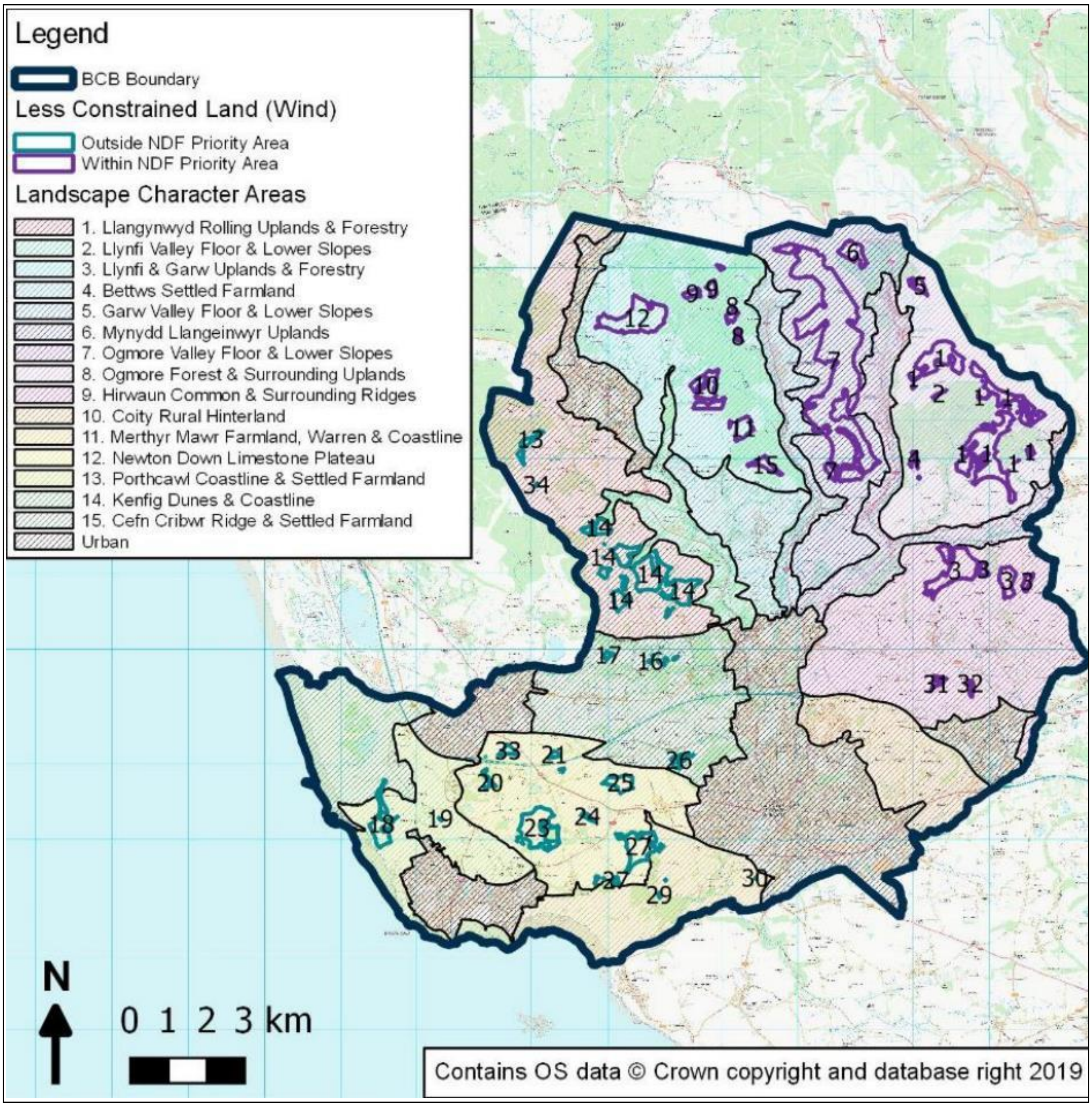


Figure 46: Less constrained wind areas and landscape character areas

(BCBC, 2016)

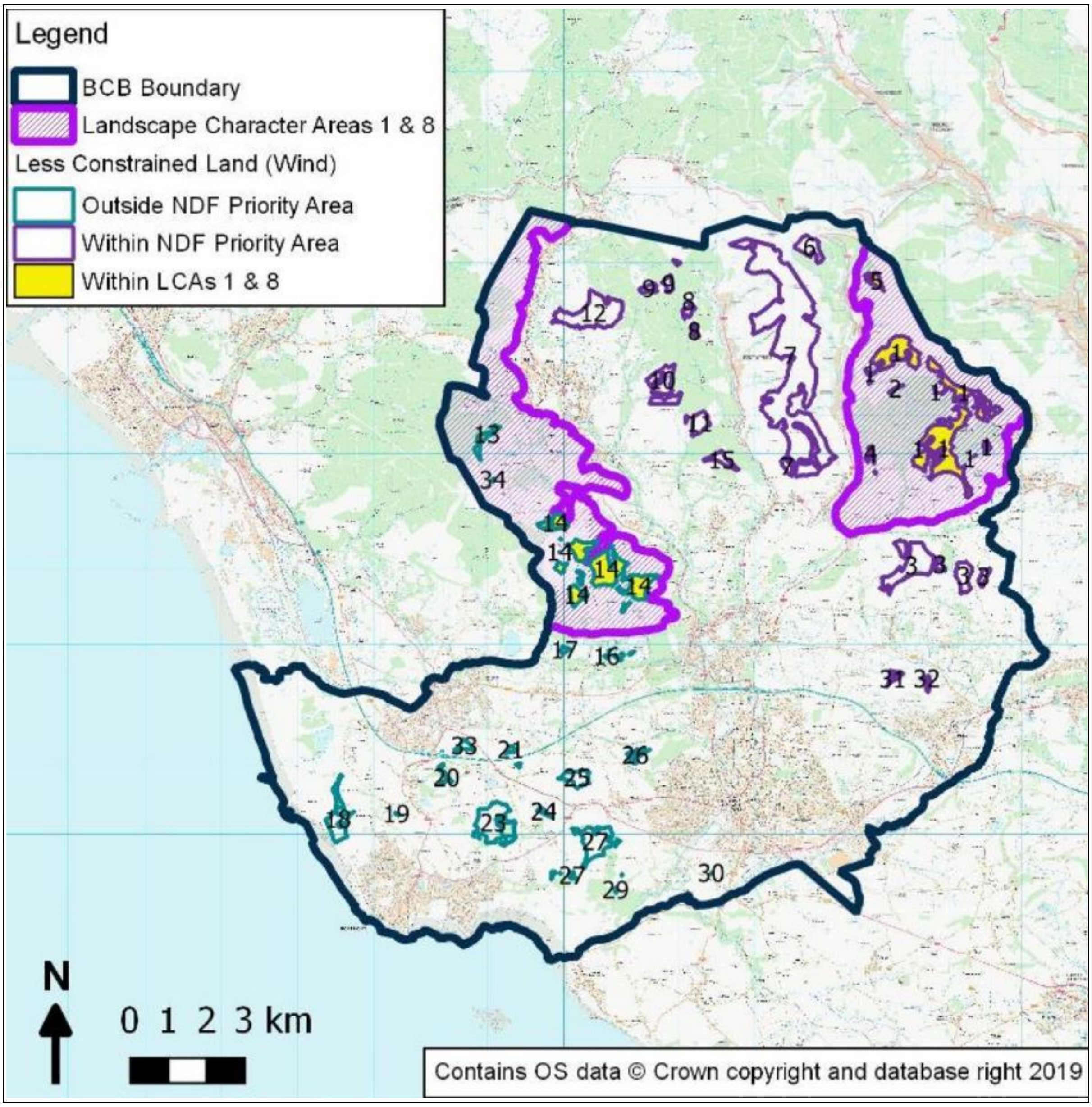


Figure 47: Less constrained wind areas and landscape character areas 1: Llangynwyd Rolling Uplands & Forestry and 8: Ogmore Forest

(BCBC, 2016)

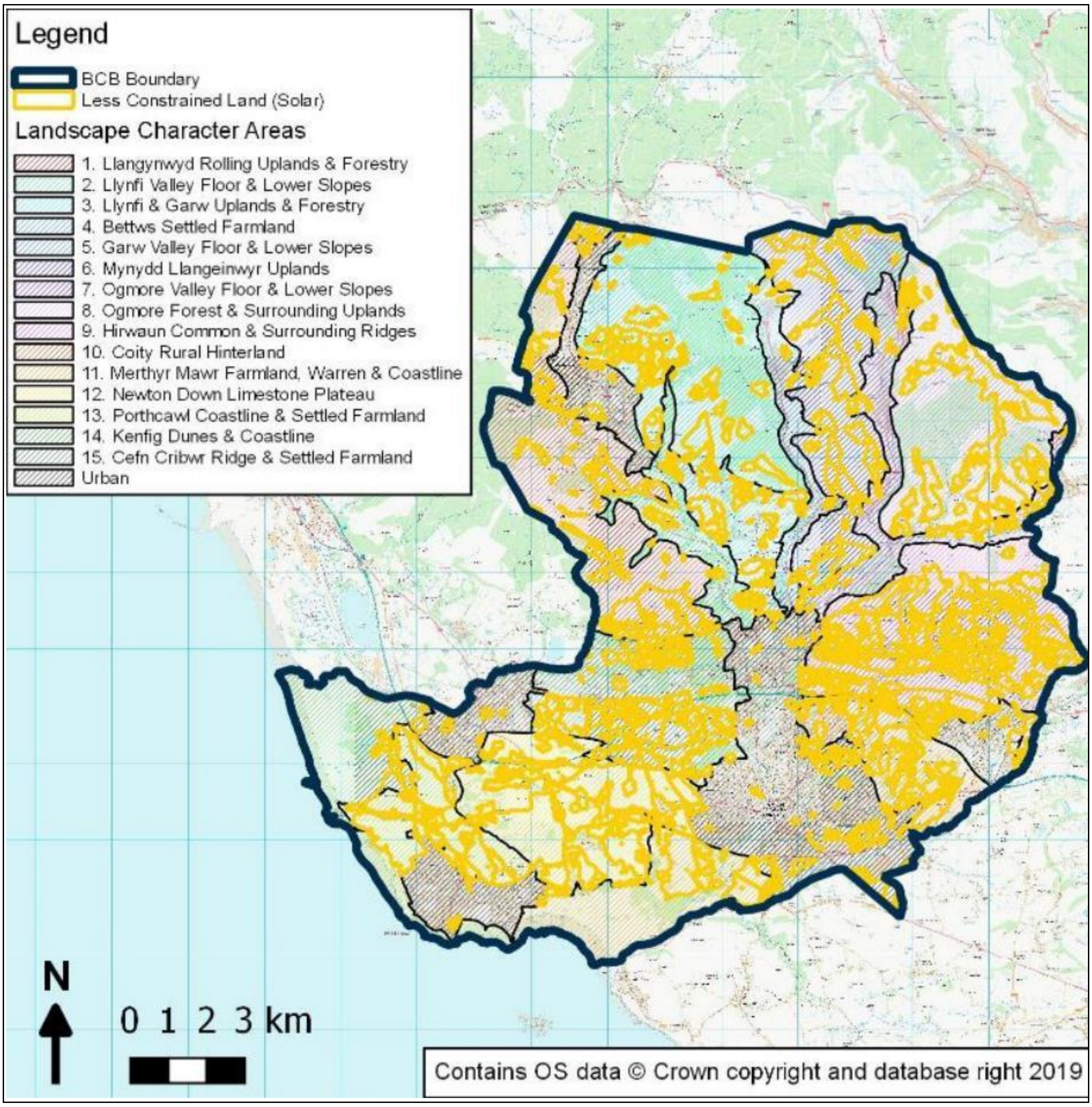


Figure 48: Less constrained solar areas and landscape character areas

(BCBC, 2016)

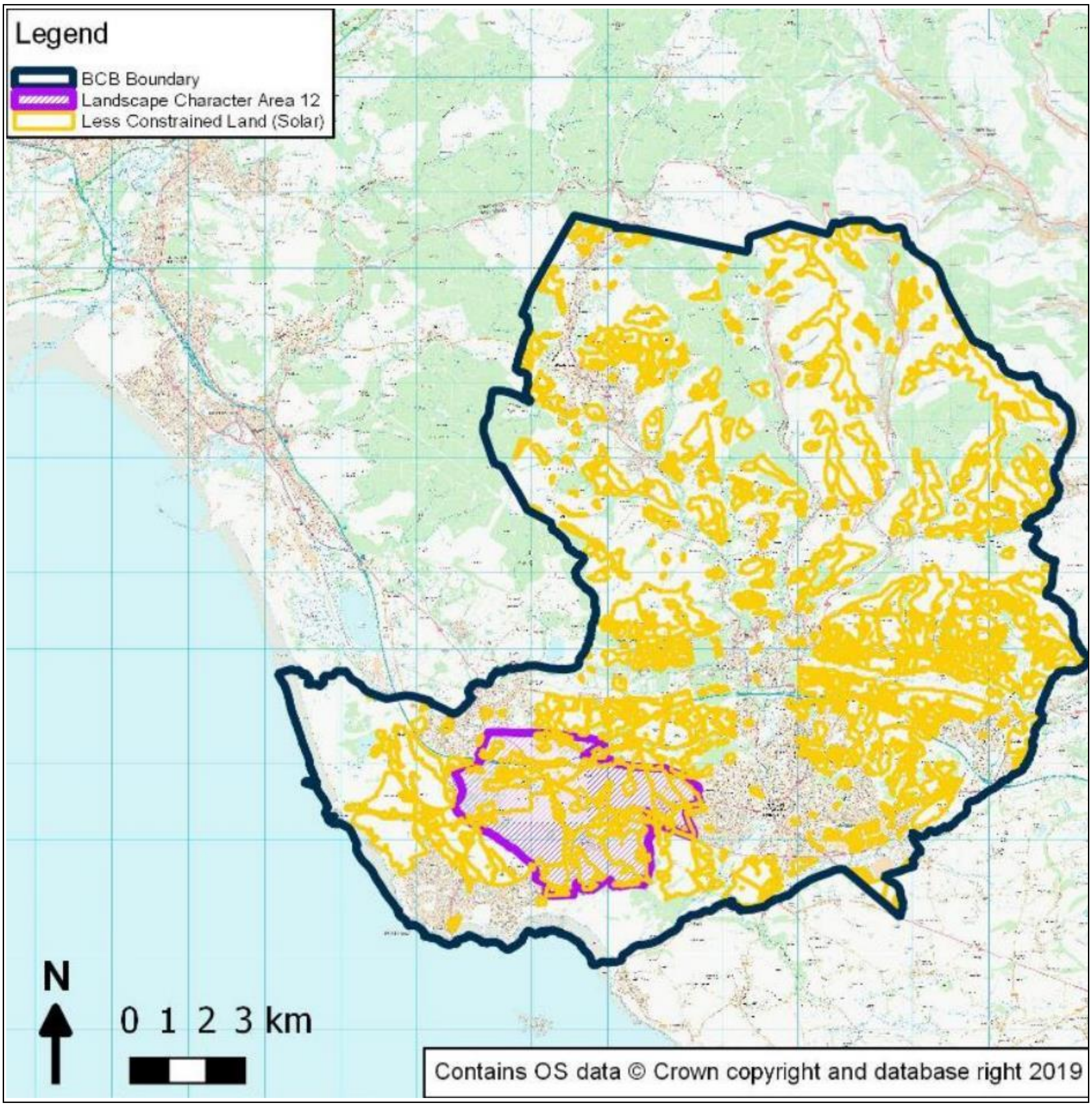


Figure 49: Less constrained solar areas and landscape character area 12: Newton Down Limestone Plateau

(BCBC, 2016)

Appendix 4: Waste data

Waste stream	Current quantity (tonnes p.a.)	Anticipated quantity in 2033 (tonnes p.a.)*	Current waste destination	Current management process	Current waste management contract end date (year)	Current waste management contract required tonnage	Anticipated waste destination in 2033
Residual waste	15,000	17,000	Materials Recovery and Energy Centre (MREC), Crymlyn Burrows, SA1 8PZ	Mechanical Biological Treatment	2030	16,700 (as with trade waste)	
Bulky Waste	2,800	3,200	Withyhedge Landfill Site, Rudbaxton, Haverford West, SA62 4DB	Non Hazardous Landfill	2030		
Food waste	7,800	6,852	Severn Trent (Agrivert), Stormy Down, Bridgend, CF33 4RS	Anaerobic digestion	2032 with 10 year optional extension		
Green waste	4,500	5,200	Cowbridge Compost, 10 Llwynhelig, Cowbridge, CF71 7FF	Windrow	2024		
Absorbent Hygiene Products	1,200	1,400	Nappicycle, Capel Hendre Industrial Estate, Ammanford SA18 3SJ	Treatment	2024		Bryn Pica, Llwydcoed, Aberdare CF44 0BX
Dry Recycling	23,000	26,500	Various	Recycling	2024		
Trade Waste	1,300	1,300	Materials Recovery and Energy Centre (MREC), Crymlyn Burrows, SA1 8PZ	Mechanical Biological Treatment	2030	16,700 (as with residual waste)	

Table 40: Waste collection/management data

** Based on assumption of a 1% increase in housing stock by 2033. Food waste per household is assumed to decline.*

Appendix 5: Further details regarding the modelling that informed the Local Area Energy Strategy

To accurately model the local energy system, data relating to parameters summarised in Table 41 were considered within the modelling.

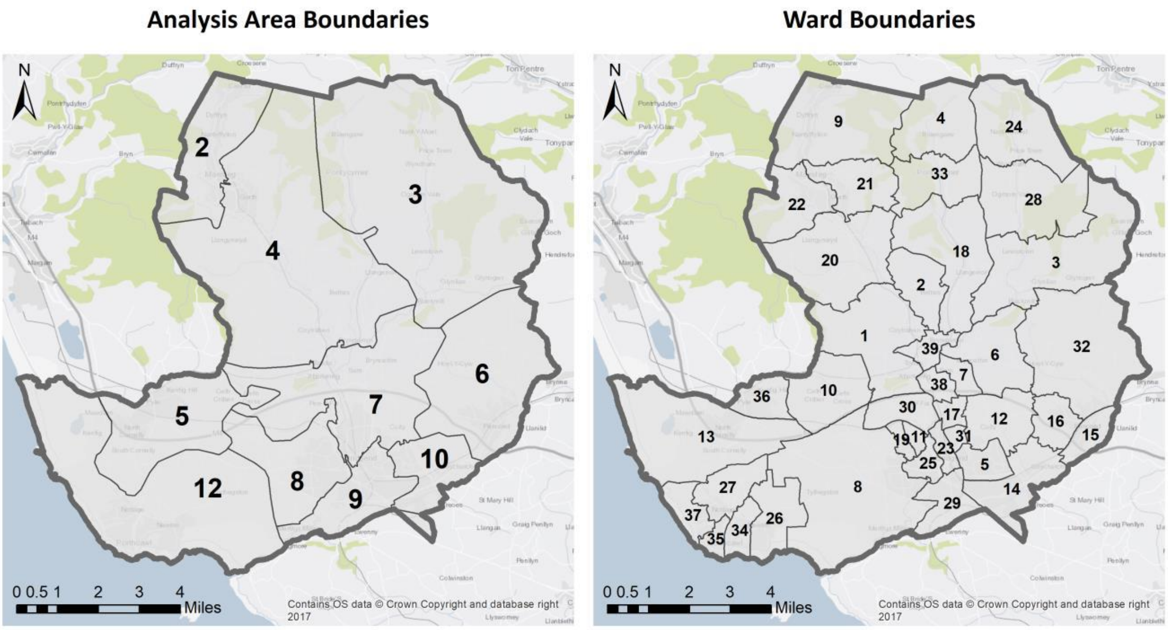
Domestic building data	The current energy demand, heating systems and thermal properties of Bridgend's domestic building stock were modelled based on data and assumptions related to building type, age, tenure and level of fabric improvements made.
Non-domestic building data	Non-domestic energy use profiles were modelled based on building use classes and sizes. Non-domestic buildings that used gas for industrial processes were identified, and heating system fuel types were identified.
Future developments	Energy demand associated with future non-domestic and domestic buildings included within the adopted local development plan were considered.
Electricity/Gas networks	Local Electricity LV and HV substation data and gas entry point data were used and the current network layouts were modelled within the software.
Physical environment	Ordnance survey data on topography, building locations and road layouts was used to enable spatial analysis of distances required for connections to be considered.
Design considerations	When modelling future scenarios, design standards, local/national targets and obligations (e.g. fuel poverty targets, area designations), and uncertainties associated with demand, development, consumer preferences and national policy were considered.

Table 41: Parameters considered within the dynamic modelling undertaken by Energy Systems Catapult

(ETI, 2018a)

Use of hydrogen was not considered in the local area energy planning undertaken however the Strategy recognises that this could have an important role in future decarbonisation of Bridgend and should be considered in ongoing energy planning (ETI, 2018b).

Due to the complexity of the options presented in the modelling software, it was necessary to aggregate different components of the energy system (ETI, 2018a). Ten analysis areas were considered based on the HV electrical network that served them (see Figure 50). They were separated on this basis so that the need (and costs) associated with network upgrades for the different options could be modelled in the most sensible manner. For example *"if the electricity loads in one analysis area increase such that the aggregated capacity of the low voltage feeders is exceeded, then reinforcement of all low voltage feeders within that area will be assumed to be required."* (ETI, 2018a, p.39). Buildings within the analysis areas were aggregated based on energy demand and cost of retrofit (ETI, 2018a).



ID	Ward	10	Cefn Cribwr	20	Llangynwyd	30	Pen-y-fai
1	Aberkenfig	11	Cefn Glas	21	Maesteg East	31	Pendre
2	Bettws	12	Coity	22	Maesteg West	32	Penprysg
3	Blackmill	13	Cornelly	23	Morfa	33	Pontycymmer
4	Blaengarw	14	Coychurch Lower	24	Nant-y-moel	34	Porthcawl East Central
5	Brackla	15	Felindre	25	Newcastle	35	Porthcawl West Central
6	Bryncethin	16	Hendre	26	Newton	36	Pyle
7	Bryncoch	17	Litchard	27	Nottage	37	Rest Bay
8	Bryntirion, Laleston and Merthyr Mawr	18	Llangeinor	28	Ogmore Vale	38	Sarn
9	Caerau	19	Llangewydd and Brynhyfryd	29	Oldcastle	39	Ynysawdre

Figure 50: Analysis areas considered in the local area energy planning

(ETI, 2018b)

Appendix 6: Further details regarding the Strategic New Development Site Options

The location of the confirmed employment sites and candidate strategic residential sites are provided in Figure 51 and Table 42, Table 43 and Table 44.

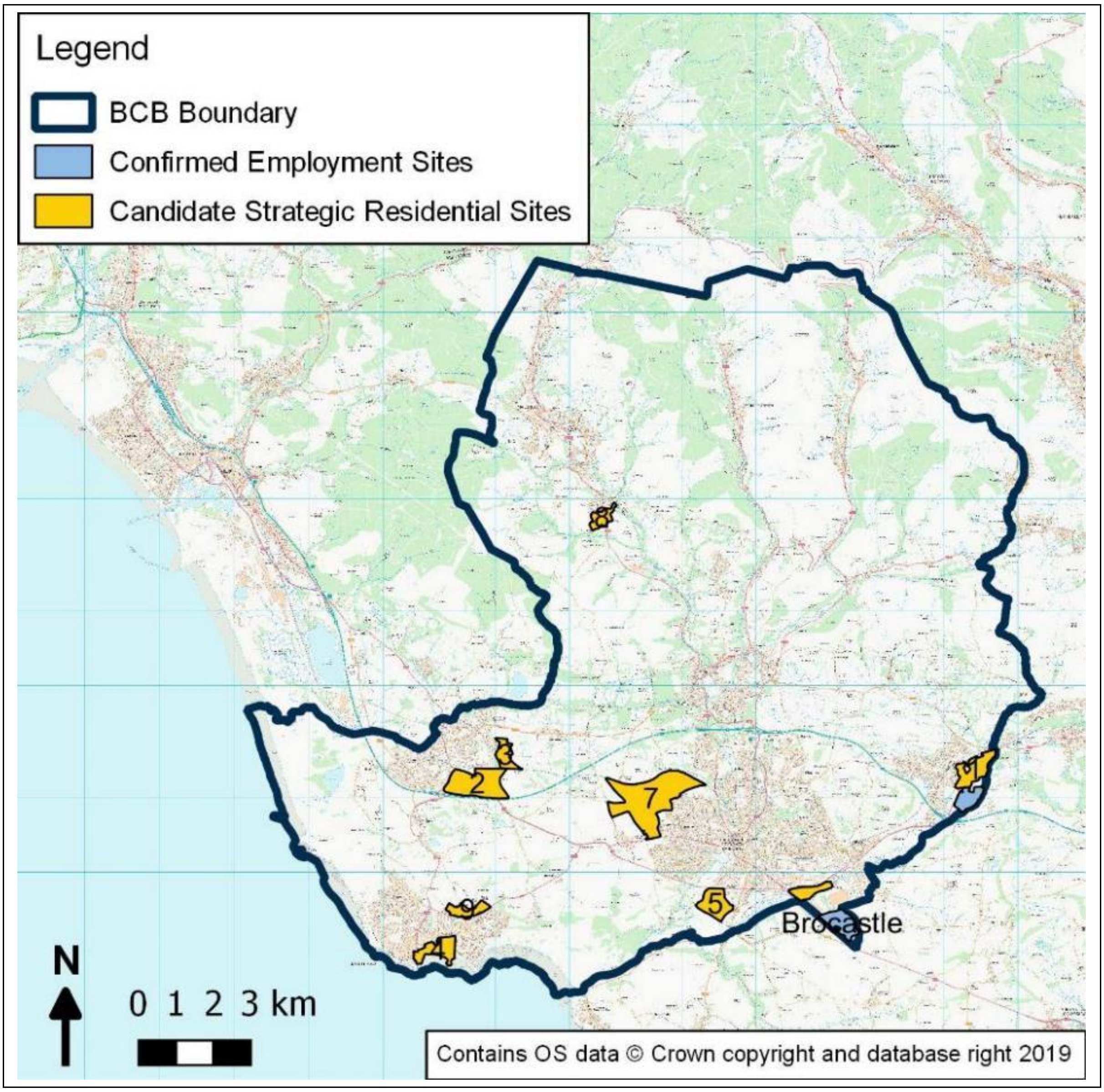


Figure 51: Strategic site locations

Site	Status	Development area	Development types
Brocastle	Outline planning consent (P/16/549/OUT) has been granted at the site.	46 hectares, 20 hectares considered developable, outline planning consent details 62,151 m^2 of development floor area.	Mixture of B8 Storage/Distribution (58% of floor area), B1a Office (11% of floor area) and B2 General Industrial/Special Industrial Group (31% of floor area)
Pencoed Technology Park	Outline planning consent (P/11/818/OUT) was previously granted at the site but has subsequently expired.	5 hectares.	Outline planning consent was previously granted for a mixture of B8 Storage/Distribution, B1a Office (and B2 General Industrial/Special Industrial Group.

Table 42: Summary details of strategic employment sites

Site name	Size (hectares)	Indicative capacity of residential units
Island Farm, Bridgend	54	1,000
Parc Afon, Ewenni	16	650
Land West of Bridgend	229	2,000
Pencoed College Campus	50	800
Land east of Pyle	100	3,500
Waun Bant Road & Pen-y-Castell Farm, Pyle	27	1,000
Land south of Pont Rhyd-y-Cyff, Maesteg	14	500
Waterfront Regeneration Site, Porthcawl	53	1,500-1,800
Zig Zag Lane, Porthcawl	26	900-1,000

Table 43: Summary details of strategic residential sites

Type	Proportion of residential units	Housing size (m^2)
Flats	14.6%	96
Detached dwellings	36.6%	100-120
Semi-detached dwellings	29.7%	64
Terraced dwellings	18.9%	60

Table 44: Indicative floor areas and the split between housing types for the residential units (provided by BCBC)

Appendix 7: Non-domestic energy benchmarks

Non-domestic energy benchmarks considered for use in the assessment of demand from Pencoed Technology Park are summarised in Figure 52, Figure 53 and Figure 54. These figures show the range in benchmarks available and the factors that can affect energy use, e.g. air conditioning, exact building use etc. For the purpose of this assessment, the BEIS (2016) figures have been used. The CIBSE (2012) benchmarks are considered out of date with respect to energy use and do not reflect the advances that have been made with respect to energy efficiency. CIBSE are in the process of collating a new database of benchmarks via an online tool – the beta version of this tool is currently being trialled (CIBSE, 2019). Whilst the Aecom (2016) benchmarks are ambitious with respect to energy demand for space heating and hot water, the non-heating elements are generally higher than those provided by BEIS (2016). Benchmarks provided by BEIS (2016) have been used in this assessment as they provide a more generic energy use for each of the categories provided which seems appropriate considering the final nature of the developments at Pencoed Technology Park are unknown.

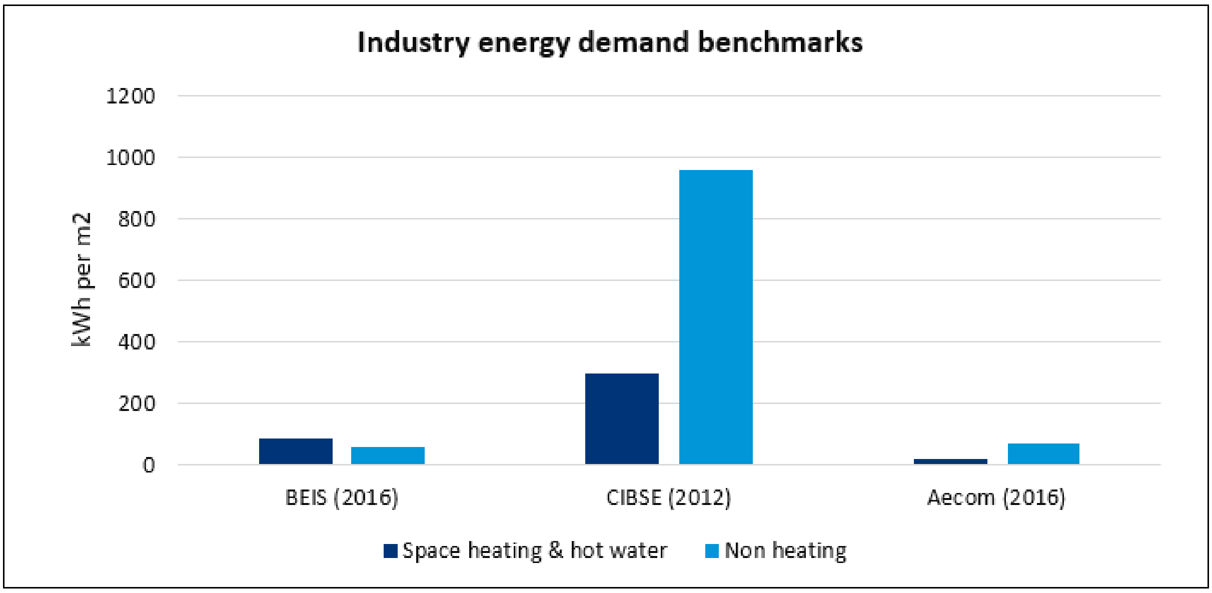


Figure 52: Industry energy demand benchmarks

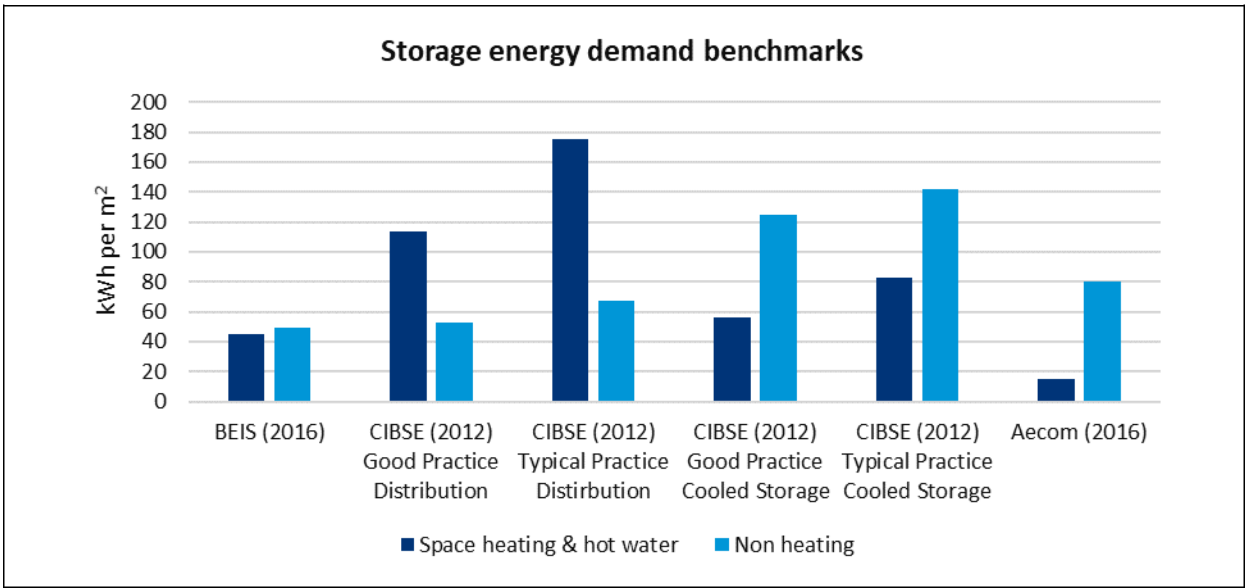


Figure 53: Storage energy demand benchmarks

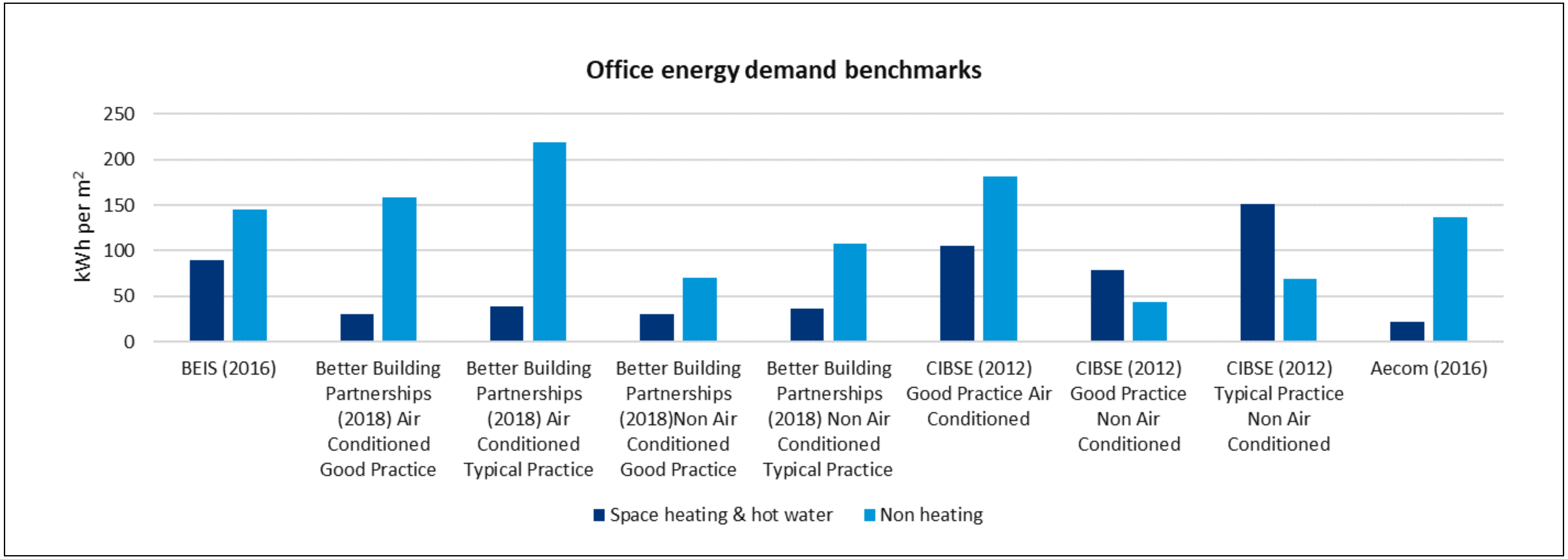


Figure 54: Office energy demand benchmarks

Notes on benchmarking comparison

CIBSE (2016) Office air-conditioned benchmarks are found by taking the average between the standard air conditioning and prestige air conditioning figures.

CIBSE (2016) Office non air-conditioned benchmarks are found by taking the average between the open plan and cellular office figures.

CIBSE (2016) Industrial energy use figures are derived by taking the average of all of the industrial sub-sectors provided.

CIBSE (2016) Warehouse figures were used to represent the storage values. Fossil fuel energy use was assumed representative of energy used for space heating and domestic hot water.

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The Carbon Trust is an independent company with a mission to accelerate the move to a sustainable, low-carbon economy. The Carbon Trust:

> advises businesses, governments and the public sector on opportunities in a sustainable, low-carbon world;
> measures and certifies the environmental footprint of organisations, products and services;
> helps develop and deploy low-carbon technologies and solutions, from energy efficiency to renewable power.

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