CARBON TRUST

Renewable and Low Carbon Energy Assessment

For Monmouthshire County Council

October 2020

The Carbon Trust's mission is to accelerate the move to a sustainable, low carbon economy. It is a world leading expert on carbon reduction and clean technology. As a not-for-dividend group, it advises governments and leading companies around the world, reinvesting profits into its low carbon mission.

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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 (Welsh Government, 2018b).

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:

> *Wales to generate electricity equal to 70 per cent of its consumption from renewable sources by 2030*
> *1 gigawatt (GW) of renewable electricity and heat capacity in Wales to be* ***locally owned*** *by 2030*
> *New energy projects to have at least an element of* ***local ownership*** *from 2020*

(Welsh Government, 2020c, p. 3)

To achieve the targets above, local planning authorities (LPAs) will need to work with renewable and low carbon energy developers and ensure that renewable and low carbon 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, 2018b, 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, 2018b, p. 92).

The Toolkit (Welsh Government, 2015) is used to inform and guide this renewable and low carbon energy assessment, but where appropriate, the methods are updated to account for the local and temporal context of the Monmouthshire County Council (MCC) Replacement Local Development Plan (RLDP) 2018-2033.

Within this assessment, the current and future energy demands of the study area (areas of Monmouthshire outside of the Brecon Beacons National Park), and progress in meeting these demands from local low carbon energy generation assets, are estimated. Against this backdrop, a resource assessment is undertaken of land within the study area to identify the potential for renewable and low carbon energy project deployment from a resource perspective.

The following technologies are considered:

- Wind energy
- Ground mounted solar PV
- Biomass energy
- Energy from waste
- Hydropower energy
- Roof-top solar PV

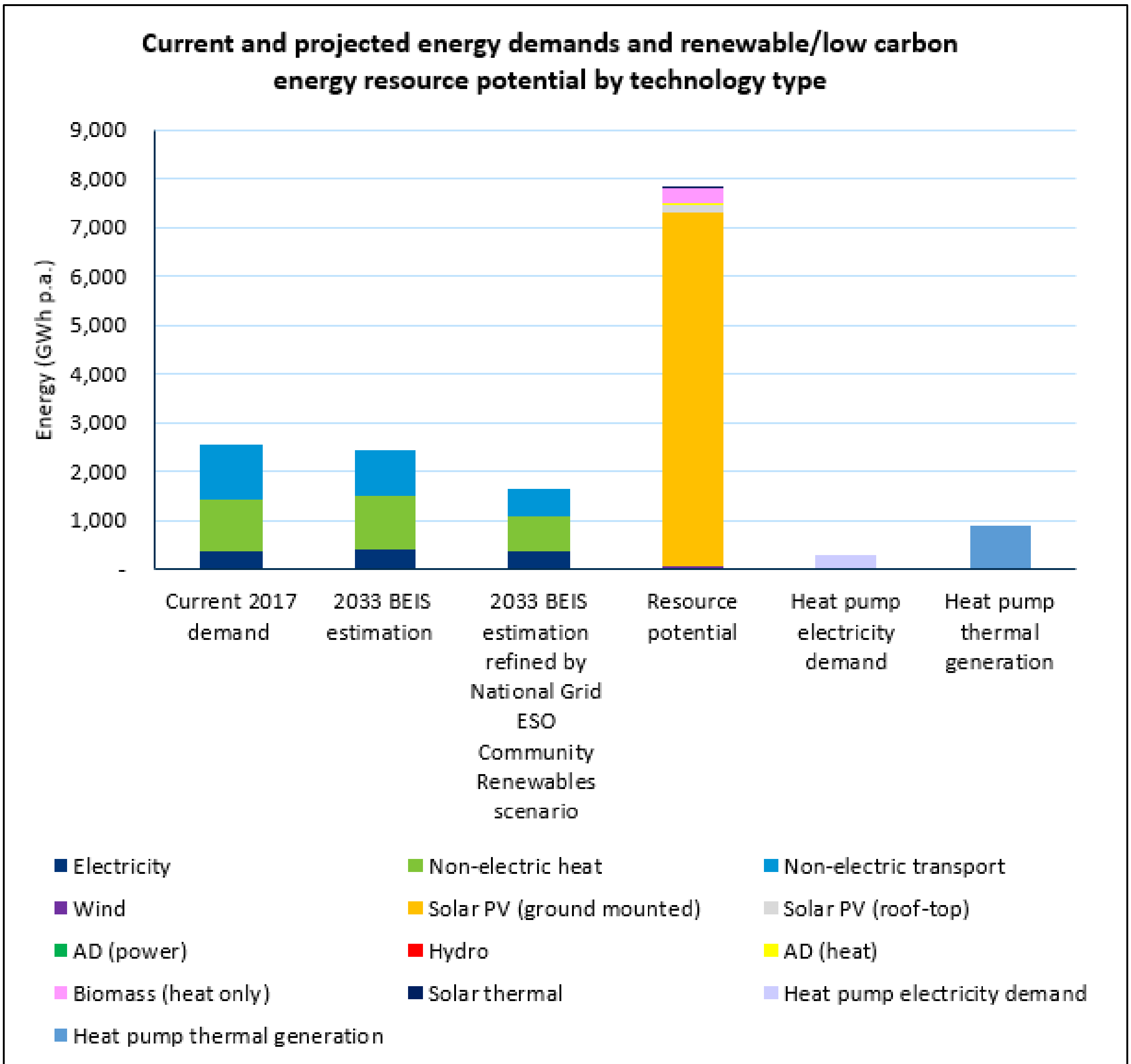
> Heat pumps

Heat network opportunities are also evaluated.

The potential resource available is compared with estimated energy demands, as shown in Figure 1. Figure 1 provides two future energy estimations; one based on projections from BEIS (2019h) and a second in which the BEIS (2019h) projection is refined with data from National Grid ESO (2019b) Community Renewables Scenario. The two estimations are included as BEIS projections do not meet the 4^{th} (2023-2027) and 5^{th} (2028-2032) carbon budgets whereas the National Grid Community Renewables scenario does meet the previous 80% carbon reduction target.

Figure 1 shows that there is sufficient theoretical resource to offset approximately three times' the study area's current energy needs with renewable/low carbon energy generated within the study area and 20 times its current electricity demand from renewable and low carbon sources. The practical resource that will be exploited is likely to be less than the resource identified due to grid capacity, competition with other land use and issues such as landscape impact. This, in addition to the discrepancy between times of generation and demand, means that energy generated in other parts of the country and offshore, and local energy storage assets are also likely to be relied upon.

Monmouthshire County Council (MCC) should consider setting ambitious renewable energy deployment targets to maximise the use of local resources available within the study area. The study area has a particularly high solar resource, with much of the study area (outside of the area of outstanding natural beauty) identified as less constrained for ground mounted solar PV. MCC should identify designated areas, "Local Search Areas", for ground mounted solar in order to guide developers and ensure that targets are met in an acceptable manner. The council should also aim to maximise deployment of roof-mounted solar PV in new building developments (where this is not required by building regulations).



Wind: assumes that the wind/solar overlap areas is available for wind
Solar PV (ground mounted): assumes that the wind/solar overlap areas is not available for solar PV
Solar PV (roof-top): provides the estimated maximum potential resource calculated
AD (power/heat): based on calculations from pigs, cattle and poultry only and assuming use within a CHP plant
Heat pumps: provides the estimated maximum potential. The heat pump thermal generation is the total generation potential from heat pumps.
Biomass: assumes all local resource is used within biomass boilers (existing biomass (CHP) generation is excluded)
Solar thermal: based on existing installations only
Energy from Waste: excluded as considered unlikely to be able to be exploited locally within the Plan period

Figure 1: Summary of current and estimated future energy demand and renewable and low carbon energy generation potential identified in the study area

Specific strategic development sites that may be integrated into the Replacement Local Development Plan (RLDP) have not yet been identified by MCC. This report will be updated at the relevant stage of RLDP development, to include an assessment of these sites.

Policy recommendations include:

- **Targets**: Adopt ambitious local renewable energy targets

- **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**: Identify preferred, broad, geographical areas for development of solar PV (termed in the assessment "Local Search Areas"), taking into account the renewable energy resource available, land use and landscape value, in order to sign-post developments to the areas considered most appropriate. Consider identifying Local Search Areas for wind developments or alternatively adopt a positive criteria based planning policy relating to wind developments, due to the low resource identified in the county, which is likely to limit the number of developments which are proposed.
- **New developments**: Review building regulations in place when the RLDP is due to be adopted and consider whether higher standards can be required in order to comply with the energy hierarchy provided in PPW 10. Support attainment of building regulations by requiring:

  - energy use to be sufficiently considered within planning applications, and
  - post-occupancy monitoring to be carried out to evidence that design standards are achieved in practice (if not required by building regulations).

- **Low carbon heating**: Discourage new developments from connecting to the gas network and encourage low carbon heating systems to be installed if not required by building regulations. At the very least new developments should be built so that they are compatible with low carbon heating systems.
- **District heat networks:** Very limited potential for district heat networks is identified, therefore it is recommended that rather than designating priority areas for heat networks, policies relating to low carbon heating, in general, are adopted. Any new district heat networks that are developed should be designed so that they are suitable for integration with lower temperature heat generation systems (e.g. solar thermal and heat pumps).

In addition to the planning policy recommendations provided above, MCC can demonstrate leadership with respect to the decarbonisation challenge by:

- Developing additional renewable energy generation projects on MCC's (or other stakeholders') own estate
- Investing in renewable energy generation technologies (joint venture or sole investor)
- Ensuring that renewable energy generation from waste is secured through any new waste management contracts
- Sharing learning from any MCC decarbonisation projects with others (private and public sector)
- Acting as an enabler for energy systems innovation, allowing new innovations to be trialled within Monmouthshire
- Committing to building any new council developments to the highest energy efficiency and environmental standards consistent with MCC's climate action commitments and policy
- Implementing energy efficiency measures on MCC's (and other stakeholders') own estate
- Managing organisation operations in the most energy efficient manner (through staff training)
- Ensuring that climate change impact and sustainable development is considered throughout all procurement activities.

Abbreviations

AD	Anaerobic Digestion
ALC	Agricultural Land Classification
AONB	Area of Outstanding Natural Beauty
ASHP	Air Source Heat Pump
BEIS	Department for Business, Energy and Industrial Strategy
BGCBC	Blaenau Gwent County Borough Council
BLPU	Basic Land and Property Unit
BSP	Bulk Supply Point
CAA	Civil Aviation Authority
CB	Carbon Budget
CCBC	Caerphilly County Borough Council
CCC	Committee on Climate Change
CCUS	Carbon Capture Use and Storage
CEE	Community Energy England
CFD	Contracts for Difference
CHP	Combined Heat and Power
COP	Coefficient of Performance
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DHN	District Heat Network
EPC	Energy Performance Certificate
ERF	Energy Recovery Facility
ESCO	Energy Service Company
ETI	Energy Technologies Institute
FIT	Feed-in Tariff
GIS	Geographic Information Systems
GSP	Grid Supply Point
GW	Gigawatt
GWh	Gigawatt Hour
HH	Household
IEA	International Energy Agency
IHA	International Hydro Association

KDE	Kernel Distribution Estimator
kW	Kilowatt
kWh	Kilowatt Hour
LDP	Local Development Plan
LLPG	Local Land Property Gazetteer
LNR	Local Nature Reserve
LPA	Local Planning Authority
LSA	Local Search Area
LZC	Low or Zero Carbon
MBT	Mechanical Biological Treatment
MCC	Monmouthshire County Council
MTCBC	Merthyr Tydfil County Borough Council
MUSCO	Multi Utility Services Company
MVA	Mega Volt Ampere
MW	Megawatt
MW_e	Megawatt Electrical
MWh	Megawatt Hour
MWh_e	Megawatt Hour Electrical
MWh_{th}	Megawatt Hour Thermal
MW_{th}	Megawatt Thermal
NCC	Newport City Council
NDF	National Development Framework
NFI	National Forestry Inventory
NNR	National Nature Reserve
NOABL	Numerical Objective Analysis Boundary Layer
NRW	Natural Resources Wales
PPW 10	Planning Policy Wales Edition 10
PSB	Public Services Board
PV	Photovoltaic
REES	Renewable Energy and Energy Efficiency Study
REGO	Renewable Energy Guarantees Origin
RHI	Renewable Heat Incentive
RLDP	Replacement Local Development Plan
RO	Renewables Obligation
RTPI	Royal Town Planning Institute

SAC	Special Areas of Conservation
SAP	Standard Assessment Procedure
SFCA	Strategic Flood Consequence Assessment
SM	Scheduled Monument
SPA	Special Protection Area
SPV	Special Purpose Vehicle
SSSI	Site of Special Scientific Interest
TAN	Technical Advice Note
TCBC	Torfaen County Borough Council
TWh	Terawatt Hour
ULEV	Ultra-Low Emission Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
WHS	World Heritage Site
WIMD	Wales Index of Multiple Deprivation
WPD	Western Power Distribution

1. Introduction

1.1 Policy Context

1.1.1 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 (Welsh Government, 2018b).

1.1.2 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).*

1.1.3 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°C (UNFCCC, 2020).

1.1.4 In 2019, following a wave of climate activism and recommendations from the Committee on Climate Change (CCC) that the UK should increase its carbon targets to net-zero by 2050 (CCC, 2019a), the Welsh Government and the UK Parliament declared a climate emergency and the UK committed to setting new net zero carbon targets for 2050. In June 2019, Welsh Government increased their carbon reduction target to a 95% reduction, in line with advice from the CCC, and has set the intention to increase this target beyond the CCC's current advice to net zero.

1.1.5 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. Further regulations are planned to bring these targets into line with the recommended 95% reduction.

1.1.6 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 (Welsh Government, 2019f). 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 (Welsh Government, 2019f). Within this plan, local authorities are identified as having a significant role to play in achieving this transition.

1.1.7 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:

- Wales to generate electricity equal to 70 per cent of its consumption from renewable sources by 2030
- 1 gigawatt (GW) of renewable electricity and heat capacity in Wales to be **locally owned** by 2030
- New energy projects to have at least an element of **local ownership** from 2020

(Welsh Government, 2020c, p. 3)

1.1.8 To achieve the targets above, local planning authorities (LPAs) will need to work with renewable and low carbon energy developers and ensure that renewable and low carbon energy generation within their authorities is maximised.

1.1.9 The low carbon transition is 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, 2019f).

1.1.10 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, 2009a). 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.

1.1.11 At a local level, Monmouthshire County Council (MCC) declared a climate emergency in May 2019 (MCC, 2020a) and gave an undertaking to develop a strategy and associated costed action plan to deliver a net zero carbon emissions target for the authority by 2030. The authority understand that they have an important role to play in ensuring that the emissions targets are achieved and have initiated a wide range of projects to help tackle it, including:

- Developed and installed a 5 MW solar farm
- Installed solar panels on nearly 30 council owned buildings
- Upgraded street lighting to LED lighting systems
- Undertaken energy efficiency measures on council owned buildings and worked with registered social landlords on energy efficiency projects
- Switched MCC's energy supply so it is 99% sourced from renewable sources
- Piloting 20 hydrogen powered vehicles
- Powering Community Meals vehicles with electricity
- Tracking vehicle usage to ensure fleet optimisation and efficiency
- Increasing use of video conferencing to reduce the need for travel.

(MCC, 2020a)

1.1.12 Whilst MCC is interested in understanding the scale of resource within its authority area to help inform local policy, Welsh Government is generating similar evidence bases to help inform national policy.

1.1.13 A consultation on the National Development Framework 2020-2040 was issued on 7th August 2019 (Welsh Government, 2019e) and closed for comments on the 15th November 2019. Whilst the draft National Development Framework is not enacted policy, the details of the consultation have been reviewed in the process of undertaking this assessment.

1.1.14 The National Development Framework (NDF) is a new spatial development plan for addressing key national priorities (including decarbonisation) through the planning system (Welsh Government, 2019e). 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, 2019e). One of the 11 outcomes of the NDF is to develop *"a Wales where people live […] in places which are decarbonised."* (Welsh Government, 2019e, p. 17).

1.1.15 The working draft NDF (*Future Wales: the national plan 2040*) (Welsh Government, 2020d) identifies Pre-Assessed Areas for large-scale (over 10 MW) wind energy developments and district heat networks, as shown in Figure 2. **Please note that the NDF is in draft form at the time of preparation of this assessment. MCC should review the final National Development Framework (*Future Wales: the national plan 2040)* when it is published to understand the implications for local development.**

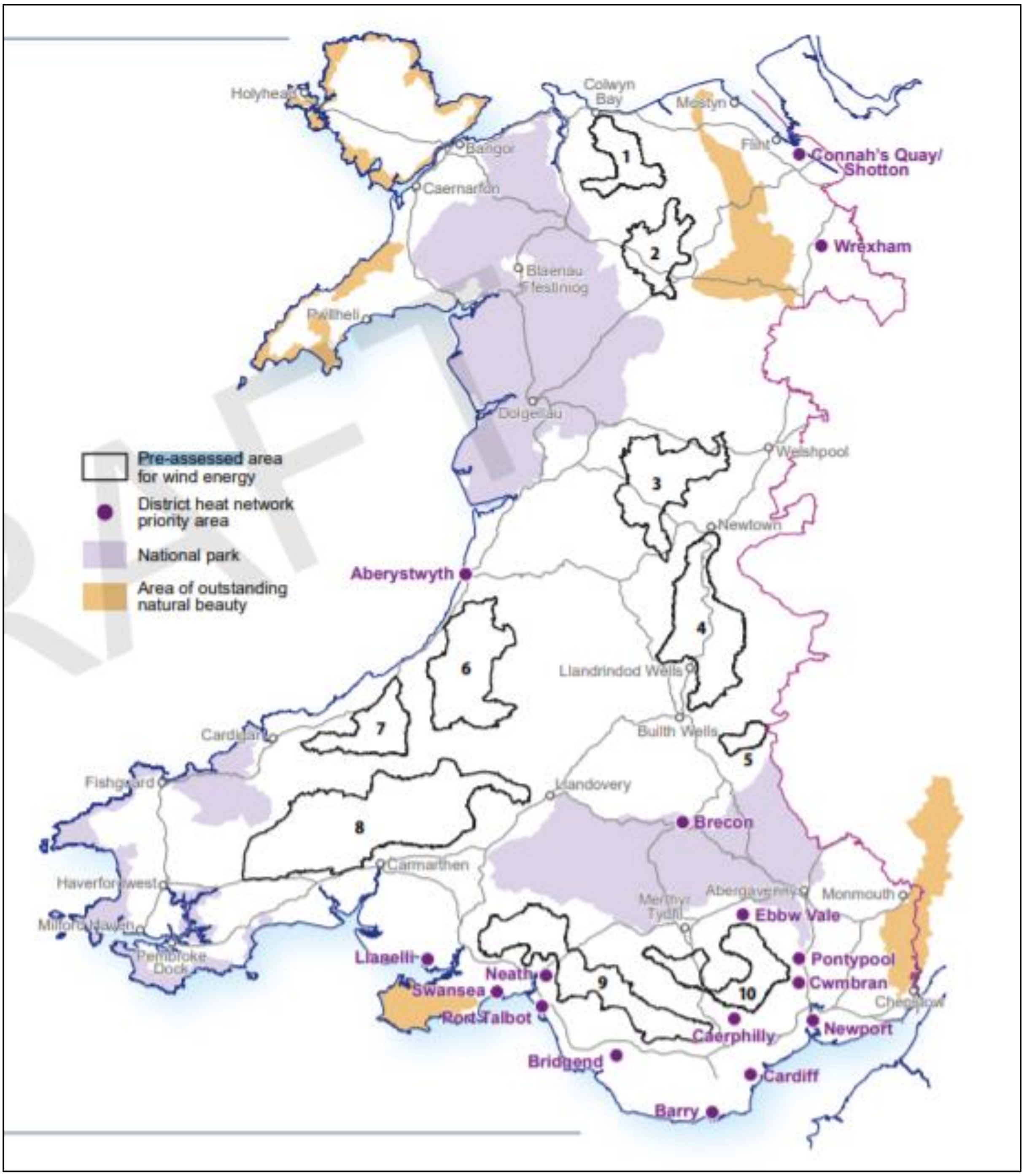


Figure 2: Wales' pre-assessed areas for wind energy and district heat network priority areas identified in the working draft NDF

(Welsh Government, 2020e, p. 94)

1.2 Renewable and Low Carbon Energy Assessment Purpose and Content

1.2.1 PPW 10 acknowledges, *"…the planning system plays a key role in delivering clean growth and the decarbonisation of energy"* (Welsh Government, 2018b, p. 87). In order to ensure this role is fulfilled, PPW 10 places a requirement on planning authorities to develop an evidence base to inform the development of renewable and low carbon energy policies. The Welsh

Government's P*ractice 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 (LDPs). 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, 2018b, p. 92).

1.2.2 This evidence base aims to estimate the scale of resource within the study area that is available for use, in order to provide some focus for setting local policy and targets. It also provides details of existing and future demand, in line with recommendations from the Toolkit, to provide a background and context for the resource-based targets. It does not identify individual sites or projects but provides an understanding of the likely suitability of the authority's area for further development of different technologies.

1.2.3 This renewable and low carbon energy assessment was commissioned alongside the same assessments for neighbouring local planning authorities; Newport City Council (NCC), Caerphilly County Borough Council (CCBC), Torfaen County Borough Council (TCBC), and Blaenau Gwent County Borough Council (BGCBC). Individual renewable and low carbon energy assessments will be completed for each of the five authorities and will be accompanied by an additional regional summary, which will consolidate the key results from each assessment, in a regional context.

1.3 Overall Method

Scope of the assessment

1.3.1 This assessment is undertaken for Monmouthshire County Council's (MCC's) planning department. As such, the study area for the assessment is area that is governed by MCC's planning policy (i.e. land within the county that is outside of the Brecon Beacons National Park).

1.3.2 The current and future energy demands of the study area, and progress in meeting these demands from local low carbon energy generation assets, are estimated. Against this backdrop, a resource assessment is undertaken of land within the study area to identify the potential for renewable and low carbon energy project deployment by 2033 if supportive policies are in place.

1.3.3 In line with the Toolkit, the following technologies are considered:

- Wind energy
- Ground mounted solar PV
- Biomass energy
- Energy from waste
- Hydropower energy
- Roof-top solar PV

1.3.4 In addition to the resource assessment, potential options for low carbon heating are considered. Heat opportunity mapping is undertaken to identify potential locations for district heat networks, and an estimation of the potential uptake of heat pumps is made. Advice is provided with respect to maximising the opportunities for locally owned energy developments, sources of funding for energy projects, additional opportunities to maximise decarbonisation and suggested development briefs for low carbon strategic development sites.

1.3.5 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 MCC Replacement Local Development Plan (RLDP) will be in place up to 2033, as such some of the specific step-by-step methods provided within the Toolkit are not suitable for the current renewable and low carbon energy evidence base, due to the differing timescales. To address this issue, the method employed within this assessment is amended where necessary to ensure that the outputs are fit for purpose and the Toolkit's requirements are met.

1.3.6 As per the Toolkit, this assessment is aimed at planning policy development rather than development management (Welsh Government, 2015, p.20). It aims to:

- provide MCC's policy planners with an evidence base to support renewable and low carbon energy policies and site allocations in their RLDP
- give some guidance on how MCC can translate the evidence base into spatial policies which guide appropriate renewable and low carbon energy development.

1.3.7 Whilst the assessment is not intended to provide a tool for assessing planning applications, it can help to inform the policy development and pre-application discussions between development management officers and developers.

1.3.8 The Toolkit sets six potential policy objectives or options for the local authority to pursue with respect to renewable and low carbon energy, and provides details of how to prepare evidence bases for each policy option. An additional policy option is included in this assessment relating to Development Design and Layout. Table 1 illustrates the relationship between the policy options and evidence bases and details the relevant Sections of this document to refer to:

- The areas of dark green shading in Table 1 indicate those elements of the evidence base that will be relevant in supporting a particular policy option
- The lighter coloured squares indicate those aspects of the evidence base that are less relevant to supporting a particular policy option, but will be useful in informing it.
- The white squares indicate that an evidence base option is not needed for that policy option.

(Welsh Government, 2015, p.31)

1.3.9 Section 10 of the assessment addresses policy options 2 and 4 within one Section.

Table 1: Relationship between policy options and evidence base

		Evidence base options				
		Evidence Base 1: Area wide renewable energy assessment	Evidence Base 2: Building Integrated uptake assessment	Evidence Base 3: Heat opportunities mapping	Evidence Base 4: Detailed viability appraisal for strategic sites*	Relevant assessment Sections
Policy options	Policy option 1: Develop area wide renewable energy targets and monitor progress					Sections 4, 5, 6 and 9
	Policy option 2: Inform site allocations for new development					Section 8
	Policy option 3: Identify suitable areas for stand-alone renewable energy development					Section 9
	Policy option 4: Identify opportunities and requirements for renewable or low-carbon energy generation linked to strategic new build development sites			Energy opportunities plan		Section 8
	Policy option 5: Develop policy mechanisms to support District Heating Networks (DHN) for strategic sites					Section 7
	Policy option 6: Identify further actions for LA, public sector and wider stakeholders					Section 10
	Policy option 7: Development design and layout					Section 8

(Welsh Government, 2015, p.33)

**Strategic sites refer to strategic development sites, strategic sites for renewable energy deployment and strategic sites for heat network development.*

1.3.10 Tables 2 and 3 provide the high-level steps set-out in the Toolkit (Welsh Government, 2015) and identify the relevant Sections of the assessment which address each step, along with the remaining steps that are outside of the scope of this assessment.

Table 2: Summary of evidence base Toolkit tasks/steps addressed by the assessment

Toolkit steps (Welsh Government, 2015)	Assessment Section	Additional steps the LPA could consider undertaking outside of the scope of this assessment
Evidence Base 1: Area wide renewable energy assessment		
Task 1. Calculate existing and future energy baseline	Section 2	
Task 2. Existing and proposed low and zero carbon energy technologies	Section 3	
Task 3. Wind energy resource	Section 4.2	
Task 4. Biomass energy resource	Section 4.4	
Task 5. Energy from waste	Section 4.5	
Task 6. Hydropower	Section 4.6	
Task 7. Solar PV farms	Section 4.3	
Evidence Base 2: Building Integrated uptake assessment		
Task 1. Introduction	Section 5.1	
Task 2. Modelling BIR uptake – overview Task 3. Modelling BIR uptake – simplified method	Section 5. The Toolkit methodology is out-of-date and as such is updated.	
Evidence Base 3: Heat opportunities mapping		
Task 1. Background	Section 7.1	
Task 2. Identify anchor heat loads Task 3. Identify off gas areas Task 4. Map residential heat demand and density Task 5. Identify areas of high fuel poverty Task 6. Identify existing DH and CHP schemes and sources of waste heat	Section 7.3	
Task 7. Map location of strategic new development sites (RLDP strategic development sites)	Section 8	
Task 8. Develop an Energy Opportunities Plan	Section 10	
Evidence Base 4 Detailed viability appraisal for strategic sites		
Task 1. Background	Section 8.1	
Task 2. Assessing energy demands of strategic new development sites (RLDP strategic development sites)	Section 8.3	
Task 3. Identify areas for strategic stand-alone renewable energy development	Section 9.3 prioritise the less constrained areas identified in Sections 4.2 and 4.3.	The local authority may wish to undertake further refinement of the less constrained areas and a separate assessment of landscape sensitivity to help inform the final Local Search Area (preferred areas for renewable energy development) allocation.
Task 4. Assessing the technical feasibility and financial viability of DHNs	Section 7.3 assesses potential financial viability of the heat clusters identified at a high-level based on the heat density	The local authority may wish to undertake a feasibility study of the areas identified to better understand the viability of the opportunities identified.

Table 3: Summary of policy development Toolkit tasks/steps addressed by the assessment

Toolkit steps (Welsh Government, 2015)	Assessment Section	Additional steps the LPA could consider undertaking outside of the scope of this assessment
Policy option 1: Develop area wide renewable energy targets and monitor progress		
Step 1. Define scenarios Step 2. Prepare summary tables Step 3. Test and discuss with stakeholders Step 4. Refine and select preferred scenario	Section 10.3, defines some scenarios and provides summary tables of the scenarios described, these are refined after discussion with the local authority.	The LPA may wish to discuss the target scenarios further with a wider range of stakeholders before selecting the preferred target for the RLDP.
Policy option 2. Inform site allocations for new development		
Step 1. Map candidate sites in GIS onto wind and solar constraints maps developed from Evidence Base 1 Step 2. Assess proximity to potential heat opportunities identified in Evidence Base 3	Section 4 identifies less constrained areas for wind and solar and Section 9 assesses these areas against further factors. This policy option is considered under the heading "Site allocations and development design and layout"	The LPA may wish to undertake wider stakeholder engagement, for example with developers and Western Power Distribution (WPD).
Policy option 3. Identify suitable areas for stand-alone renewable energy development		
Toolkit steps are not explicitly stated, but it is suggested that potential broad areas or sites for wind, solar PV, or biomass CHP are identified.	Section 9 assesses less constrained areas for wind and solar identified in Section 4 against additional factors, to identify potential Local Search Areas for development.	The LPA may wish to test the areas identified and recommended for Local Search Area allocation with other stakeholders (e.g. developers, politicians, WPD) before the allocation is made. The LPA may also wish to carry out further analysis of the sites, e.g. a landscape sensitivity assessment.
Policy option 4. Identify opportunities and requirements for renewable or low-carbon energy generation linked to strategic new build development sites (RLDP strategic development sites)		
Toolkit steps are not explicitly stated. It is suggested that proximity of RLDP strategic development sites and areas suitable for renewable energy/district heat network opportunities are identified. A carbon reduction target for the RLDP strategic development sites is considered but the cost should not cause undue burden.	Section 8 will be updated to summarise the potential for integrating renewable energy and low carbon heating into the RLDP strategic development sites when MCC has identified them.	The LPA could commission a more detailed assessment of the viability of integrating renewable and low carbon energy developments in to the RLDP strategic development sites.
Policy option 5. Develop policy mechanisms to support District Heating Networks (DHN) for strategic sites (strategic sites for district heat networks)		
Toolkit steps are not explicitly stated. It is suggested that it is demonstrated that district heat networks at RLDP strategic development sites are financially viable, carbon savings can be achieved and any carbon buyout funds do not present undue burden.	Section 7 considers technical and financial viability at a high-level. Additional low carbon heating technologies are considered.	The LPA could consider commissioning a more detailed assessment of the technical and financial viability of different options. If a carbon buy-out fund is included within proposed policies the local authority should undertake financial modelling to ensure the level associated with the fund does not present an undue burden.
Policy 6. Identify further actions for LA, public sector and wider stakeholders		
Toolkit steps are not explicitly stated. It is suggested that the process of developing further actions, can be started through stakeholder engagement. The heat opportunities and area wide energy assessment, may identify potential project opportunities for the local authority to develop or have a key role in.	Section 10 provides a list of potential additional actions informed by the Toolkit suggestions, discussions with the LPA and Carbon Trust's knowledge. Sections 4 and 7 identify potential energy opportunities for the local authority to consider.	The local authority could evaluate the less constrained areas identified for wind and solar against their land holdings and consider whether to progress with developing their own sites, or advertising them for others to develop. The local authority could commission a more detailed assessment of the viability of certain strategic sites for district heat networks identified in the Energy Opportunities Plan. The actions identified could be discussed with wider stakeholders to gain support and develop further.
Policy 7: Development design and layout		
This is an additional policy area requested by the commissioning local authorities, it is not included within the Toolkit.	Section 8 will be updated to provide background to the RLDP strategic development sites when MCC has identified them. Section 10 provides further information and evidence to consider when setting development design and layout criteria. This policy option is considered under the heading "Site allocations and development design and layout"	

Local Authority next steps

1.3.11 The policy recommendations made in Section 10 are informed by the evidence base generated by the assessment and look to maximise planning policy support for attaining decarbonisation targets. Following the completion of this assessment, MCC should consider the recommendations made alongside the other Replacement Local Development Plan (RLDP) objectives (for example economic requirements, housing requirements etc.) and the LPA's resource capacity to determine how to implement the recommendations within their RLDP policy proposals. It is recommended that additional stakeholders are consulted to support this process. Completion of the additional steps identified in Tables 2 and 3 may also help to support this process. Stakeholders to engage with include:

- Local Authority elected members and officers from relevant departments, such as officers responsible for:
  - Planning policy and development management
  - Waste
  - Energy management
  - Landscape/conservation
  - Economic development/regeneration
  - Sustainable development
  - Property/estates
- External stakeholders:
  - Statutory agencies, such as Natural Resources Wales (NRW)
  - Renewable energy developers
  - Housing developers
  - Other local stakeholders, such as National Farmers' Union (NFU), local energy agencies, etc
  - Local Service Board representatives (e.g. NHS Trust, Police, Fire, NGOs, not for profit organisations, faith organisations plus UK Government Departments (e.g. MoD)
  - Utilities, Energy Service Companies (ESCOs) and multi utility services companies (MUSCOs).

Resource outside the scope of the assessment

1.3.12 The scope of this assessment is largely set by Toolkit (Welsh Government, 2015), and looks to inform planning policy relating to local renewable energy developments. Decarbonisation of the local and national energy system will also benefit from developments not included within the scope of the assessment and those outside of the local area, e.g. offshore wind farms.

1.3.13 The following technologies are not specifically included within the scope of the assessment.

Building integrated technologies

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

Innovative heat pump solutions

1.3.15 There are a number of innovative heat pump solutions which are available, and becoming available, following trials and experiences elsewhere. These solutions include using heat pumps with minewater. A minewater heat network has been in operation in Heerlen in the Netherlands since 2008 (Verhoeven et al., 2014), and there is an operational minewater heat pump providing heat to a farm complex in Crynant, Neath. Within South Wales, the Seren research project has assessed the heating potential of the South Wales coal-field and has suggested that disused mines could provide the potential to heat at least 20,000 homes (Seren, 2015). Research into the practicalities of accessing and distributing this heat is ongoing, with Bridgend County Borough Council pioneering efforts by developing a minewater heat network project in the Upper Llynfi Valley. Additional innovative heat pump solutions include accessing waste heat from waste water and industrial processes.

1.3.16 Potential heat pump uptake is considered within the assessment, but the specific heat sources used by the heat pumps are not considered, and are outside the scope of the assessment. The heat source used would depend on specific characteristics of the building type and location.

Geothermal energy

1.3.17 Geothermal energy is energy stored in the form of heat beneath the Earth's surface that, depending on its characteristics, can be used for heating, cooling or to generate electricity. In certain locations, particularly in regions where there is volcanic activity, geothermal energy is sufficiently concentrated to provide hot water and steam which is accessible from the Earth's surface (generally via drilling). This form of energy generation is particularly common in Iceland and New Zealand, where there are significant concentrations of accessible, geothermal energy. The resource potential of geothermal energy is not included within the scope of this assessment.

1.3.18 Shallower geothermal energy, associated with heat stored in ground water on the Earth's surface, flooded mines and underground aquifers, can be used with heat pumps to provide thermal energy for space heating and hot water. The potential for heat pump uptake is considered in Section 5 of the assessment, but the specific heat sources are not considered.

Energy storage

1.3.19 It is anticipated that energy storage will become increasingly important alongside the anticipated increase in variable energy supply from renewable energy sources. This will help to reduce the consequences of intermittent generation and maintain an electricity system balance between supply and demand. Types of energy storage include pumped storage, compressed air, molten salt (thermal), Li-ion batteries, lead-acid batteries, flow batteries, hydrogen and flywheels (EESI, 2019).

1.3.20 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 approximately 2,800 MW of storage capacity (IHA, 2018). 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 the Monmouthshire study area.

1.3.21 A study by Scottish Renewables (2016), however, has found that the wider benefits of pumped hydro projects are not fully realised financially within current market conditions. 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 they can provide to the energy system, it is possible this will become an exploitable resource within the Monmouthshire study area towards the end of the RLDP period.

Hydrogen

1.3.22 Hydrogen has been identified as a fuel which could become more common in our future energy system. It is a flexible fuel which can act as an energy store, be used to generate heat and electricity and as a transport fuel. Hydrogen can be combusted in a way that the only by-product associated with it is water, making it an attractive fuel source in terms of both air pollution and climate change.

1.3.23 Hydrogen can only be considered as a low carbon energy source if it is generated from renewable energy sources (for example hydrogen can also be produced from fossil fuels). Different techniques for producing hydrogen from renewable sources are being investigated and developed, but the most mature and relevant to the study area are electrolysis of water using electricity from renewable sources, and gasification of biomass converting the carbon in biomass to carbon dioxide and capturing the hydrogen as a separate fuel. Gasification of biomass would require carbon capture and storage to be integrated with the process to ensure that the carbon dioxide is not released to the atmosphere. Hydrogen is not considered specifically within this assessment, however the resource identified in Section 4 could be used to produce hydrogen via these two processes.

Electric vehicles

1.3.24 The Toolkit does not call for electric vehicles to be incorporated within the assessment. However, given their inclusion within PPW 10 and the draft NDF text, the following is provided as contextual analysis. As with energy storage it is anticipated that electric vehicles (EVs) will become increasingly important during the RLDP period. The uptake of electric vehicles will cause an increase in both local electricity energy demand and power demand. Different charger types have different power demands associated with them with:

- Slow charging (up to 3 kW) able to charge EVs over 6-12 hours
- Fast charging (7-22 kW) generally able to charge in 3-4 hours; and
- Rapid charging points (50 kW and greater) able to provide approximately 80% charge in around 30 minutes.

1.3.25 To facilitate uptake in EVs the network of charging infrastructure will need to be expanded, in both public areas and within private residences and businesses. This charging infrastructure may require upgrades/reinforcement to be carried out on the existing electrical networks.

1.3.26 WPD (2019) provide an EV Capacity Map on their website. This map provides the following details for substations on the WPD network with respect to the capacity available for EV charge points to be connected:

- Extensive capacity available
- Capacity available
- Some capacity available
- Capacity not specified

1.3.27 The following information is available for Monmouthshire County Council at the time of writing (May 2020, with the information dated May 2019):

- Substations with extensive capacity available: 90
- Substations with capacity available: 100
- Substations with some Capacity available: 31

(WPD, 2019)

Offshore wind

1.3.28 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, 2018a). The Carbon Trust (2018a) 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, 2018a, p.4)

1.3.29 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, 2018a, p.5). With respect to waters near Monmouthshire, 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, 2018a). 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 Monmouthshire's coastline.

Marine energy

1.3.30 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). Summary details of the technologies included in Figure 3 are provided in Table 4.

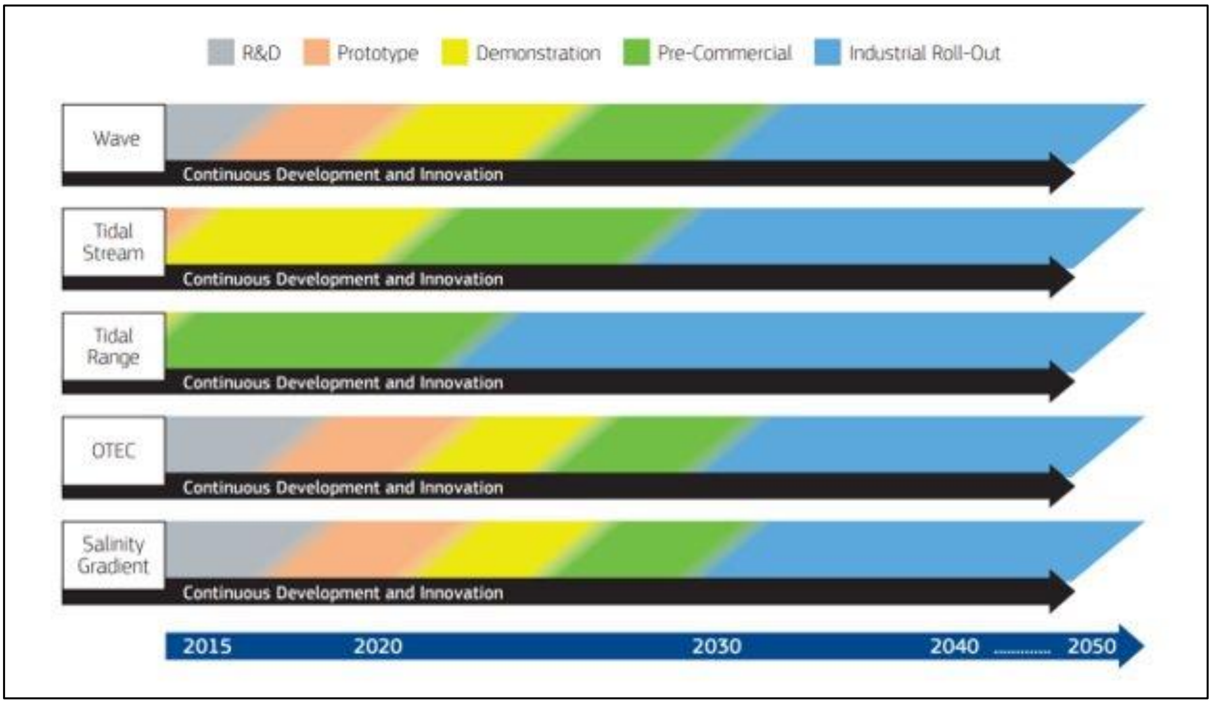


Figure 3: Development of marine energy technologies

(Ocean Energy Forum, 2016, p.23)

Table 4: Marine energy sources summary (outside of the scope of renewable energy assessment)

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 may become a potential resource that could be exploited off Monmouthshire's coast
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 Monmouthshire area during the RLDP 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. Tidal Lagoon Power (2020) have identified potential for a 1.4-1.8 GW tidal lagoon-based generator to be deployed in Newport.
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.

Overall method

1.3.31 Sections 2 to 9 provide details of the individual methods followed for the generation of each element of the evidence base within the Renewable and Low Carbon Energy Assessment. The overall method for this assessment is summarised in Figure 4.

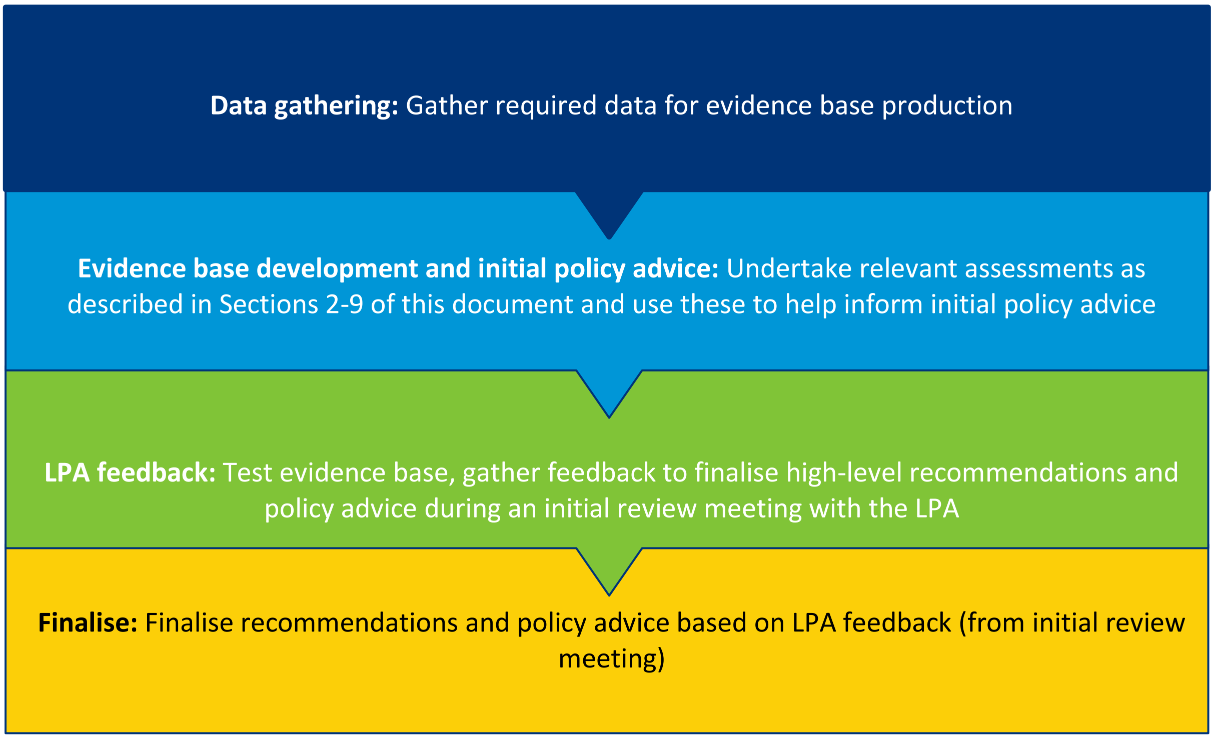


Figure 4: Overall project method

2. Existing and Future Energy Demand Baseline

2.1 Introduction

2.1.1 In order to understand the scale of the energy consumption at a local level, the current and future energy demand of the Monmouthshire study area, i.e. not including areas within the Brecon Beacons National Park, is estimated.

2.1.2 The Toolkit suggests that the *"future energy demand should be established in order to: Provide indicative figures to inform area wide renewable energy installed capacity targets."* (Welsh Government, 2015, p. 43), however PPW 10 notes that: renewable energy targets "*should be calculated from the resource potential of the area and should not relate to a local need for energy"* (Welsh Government, 2018b, p. 90). This requirement acknowledges that some areas are typically characterised with higher energy demands and lower renewable energy generation potential.

2.2 Method

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

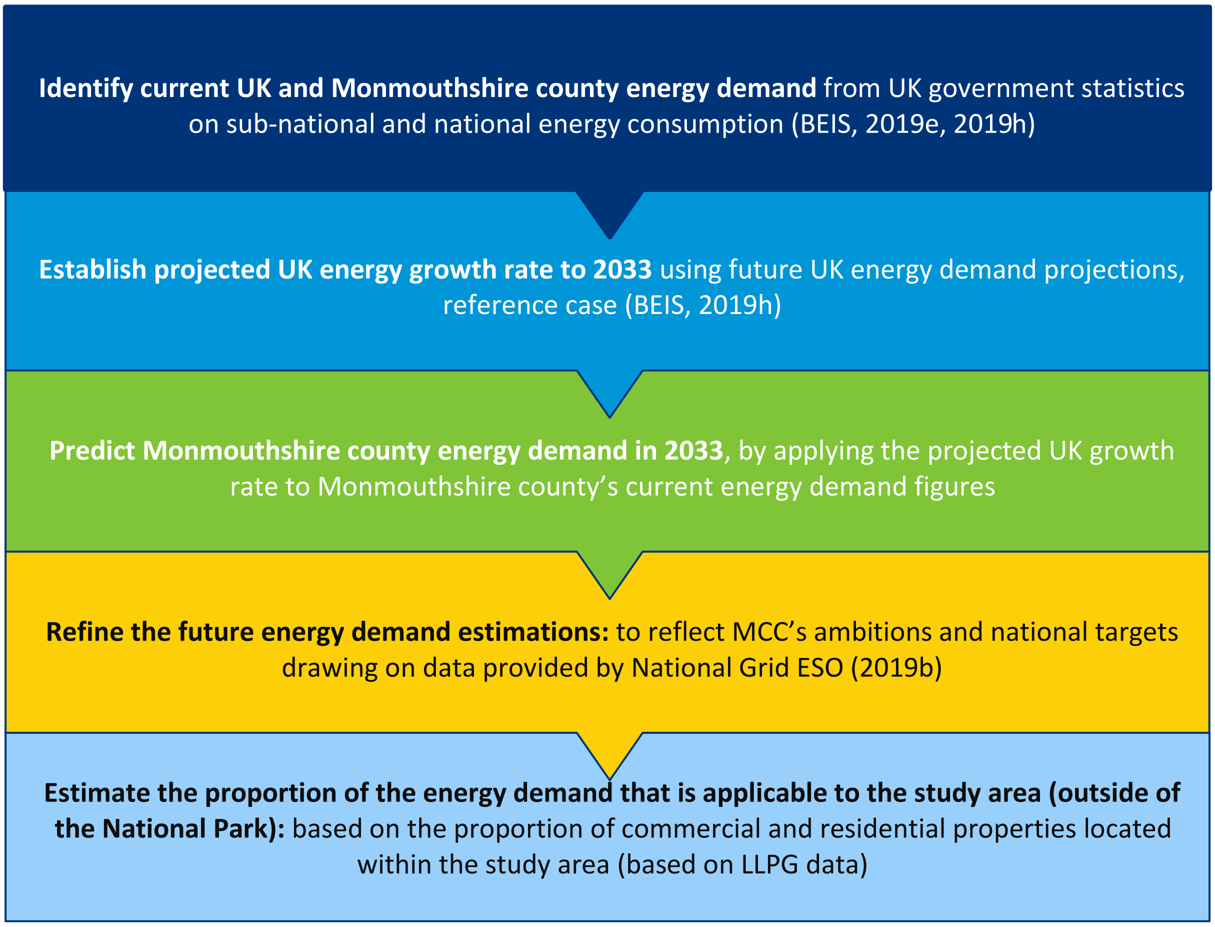


Figure 5: Method for estimating the existing and future energy baseline within the study area

2.2.2 The local energy demand is estimated by applying national projected growth rates to current local energy demand, rather than considering local population/development growth projections.

2.2.3 The latest UK energy projections (BEIS, 2019h) available at the time of writing (May 2020) forecast energy demand to 2035. The end date of the Monmouthshire RLDP is 2033.

2.2.4 Data provided by BEIS (2019e, 2019h) is split into sector (e.g. agriculture) and fuel source (e.g. natural gas). 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 is grouped as follows:

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

2.2.5 The category allocations are provided in Table 5. For the purpose of this assessment, energy demand associated with the iron and steel industry, aviation and shipping is excluded from the growth rates calculated as they are not considered relevant to Monmouthshire's local energy demand.

2.2.6 The energy demand provided is based on gross energy demand and therefore doesn't account for energy conversion efficiencies (e.g. when converting the energy in natural gas to thermal energy to provide space heating).

2.2.7 The data source combines traffic activity (from the DfT national traffic census) with fleet composition data and fuel consumption/emissions factors.

2.2.8 The energy use categories recommended by Welsh Government (2015) are referred to and where recommendations are not provided, details given within UK government guidance documents are used to inform allocation criteria (BEIS, 2019b, 2019c, 2019e, 2019f, 2019g, 2019h, 2019i). Contrary to the Toolkit (Welsh Government, 2015) suggestion, "Bioenergy & Wastes" is included within the assessment, as it constitutes 4% of the current energy demand within Monmouthshire. *The Sub-National Consumption Statistics Methodology and Guidance Booklet* (BEIS, 2019c) categorises this category as *"Residual fuels (non-gas, non-electricity and non-road transport)"* (BEIS, 2019c, p. 8). As such, within this assessment, bioenergy and waste is categorised as "non-electric" heat and is modelled to follow the growth trend for the UK non-electric heat category.

Table 5: Energy sector category allocations

Assessment category	UK data category (BEIS 2019h)	Sub-national data category (BEIS, 2019e)
Electricity	Agriculture: Electricity Commercial: Electricity Residential: Electricity Other Industry sectors: Electricity Public services: Electricity Transport: Electricity	Electricity: Industrial Electricity: Domestic
Non-electric heat	Agriculture: Natural gas Commercial: Natural gas Residential: Natural gas Other Industry sectors: Natural gas Public services: Natural gas Agriculture: Petroleum products Commercial: Petroleum products Residential: Petroleum products Other Industry sectors: Petroleum products Public services: Petroleum products Agriculture: Renewables Commercial: Renewables Residential: Renewables Other Industry sectors: Renewables Public services: Renewables Agriculture: Solid/manufactured fuels Commercial: Solid/manufactured fuels Residential: Solid/manufactured fuels Other Industry sectors: Solid/manufactured fuels Public services: Solid/manufactured fuels	Coal: Industrial & commercial Coal: Domestic Manufactured fuels: Industrial Manufactured fuels: Domestic Petroleum products: Industrial & commercial Petroleum products: Domestic Petroleum products: Public sector Petroleum products: Agriculture Gas: Industrial & commercial Gas: Domestic Bioenergy & wastes: Total
Non-electric transport	Transport: Natural gas Transport: Petroleum products (rail) Transport: Petroleum products (road transport) Transport: renewables Transport: Solid/manufactured fuels	Coal: Rail Petroleum products: Road transport Petroleum products: Rail

2.2.9 BEIS states that the petroleum products in agriculture category includes "*Deliveries of fuel oil and gas oil/diesel for use in agricultural power units, dryers and heaters. Burning oil for farm use.*" (BEIS, 2019b, p.62). Whilst this use includes both production of electricity and heat, it is categorised as non-electric heat within this study for simplicity and as the proportional breakdown between the two uses is unknown. Overall the total energy amount associated with petroleum products in agriculture is approximately 0.4% of the total UK energy demand in 2017 (BEIS, 2019h).

2.2.10 Future energy demand for 2033 is initially estimated utilising the current (May 2019) UK Government energy projections (BEIS, 2019h), and applying the UK growth rates to the study area's energy consumption. 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 Government 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, 2019g). As stated above, 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, 2019g). If additional policies are introduced or existing policies are strengthened, this projection may change in future editions of the projections.

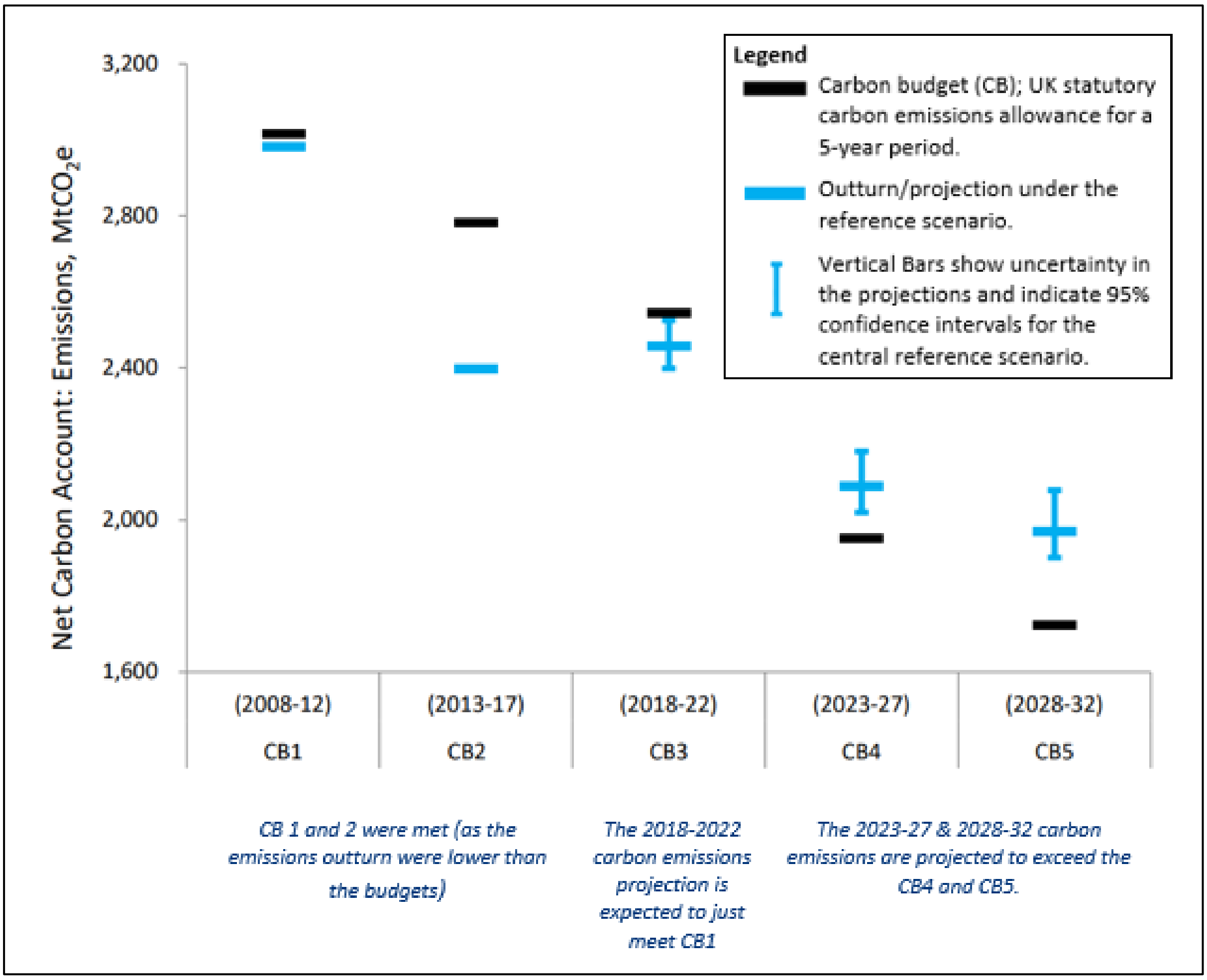


Figure 6: Actual and projected progress against carbon budgets

(BEIS, 2019g)

2.2.11 In addition to the BEIS (2019h) projections on future energy mixes, National Grid ESO, produce their own annual Future Energy Scenarios (National Grid ESO, 2019a). 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 ESO, 2019a), and these are based on a framework of two key drivers (see Figure 7):

- Speed of decarbonisation, and
- Level of decentralisation (i.e. the extent to which generation moves away from large, centralised generators to smaller, more dispersed generators).

2.2.12 Two of the scenarios, Two Degrees and Community Renewables, meet the UK's previous 80% 2050 carbon reduction target (against a 1990 baseline), and two do not, Steady Progression and Consumer Evolution (National Grid ESO, 2019a), as summarised in Table 6.

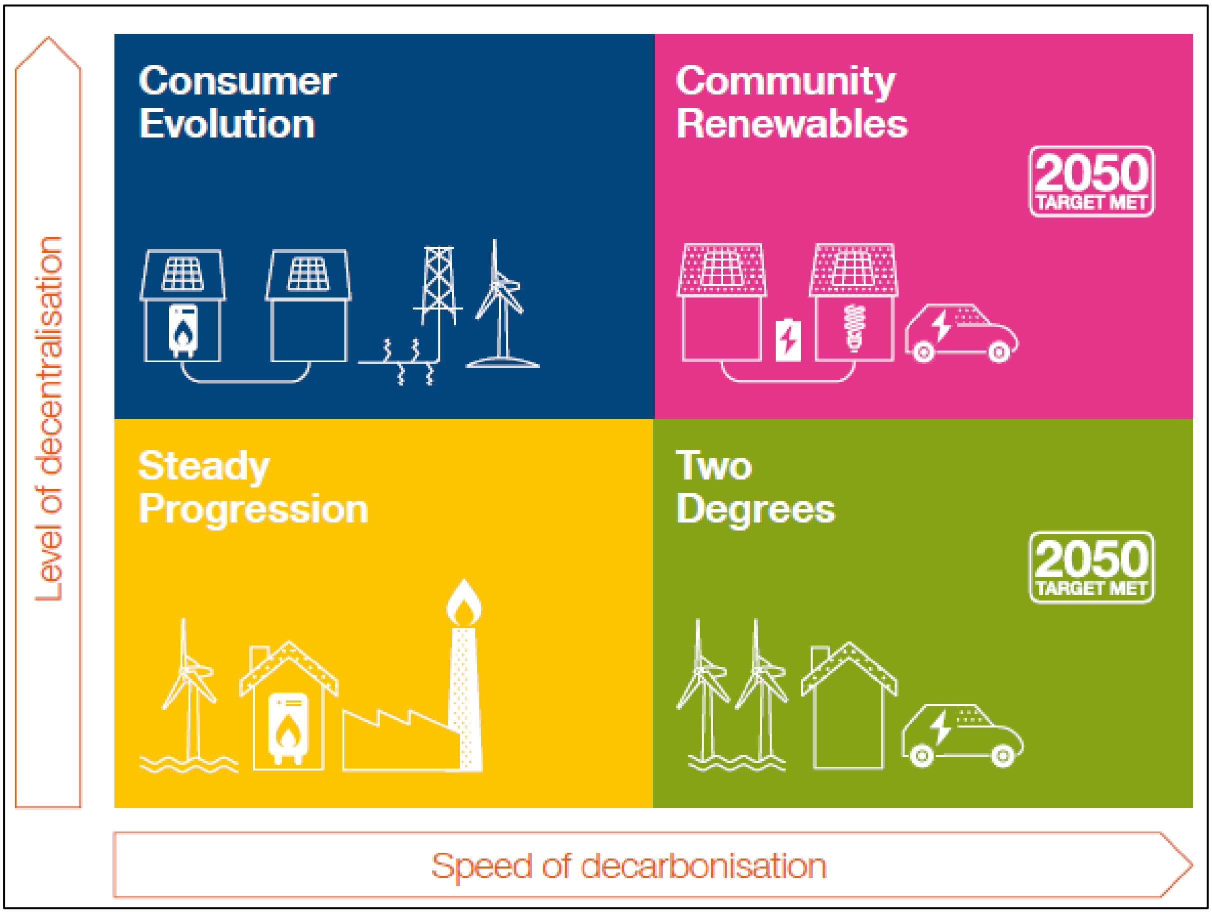


Figure 7: National Grid ESO 2019 Future Energy Scenarios

(National Grid ESO, 2019a, p.17)

Table 6: National Grid ESO 2019 Future Energy Scenarios Summary

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.

(National Grid, 2019a)

2.2.13 In order to achieve decarbonisation of the county as a whole it is considered that the energy demand within the study area will need to be reduced beyond the current BEIS (2019h) projections, and as such these estimations are refined with data from National Grid ESO (2019a).

2.2.14 The Community Renewables scenario puts an emphasis on decentralised, localised solutions, whereas Two Degrees is focused on centralised solutions. As this assessment is focused on the local potential of Monmouthshire to tackle decarbonisation, the Community Renewables scenario is used to refine the energy demand projections for 2033. Changes at a national level will be required for this scenario to come to fruition, however as current government projections indicate that future carbon budgets will not be met, it is anticipated that revised national policies will be introduced during the Plan period.

2.2.15 National Grid ESO (2019b) provide detailed data on the modelling results for the Future Energy Scenarios work, including annual electricity demand, annual gas demand and annual road fuel demands to 2050. The growth rates for annual electricity demand and annual gas demand from 2017 (date of latest sub-national energy demand data (BEIS, 2019e)) to 2033 are calculated and applied to the UK overall data provided by BEIS (2019g). The growth rate for annual road fuel uses 2019 as the starting year (data derived from National Grid ESO's modelling based upon average fleet miles per vehicle type and the number of vehicles; this is only ever forwards looking), but is applied to the 2017 figures calculated from the sub-national energy demand data. For fuels not included in National Grid ESO's (2019b) data tables, the BEIS reference case scenario growth rates continue to be used. This includes petroleum products for uses other than road transport, non-electric renewables, rail transport and solid/manufactured fuels. Overall growth rates for electricity, non-electric heat, and non-electric transport are calculated and applied to the current study area energy demand data to provide an alternative future energy demand estimation.

2.2.16 National Grid ESO (2019a) undertook sensitivity analysis to investigate 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). With respect to energy demands the projections for 2050 provided in National Grid ESO (2019b) show that the total energy demand under the Community Renewables Scenario is less than the total energy demand under the Net Zero scenario, as the basis of this scenario is focused on Two Degrees. As such, it is considered that a further refinement for Net Zero is not necessary.

2.2.17 Whilst National Grid ESO (2019a) update their Future Energy Scenarios on an annual basis, the details from the 2019 study are still relevant. They are used in this assessment to demonstrate the difference between different future energy system projections and the need to reduce our energy demand as well as increase our renewable and low carbon energy generation in order to decarbonise. As the climate emergency increases this need will become more urgent.

2.2.18 To estimate the proportion of the county's energy demand which is attributable to the study area, it is assumed that the energy demand will be proportional to the number of commercial/residential buildings within the study area in comparison to the whole county. For Monmouthshire, buildings in the study area make up approximately 92% of those in the total county (based on Local Land and Property Gazetteer (LLPG) data).

2.3 Results

2.3.1 Table 7 provides the current and future estimated energy demand for the UK alongside the estimated growth rates for each sector, based on the BEIS reference case scenario and then revised to account for the Community Renewables scenario for gas, electricity and road fuel. The current and future energy demand baseline for the study area is provided in Table 8 and Figure 8, again using both the BEIS reference case scenario and additional reduction using the Community Renewables scenario (NB different data sources provide slightly different UK annual demand, e.g. BEIS (2019e) gives 2017 electricity demand of 280 TWh, BEIS (2019b) state 295 TWh. Data from BEIS (2019h) is used in Table 8 and for the UK growth rate).

Table 7: Current/future UK energy demand baseline

	Current 2017 demand	2033 BEIS estimated growth rate	2033 BEIS estimation	2033 BEIS estimated growth rate refined by National Grid ESO Community Renewables scenario	2033 BEIS estimation refined by National Grid ESO Community Renewables scenario
Electricity	298 TWh	111%	332 TWh	103%	306 TWh
Non-electric Heat	667 TWh	103%	687 TWh	66%	438 TWh
Non-electric Transport	477 TWh	84%	403 TWh	53%	253 TWh

(Data in table are rounded and may not appear exact)

(BEIS, 2019h, National Grid ESO, 2019b)

Table 8: Current/future energy demand baseline for the Monmouthshire study area

	Current 2017 demand	2033 BEIS estimated growth rate	2033 BEIS estimation	2033 BEIS estimated growth rate refined by National Grid ESO Community Renewables scenario	2033 BEIS estimation refined by National Grid ESO Community Renewables scenario
Electricity	371 GWh	111%	413 GWh	103%	380 GWh
Non-electric Heat	1,057 GWh	103%	1,088 GWh	66%	694 GWh
Non-electric Transport	1,113 GWh	84%	940 GWh	53%	589 GWh
Total	2,541 GWh	96%	2,441 GWh	65%	1,663 GWh

(Data in table are rounded and may not appear exact)

(BEIS, 2019e, 2019h, National Grid ESO, 2019b)

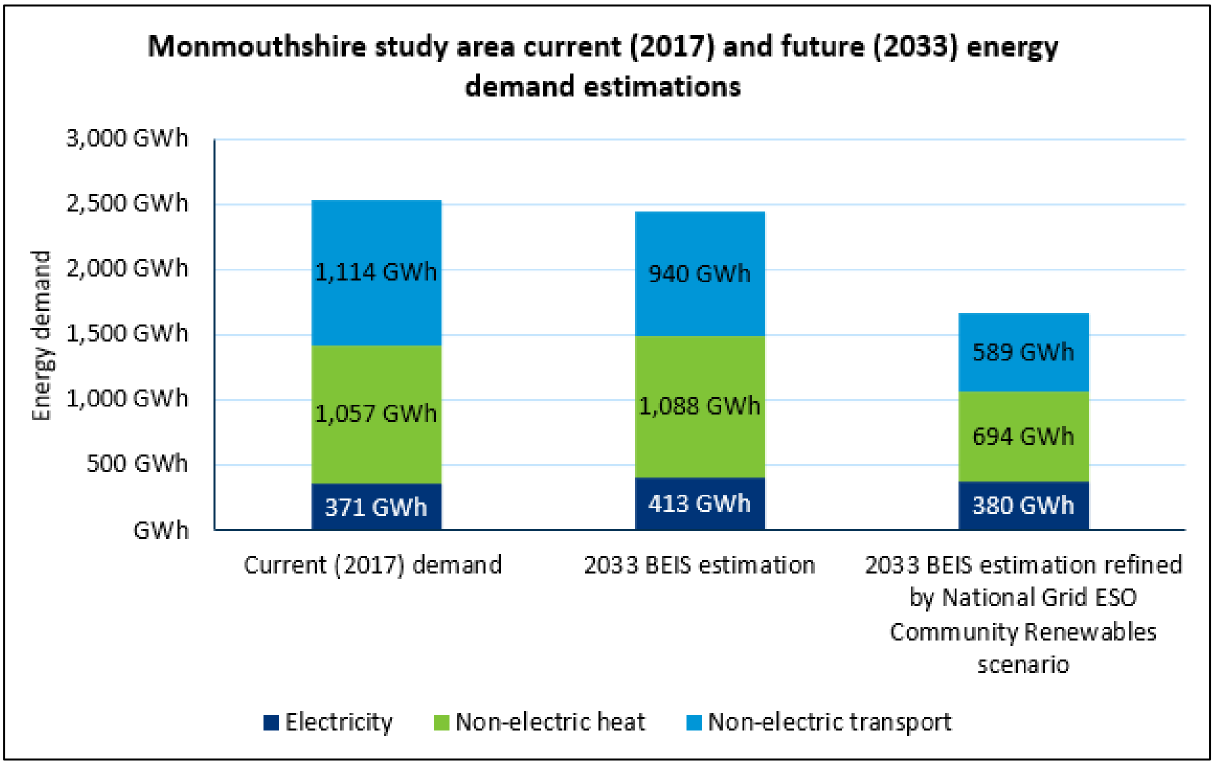


Figure 8: Monmouthshire study area's current (2017) and future (2033) energy demand estimations

2.3.2 The 2017 electricity and non-electric heating energy demand for Monmouthshire is lower than the 2020 electricity and non-electric heating projection provided in the previous Renewable Energy and Energy Efficiency Study, which didn't include an estimation for transport energy demand (Camco, 2012). This could indicate the successful deployment and integration of energy efficiency measures with respect to heating demand, and, potentially, a reduction in demand/output.

2.3.3 Both 2033 demand estimations suggest that there will be an increase in electricity demand. The lower non-electric heating and non-electric transport demand estimations associated with the Community Renewables scenario data, is likely due to higher levels of fabric efficiency improvements and electrification of heat and transport than is currently considered within the BEIS (2019h) reference case. Whilst using the Community Renewables scenario is likely to assume higher levels of electrification of heat and transport, the electricity growth rate is not as high as under the BEIS (2019h) reference case, which is likely due to the high levels of energy efficiency (both fabric and appliance) considered within the Community Renewables scenario.

2.3.4 Comparing the different future scenarios 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.

2.3.5 As acknowledged by National Grid ESO (2019a, p.2), to achieve net-zero *"Action on electrification, energy efficiency and carbon capture will all be needed…"*.

2.4 Conclusions

2.4.1 For national energy and decarbonisation targets to be met, the national decarbonisation rate will need to be faster than the current reference projection set out by UK Government (BEIS, 2019g, 2019h). This will likely require increased electrification of heat and transport. 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 allow for only a small increase in electricity demand in comparison to today.

3. Existing and Proposed Low and Zero Carbon Energy Technologies

3.1 Introduction

3.1.1 The levels of existing and proposed renewable and low carbon energy technologies within the Monmouthshire study area, i.e. not including areas with the Brecon Beacons National Park, are estimated in order to understand the current progress made in transitioning to a low carbon economy. The Toolkit suggests that understanding the level of existing generation in the area can help to inform target setting (Welsh Government, 2015).

3.2 Method

3.2.1 The method followed is summarised in Figure 9.

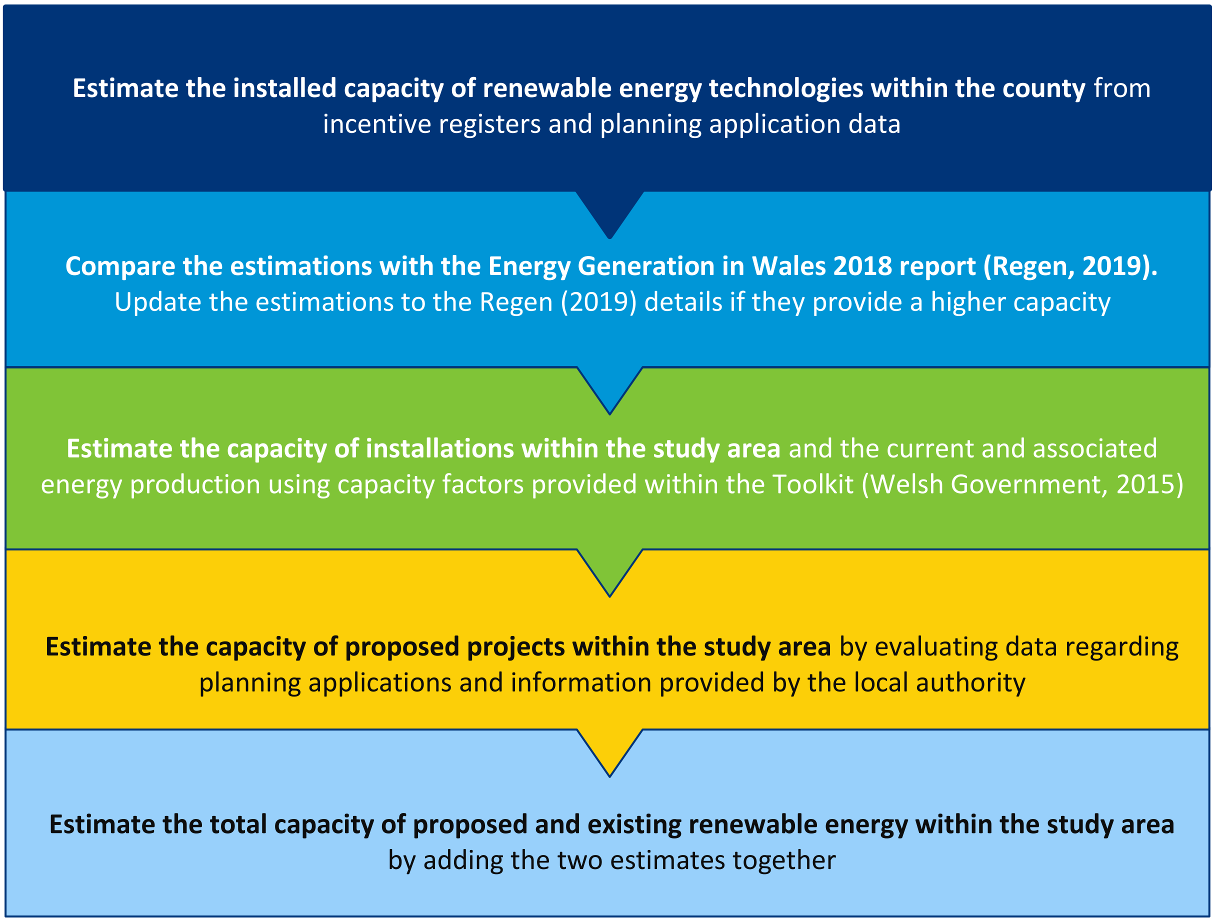


Figure 9: Method for estimating the existing and proposed renewable energy and low carbon energy capacity within the study area

3.2.2 The following data sources are used to estimate the capacity of existing renewable and low carbon technologies:

- Ofgem Combined Heat and Power (CHP), Renewables Obligation (RO) and Renewable Energy Guarantees of Origin (REGO) registers (Ofgem, 2020b)
- Ofgem Feed-in Tariff (FIT) register (Ofgem, 2020a)
- Renewable Heat Incentive (RHI) deployment data (BEIS, 2020b)
- CFD register (Low Carbon Contracts Company, 2020)
- Renewable Energy Planning Database (BEIS, 2020a)
- Planning application data (MCC, 2020b)
- Data regarding wind turbines in south-east Wales (BGCBC, 2019)
- Energy Generation in Wales 2018 report (Regen, 2019)

3.2.3 The capacity of proposed renewable and low carbon energy technologies is determined from:

- BEIS' Renewable Energy Planning Database (BEIS, 2020a)
- Planning application data (MCC, 2020b)
- Ofgem CHP, RO and REGO registers (Ofgem, 2020b)

3.2.4 "Proposed" generators are those that have gained planning consent but have not yet been installed and are not reported as "abandoned" within the Renewable Energy Planning Database (BEIS, 2020a). Some installations which have gained planning consent may not progress to implementation for other reasons, such as lack of financial viability. It is anticipated that more projects will emerge during the Plan period than are included in the proposed generators list provided in this Section.

3.2.5 The proportion of the installations within the study area is estimated as follows:

- Onshore wind: all installations are assumed within the study area
- Ground mounted solar: all installations are assumed within the study area
- Roof-mounted solar: the proportion of installations within the study area is based on the number of commercial/residential buildings within the study area in comparison to the whole county
- Anaerobic digestion: within study area, established from The Official Information Portal on Anaerobic Digestion (2020)
- Hydro: established from planning application data
- Biomass (CHP power/heat): established from RO data (Ofgem, 2020b), assumes all biomass CHP generators are within the study area
- Heat pumps: the proportion of installations within the study area is based on the number of commercial/residential buildings within the study area in comparison to the whole county
- Biomass (heat): the proportion of installations within the study area is based on the number of commercial/residential buildings within the study area in comparison to the whole county
- Solar thermal: the proportion of installations within the study area is based on the number of commercial/residential buildings within the study area in comparison to the whole county

Box 1: Notes regarding estimation of existing renewable energy capacity

The existing renewable energy capacity (MW) within Monmouthshire is initially estimated using primary data from Ofgem and MCC including CHP, RO, REGO, FIT, RHI and CFD registers and planning application data (the "assessment estimation"). Some irregularities are present within the datasets and these are corrected where found.

The resultant estimations are compared with the Energy Generation in Wales 2018 report (Regen, 2019), with the following observations:

- Solar PV, heat pumps, and hydro: The assessment estimation is greater than provided in Regen (2019)
- Wind, anaerobic digestion (power and heat), biomass (heat only), biomass (CHP power and heat) and solar thermal: The assessment estimation is less than provided in Regen (2019)

Whilst the assessment estimation benefits from accessing more up-to-date datasets, in addition to renewable incentive registers and planning application data, Regen (2019) had access to further data sources including:

- Western Power Distribution connections data
- Gemserv MCS data
- Contact with utilities, installers and industry organisations.

As a result of these further datasets, Regen (2019) may have identified additional installations not included in the datasets used to inform the assessment estimation. In order to ensure that the existing capacity of renewable energy generation is not underestimated, but to also benefit from the most up-to-date data available, the highest MW estimation for each category is provided in the results. As well as discrepancies in the MW capacity of installations there are discrepancies in the number of installations. In some cases, the MW capacity in Regen (2019) is less than the assessment MW capacity but the number of installations is greater. In this case the data source with the greatest MW capacity is used and the number of installations from the same data source are taken where relevant to the assessment.

Before using the data, they are reviewed and "cleaned". RHI data obtained from BEIS (2020b) contained anomalies which are corrected before use.

Capacity factors provided by the Toolkit are used to estimate energy generation from the energy capacity of different technologies. There is a contradiction regarding the capacity factor to use to estimate heat energy production associated with biomass boilers – with two values provided in the Toolkit. A capacity factor or 0.3 is assumed in this assessment as per note 52 in Project Sheet C of the Toolkit (Welsh Government, 2015, p.154).

3.3 Results

3.3.1 Table 9 provides details of existing renewable and low carbon generation capacity installed in the Monmouthshire study area. A sewage gas plant at Llanfoist is included in the Renewables Obligation register, however Welsh Water has confirmed that this plant has been decommissioned. Table 10 gives details of the known proposed developments within the study area, and Table 11 consolidates the information on both existing and proposed capacity within the study area.

Table 9: Existing renewable and low carbon energy projects within Monmouthshire study area

Technology	Study area capacity (MW)	Study area estimated annual energy generation (MWh p.a.)
Wind	0.3	710
Solar PV (ground mounted)	35.5	31,087
Solar PV (roof mounted)	13.6	11,894
Anaerobic Digestion (CHP power)	0.4	3,154
Hydro	0.2	511
Biomass (CHP power)	18.0	141,912
Total estimated power generation	**67.9**	**189,266**
Biomass (CHP heat)	7.1	31,098
Anaerobic Digestion (CHP heat)	0.2	767
Heat Pumps	3.5	4,103 (net thermal benefit assuming a Seasonal Performance Factor of 3, i.e. the energy generation is reduced by the assumed electrical input)
Biomass (heat only)	18.1	47,622
Solar thermal	0.3	486
Total estimated heat generation	**29.2**	**84,075**

(Data in table are rounded and may not appear exact)

Table 10: Proposed renewable and low carbon energy projects within Monmouthshire study area

Technology	Site	Capacity (MW)	Estimated annual energy generation (MWh p.a.)
Solar PV (ground mounted)	Buckwell Farm Solar Park	8.1	7,096
Solar PV (roof mounted)	Magor Brewery	1.7	1,489
Solar PV (floating/ground mounted)	Court Farm reservoir Pentopyn	2.8	2,455
Total proposed power generators		**12.6**	**11,039**
Total proposed heat generators		**0.0**	**0**

(Data in table are rounded and may not appear exact)

Table 11: Capacity of existing and proposed renewable and low carbon energy projects within Monmouthshire study area

Technology	Study area capacity (MW)	Study area estimated annual energy generation (MWh p.a.)
Wind	0.3	710
Solar PV (ground mounted)	46.4	40,637
Solar PV (roof mounted)	15.3	13,383
Anaerobic Digestion (CHP power)	0.4	3,154
Hydro	0.2	511
Biomass (CHP power)	18.0	141,912
Total estimated power generation	**80.5**	**200,306**
Biomass (CHP heat)	7.1	31,098
Anaerobic Digestion (CHP heat)	0.2	767
Heat Pumps	3.5	4,103 (net thermal benefit assuming a Seasonal Performance Factor of 3, i.e. the energy generation is reduced by the assumed electrical input)
Biomass (heat only)	18.1	47,622
Solar thermal	0.3	486
Total estimated heat generation	**29.2**	**84,075**

(Data in table are rounded and may not appear exact)

3.3.2 The amount of existing low carbon energy generation (excluding thermal energy generated by heat pumps) in the Monmouthshire study area equates to approximately 11% of current total energy demand and 16% of the lower 2033 demand estimate, as illustrated in Figure 10. The current electricity generation equates to approximately 51% of the current electricity demand and 50% of the lower future electricity demand estimate. Figure 10 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.

3.3.3 Figure 11 shows the sources of current energy generation, highlighting that the majority of energy is currently generated from biomass. Figure 12 shows the sources of current and proposed energy generation, and shows that generation continues to be dominated by biomass. Figures 11 and 12 include the thermal energy generated by the heat pumps minus the electrical input.

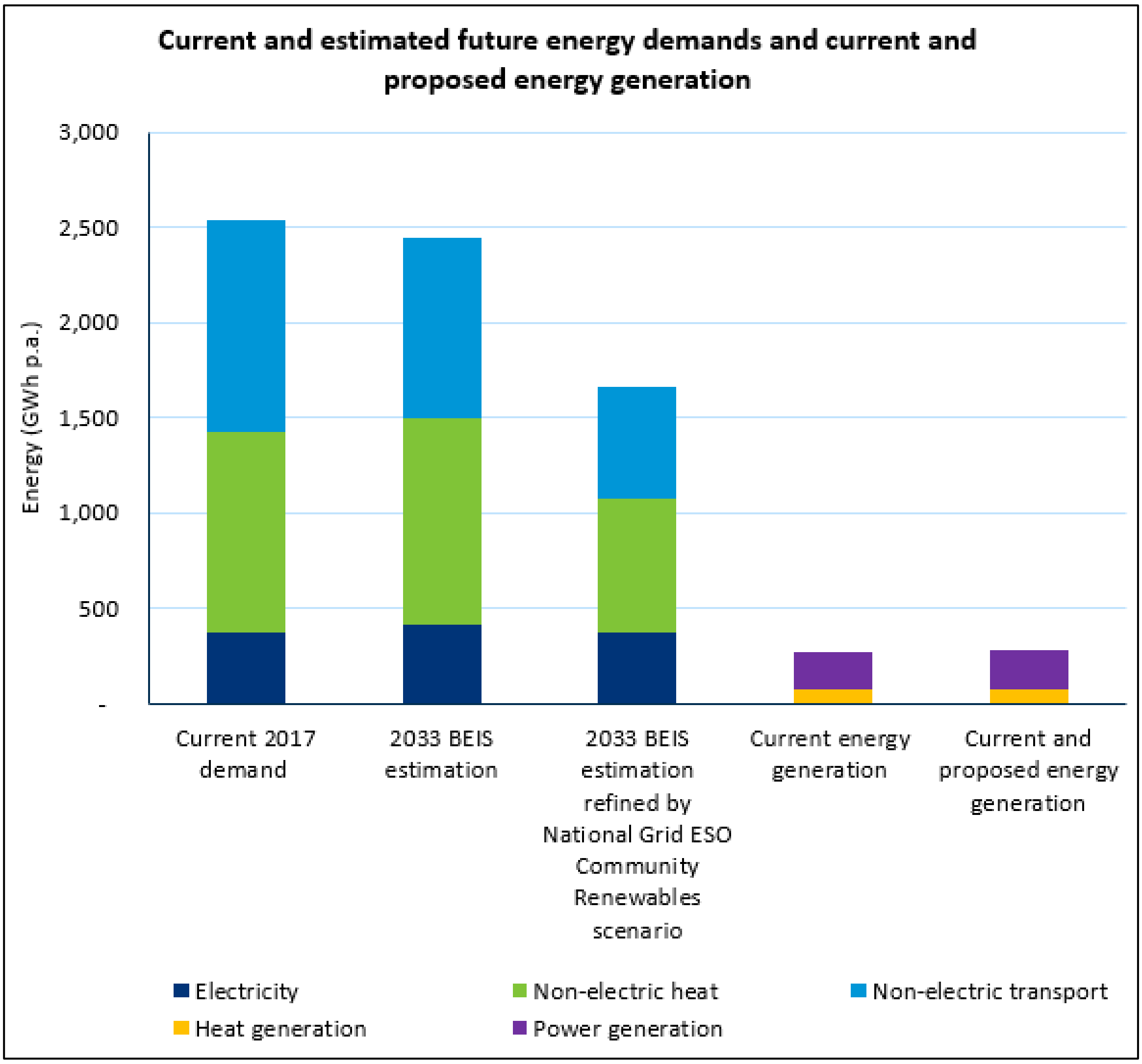


Figure 10: Comparison of current/future energy demand and current low carbon energy generation

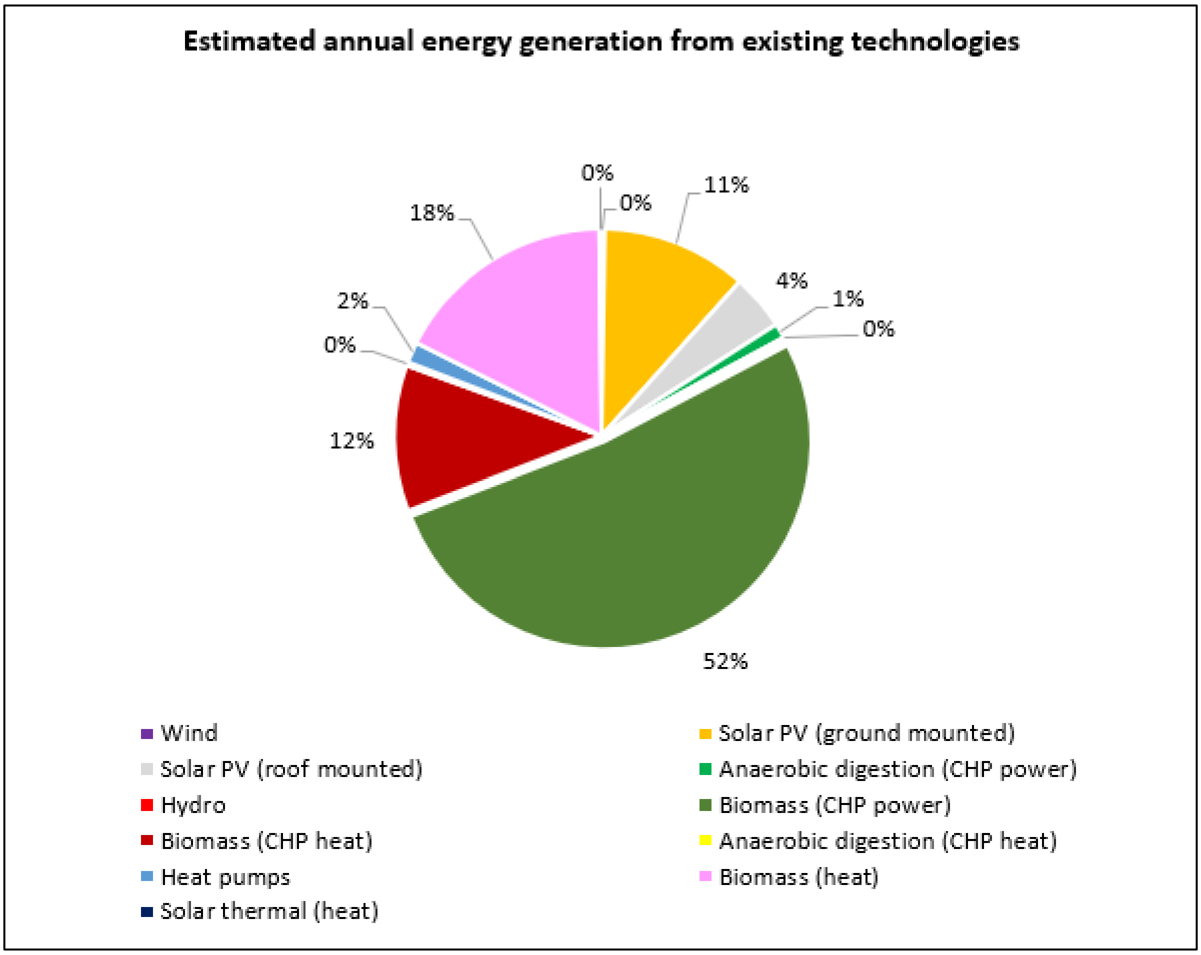


Figure 11: Estimated current annual low carbon energy generation in the study area

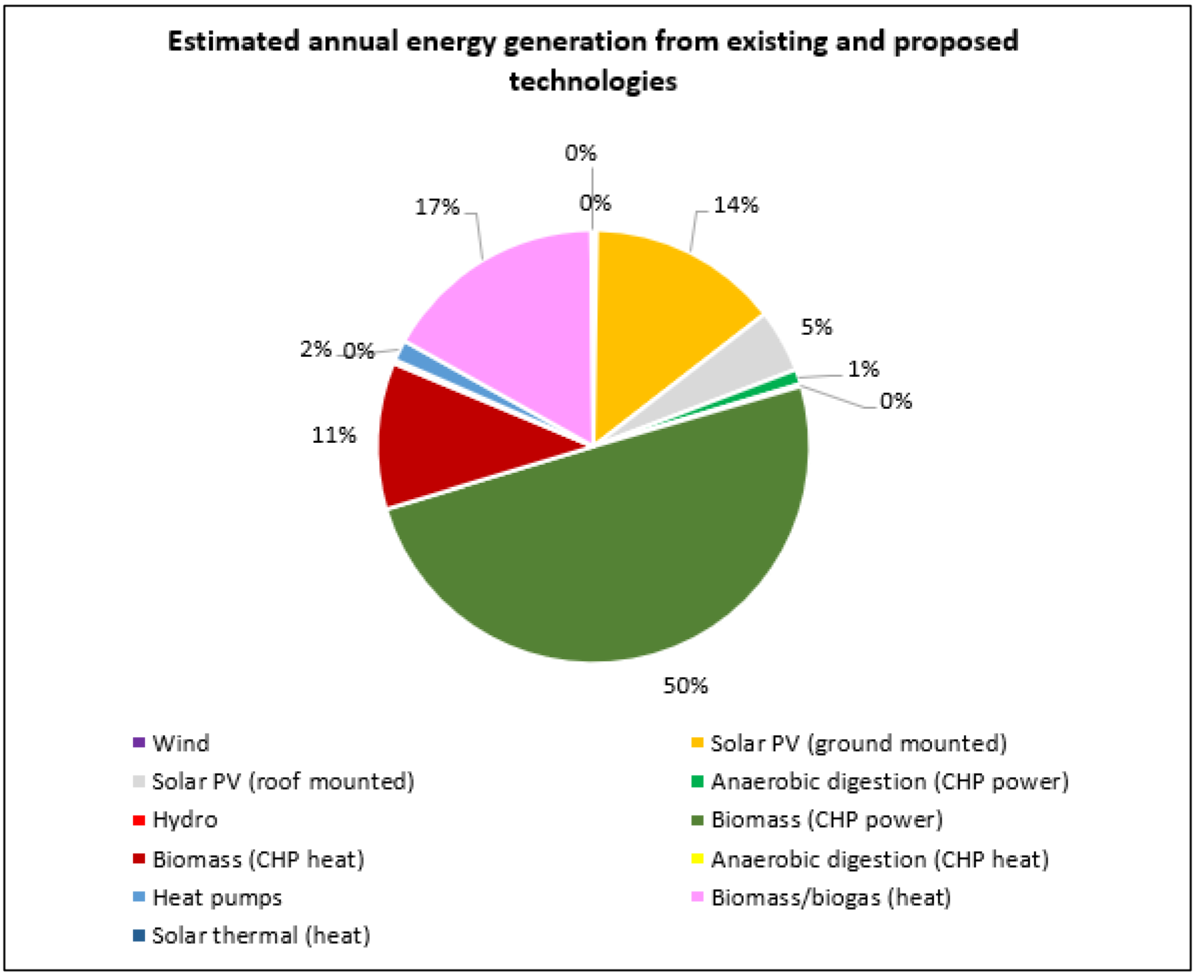


Figure 12: Estimated current and proposed annual low carbon energy generation in the study area

3.4 Conclusions

3.4.1 In order to meet/offset the lower future energy demand estimation of the Monmouthshire study area, the level of existing renewable/low carbon energy generation needs to increase approximately six-fold (excludes thermal generation from heat pumps). To achieve 70% of current local electricity demand from renewable sources, the renewable electricity generation needs to increase approximately 37% from existing generation. (Comparing results from Table 7 and Table 8).

3.4.2 Existing and proposed renewable energy generation in the Monmouthshire study area is dominated by biomass (contributing approximately 78% of the total generation).

3.4.3 As referenced at 2.1.2, the Toolkit suggests that the "*future energy demand should be established in order to: Provide indicative figures to inform area wide renewable energy installed capacity targets.*" (Welsh Government, 2015, p. 43), however PPW 10 notes that: renewable energy targets "*should be calculated from the resource potential of the area and should not relate to a local need for energy*" (Welsh Government, 2018b, p. 90). Therefore, whilst the observations in this Section provide interesting context they should not necessarily limit or set targets without considering the following Sections of the assessment.

4. Renewable Energy Resource Potential

4.1 Introduction

4.1.1 The Toolkit (Welsh Government, 2015) splits the Area Wide Renewable Energy Assessment into seven tasks. The methodology for meeting the task requirements relating to renewable energy generation potential (tasks E1.3 – E1.7 of the Toolkit) is detailed in each resource Section and includes the assessment of building integrated renewables (task 2.2 of the Toolkit). Data sources required for completion of the task are listed within the individual resource Sections. Note that in some cases data sources used vary from those suggested in the Toolkit, however data used is appropriate for the task requirements.

4.1.2 The resource potential assessed are in the following areas:

- wind energy resource
- ground-mounted solar PV resource
- biomass energy resource
- energy from waste and anaerobic digestion
- hydropower energy resource.

4.1.3 Building integrated renewables (roof-top solar PV and heat pumps) and heat network opportunities are considered in Sections 5 and 7 respectively.

4.2 Wind Energy Resource

Introduction

4.2.1 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
- landscape sensitivity
- distance to properties and infrastructure.

4.2.2 A strategic high-level constraints assessment of the Monmouthshire study area, i.e. not including areas with the Brecon Beacons National Park, is undertaken. This constraints exercise identifies areas outside of known constraints to identify areas that are considered “less constrained” with respect to wind developments. From this, the accessible wind power potential within the study area is estimated.

Box 2: 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 areas, or consent developments within the less-constrained areas. Individual site-specific studies are still necessary, however, at a high-level, this assessment identifies areas that are likely to be more suitable for development (from a planning and technical perspective) and enables an indicative resource potential to be estimated.

When identifying Local Search Areas for development and assessing individual planning applications, the local planning authority may identify additional constraints that require consideration.

Method

4.2.3 The method undertaken is summarised in Figure 13.

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 the most suitable areas are retained

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

Estimate wind resource potential within less-constrained areas within the wind clusters, based on 5 turbines per km^2 and 10 MW per km^2 (Welsh Government, 2015)

Figure 13: Method for identifying wind resource capacity

Box 3: Note on land areas

The less constrained land areas are identified using a 2m by 2m resolution.

The areas (km^2) of the land identified are calculated using geographical information systems (GIS) to the nearest square metre.

4.2.4 The candidate wind turbine typology used for the assessment is 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 the Toolkit (Welsh Government, 2015). In a post-subsidy environment, a turbine of this size is more likely to be financially viable, than a smaller turbine.

Box 4: Notes on indicative capacity methodology

The Toolkit (Welsh Government, 2015) suggests calculating the potential capacity by using 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 identifies 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 does not assume this and some clusters may therefore be estimated to have a capacity of less than (or more than) 2 MW. As such two methodologies are used to calculate the capacity of land available – a capacity based on 10 MW/km^2 and a capacity based on an indicative capacity of 5 turbines per km^2 (with areas smaller than 0.2 km^2 still able to accommodate a single turbine, but following this the full 0.2 km^2 is required for each additional turbine). The second methodology may still underestimate the potential capacity where a cluster is made up of several small areas spaced sufficiently far apart to provide acceptable wake clearance for more than one turbine to be developed.

4.2.5 The wind data utilised in the assessment is based on a dataset generated by the Met Office (no date) of estimated average annual wind speeds at 45 m height for each 1.5 km^2 of the UK. Whilst this data provides an indication of wind speeds, at 1.5 km^2 it provides a low geographical resolution, which may mean that higher wind speeds associated with local high spots of topography are not identified.

4.2.6 Due to low estimated wind speeds provided by the Met Office (no date) dataset for Monmouthshire, an additional assessment utilising a second wind dataset is undertaken. The second wind dataset referred to is the Numerical Objective Analysis Boundary Layer (NOABL) database, which was developed by the Department of Trade and Industry pre-2001 (DECC, 2012). As per the wind speed dataset provided by the Met Office (no date), the NOABL data only provides an indication of wind speeds. It does, however, provide this at a slightly higher geographical resolution of 1 km^2 and therefore identifies many additional areas within the study area as less constrained for wind developments. This database is used for comparison and interest only, with the less constrained areas, and associated capacities referred to in other Sections of this assessment based on the original Met Office wind database.

4.2.7 The high-level constraints considered within this assessment, and data sources used, are summarised in Appendix 1. Additional constraints, including grid infrastructure and landscape value are discussed in Section 9.

Results

4.2.8 The initial GIS constraints assessment, using the Met Office (no date) dataset, identifies less constrained areas covering just 0.709 km^2 in total (pre-aerial imagery refinement) with potential for wind development.

4.2.9 Following the aerial imagery visual refinement exercise, this is reduced to 0.708 km^2. The individual areas are grouped into 16 clusters by amalgamating less constrained areas within 4 rotor diameters (320m) of one another. The locations of the clusters are summarised in Table 12 and identified in Figure 14.

Table 12: Cluster locations

Cluster	Location
1	Graig Syfyrddin
2	Northern Hills (1)
3	Northern Hills (2)
4	Northern Hills (3)
5	Northern Hills (4)
6	Northern Hills (5)
7	Northern Hills (6)
8	Buckholt Woods
9	Chepstow Parkland (1)
10	Chepstow Parkland (2)
11	Chepstow Parkland (3)
12	Chepstow Woods (1)
13	Chepstow Woods (2)
14	Chepstow Woods (3)
15	Leechpool
16	M4

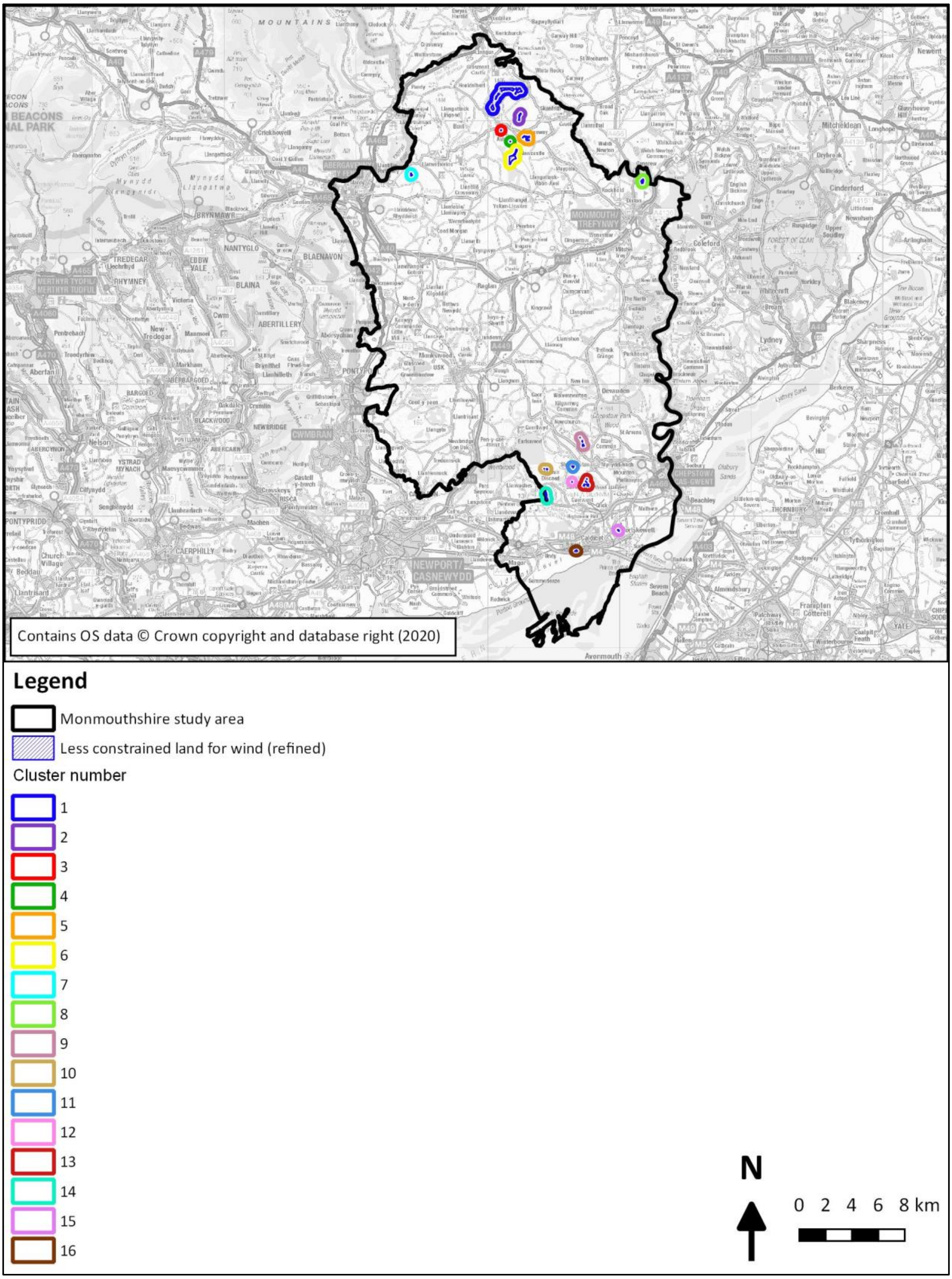


Figure 14: Less constrained land for wind (refined) and grouped by clusters

4.2.10 Table 13 provides details of the total areas within each of the 16 clusters and their indicative wind capacity. The total indicative capacity for the study area is 32 MW with a generation potential of approximately 76 GWh p.a. when calculated on a 5 turbines per km^2 basis, and 7 MW and 17 GWh p.a. when calculated on a 10 MW/km^2 basis.

Table 13: Wind cluster capacities

Cluster (see Figure 14 for locations)	**Area km^2**	**Turbine no. based on 5 turbines per km^2**	**Capacity based on 5 turbines per km^2 (MW)**	**Generation potential based on 5 turbines per km^2 (MWh p.a.)**	**Capacity based on 10 MW/km^2 (MW)**	**Generation potential based on 10 MW/km^2 (MWh p.a.)**
1	0.308	1	2	4,730	3.1	7,287
2	0.020	1	2	4,730	0.2	482
3	0.001	1	2	4,730	0.0	19
4	0.001	1	2	4,730	0.0	15
5	0.047	1	2	4,730	0.5	1,113
6	0.201	1	2	4,730	2.0	4,760
7	0.015	1	2	4,730	0.1	351
8	0.034	1	2	4,730	0.3	806
9	0.012	1	2	4,730	0.1	290
10	0.003	1	2	4,730	0.0	64
11	0.007	1	2	4,730	0.1	155
12	0.0001	1	2	4,730	0.0	3
13	0.020	1	2	4,730	0.2	476
14	0.030	1	2	4,730	0.3	703
15	0.004	1	2	4,730	0.0	90
16	0.006	1	2	4,730	0.1	137
Total	**0.708**	**16**	**32**	**75,686**	**7**	**16,751**

(Data in table are rounded and may not appear exact)

4.2.11 The baseline assessment identifies 0.3 MW of existing wind turbine capacity within the study area. Data regarding consented wind turbines in South Wales provided by BGCBC (2019) only provides location details for 0.03 MW of wind capacity. The location and power of these wind turbines is reviewed to understand if they fall within four rotor diameters of the less constrained wind areas identified. None of the existing wind turbines within this dataset (BGCBC, 2019) are located within the cluster areas identified, as such they represent additional capacity and are treated as such in Table 14, which show the additional capacity based on the 5 turbines per km^2 method. The additional turbine capacity identified within the baseline are also assumed to be located outside of the identified clusters and therefore are also presented as additional capacity in Table 14. Following consideration of existing wind turbines, the potential wind capacity identified is 32.3 MW.

Table 14: Wind cluster capacities accounting for existing wind generation

Cluster (see Figure 14 for locations)	**Capacity based on 5 turbines per km² (MW)**	**Generation potential based on 5 turbines per km² (MWh p.a.)**
1	2	4,730
2	2	4,730
3	2	4,730
4	2	4,730
5	2	4,730
6	2	4,730
7	2	4,730
8	2	4,730
9	2	4,730
10	2	4,730
11	2	4,730
12	2	4,730
13	2	4,730
14	2	4,730
15	2	4,730
16	2	4,730
Additional turbine capacity located outside of clusters	0.3	710
Total	**32.3**	**76,396**

(Data in table are rounded and may not appear exact)

4.2.12 Section 4.3 identifies areas that are less constrained for solar PV. The total area overlap of the less constrained wind and solar areas is identified in Figure 15 and the corresponding theoretical potential wind and solar capacities associated with these areas are summarised in Table 15. The wind capacity is based on the 5 turbines per km² method. It may be possible to design developments so that both technologies can be accommodated, therefore, one development will not necessarily preclude another, although the total installed capacity is likely to be reduced.

Table 15: Area overlap between less constrained wind and solar areas

Cluster (see Figure 14 for locations)	**Area (km²)**	**Turbine no.**	**Turbine capacity (MW)**	**Potential wind generation (MWh p.a.)**	**Solar capacity (MW)**	**Potential solar generation (MWh p.a.)**
1	0.2	1	2	4,730	13.0	11,351
2	0.002	1	2	4,730	0.1	111
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	0.00004	1	2	4,730	0.002	2
6	0.04	1	2	4,730	2.4	2,124
7	0.0005	1	2	4,730	0.03	25
8	-	-	-	-	-	-
9	0.00009	1	2	4,730	0.01	5
10	0.002	1	2	4,730	0.1	83
11	0.007	1	2	4,730	0.4	328
12	0.0001	1	2	4,730	0.01	6
13	0.02	1	2	4,730	1.1	1,006
14	0.03	1	2	4,730	1.7	1,446
15	-	-	-	-	-	-
16	-	-	-	-	-	-
Total	**0.3**	**11**	**22**	**52,034**	**19**	**16,485**

(Data in table are rounded and may not appear exact)

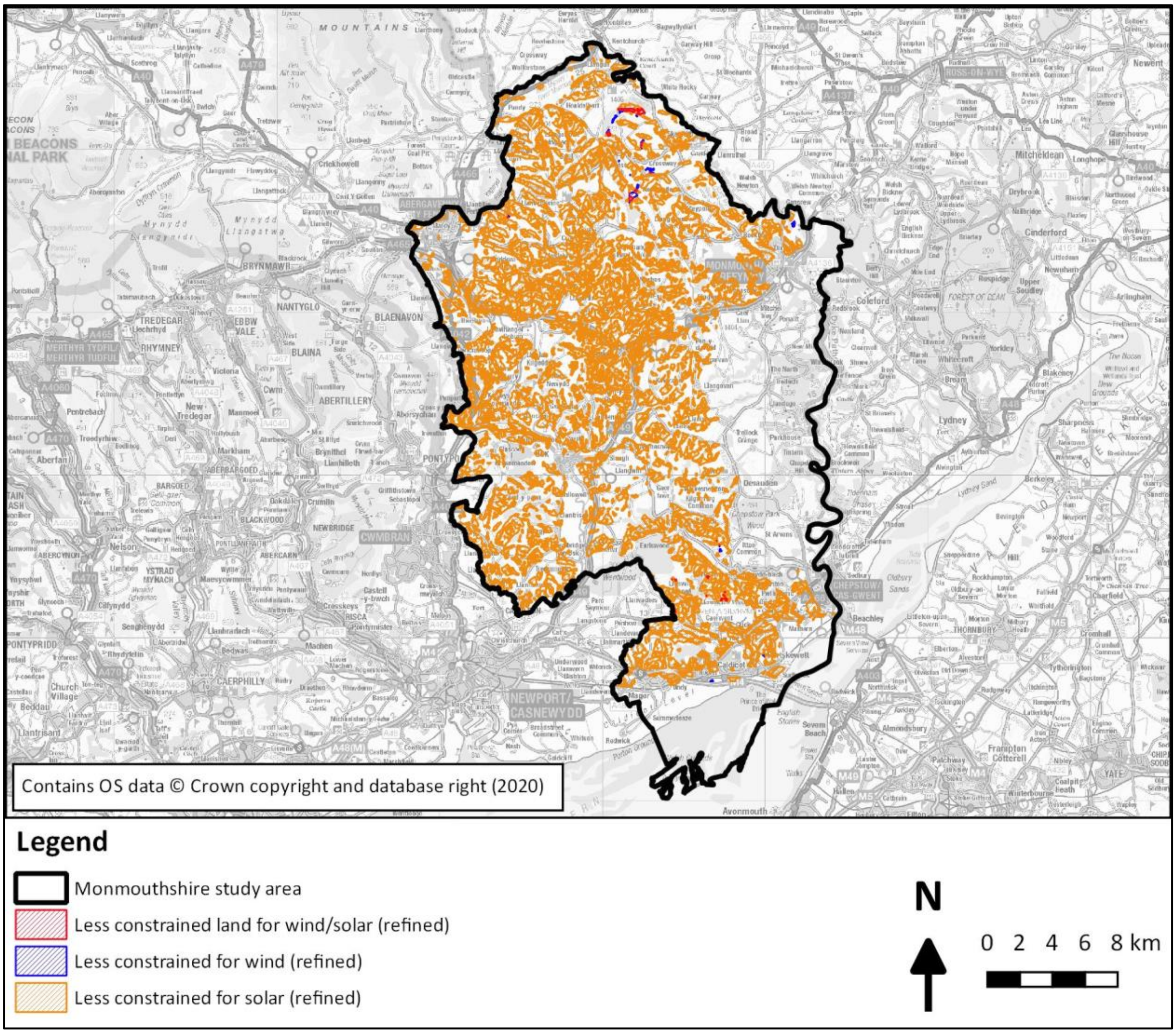


Figure 15: Refined less constrained land for wind alongside refined less constrained land for solar

4.2.13 Table 16 provides an estimation of the reduced potential for wind if half of the area overlap between less constrained wind and solar areas is utilised for wind and half is utilised for solar, utilising the 5 turbines per km^2 method.

Table 16: Wind capacity calculation accounting for wind/solar overlap

Capacity of less constrained areas (refined) based on 5 turbines per km^2 and accounting for existing turbines (MW)	32
Turbine capacity of wind/solar less constrained land overlap (MW)	22
Reduced capacity of less constrained areas on the basis that half of the wind/solar less constrained land overlap is used for wind (MW)	21
Potential wind energy generation on the basis that half of the wind/solar less constrained land overlap is used for wind (MWh p.a.)	50,379

(Data in table are rounded and may not appear exact)

4.2.14 The low wind potential identified in Monmouthshire is primarily due to the low wind speeds. The results of the constraints exercise if the NOABL (DECC, 2012) dataset is used instead of the Met Office (no date) dataset is summarised in Table 17.

Table 17: Estimated wind potential based if NOABL (DECC, 2012) wind speed dataset is used

Capacity of less constrained areas (refined) based on 5 turbines per km^2	98
Capacity of less constrained areas based on 5 turbines per km^2 and accounting for existing turbines (MW)	98.3
Turbine capacity of wind/solar less constrained land overlap (MW)	14
Reduced capacity of less constrained areas on the basis that half of the wind/solar less constrained land overlap is used for wind (MW)	91.3
Potential wind energy generation on the basis that half of the wind/solar less constrained land overlap is used for wind (MWh p.a.)	215,859

(Data in table are rounded and may not appear exact)

Conclusions

4.2.15 The constraints assessment identifies just small areas of land in the study area as less constrained for wind developments. These areas are generally clustered in the most northerly part of the county and the most southerly part of the county. It is estimated this land could accommodate approximately 32 MW of wind capacity, generating approximately 76 GWh p.a. of electricity (Table 14). This is equivalent to the amount of electricity used to power over 25,000 typical homes for a year (it should be noted there are other users of electricity apart from residential properties such as industry, commercial, transport etc.). This is considered a low resource capacity given the size of the study area.

4.2.16 Due to the low wind resource identified and high solar resource, it is recommended that when considering the resource available it is assumed that all the land identified as less constrained for wind is developed for this purpose rather than solar. It may be possible to design developments so that both technologies can be accommodated, therefore one development will not necessarily preclude another, although the total installed capacity is likely to be reduced.

4.2.17 The current assessment has identified less potential for wind developments than the previous Renewable Energy and Energy Efficiency study for Monmouthshire (Camco, 2010). The previous assessment was based on a candidate turbine of 2.5 MW capacity, which could account for this discrepancy.

4.2.18 Low estimated wind speeds are the primary reason for the low potential resource identified within this assessment. The wind speed data used in the assessment is relatively low resolution, and therefore there may be additional potential if local spots of higher wind resource are identified by developers. Using the NOABL (DECC, 2012) wind speed dataset instead of the Met Office (no date dataset) increases the potential wind capacity approximately three-fold, with additional less constrained areas identified in the central county area.

4.2.19 Additional factors (e.g. aviation constraints, grid constraints, landscape value, etc.) affecting the potential to exploit development of wind farms within the wind clusters identified are considered further in Section 9.

4.3 Ground Mounted Solar Resource

Introduction

4.3.1 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 16).

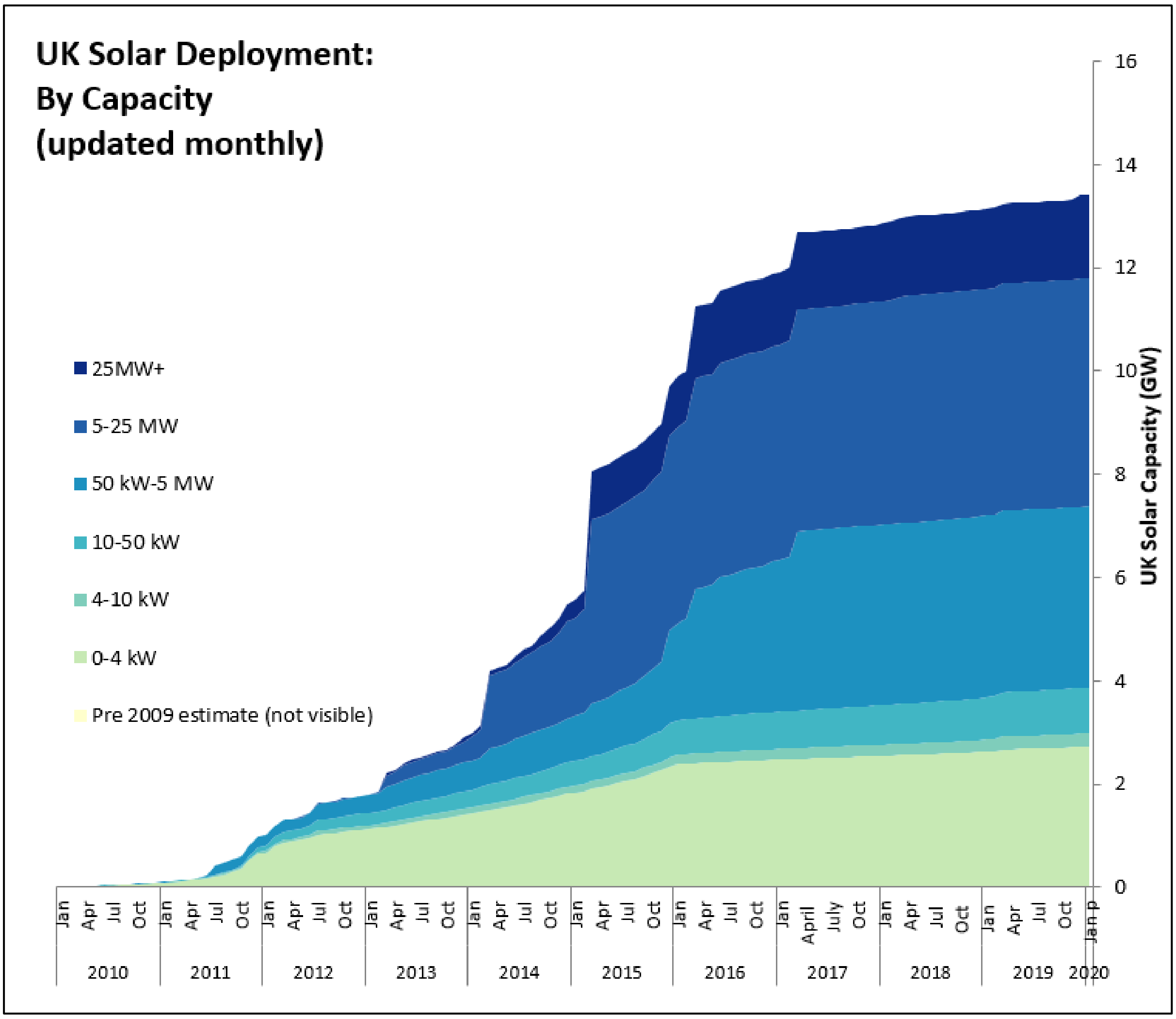


Figure 16: UK solar PV deployment since 2010

(BEIS, 2020c)

4.3.2 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
- landscape sensitivity
- distance to properties and access infrastructure.

Method

4.3.3 A strategic high-level assessment of accessible large-scale solar power potential within the Monmouthshire study area i.e. not including areas within the Brecon Beacons National Park, is undertaken via a constraints assessment to identify areas that are less constrained with respect to solar developments. The method undertaken is summarised in Figure 17.

Identify less constrained land outside of high-level constraints, and identify land within Development Advice Map Zones C1 and C2 across the region*

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

Refine identified land using aerial imagery: review areas associated with urban locations identified in the Strategi® dataset (Ordnance Survey, 2016) and remove land that at a high-level appears unsuitable, e.g. school playing fields, golf courses, cemeteries

Remove areas remaining that are less than 0.5 MW solely within study area and estimate solar resource potential within the "less-constrained" areas (this step is required in addition to the "Refine by size" step as additional smaller areas may result following the refinement exercise)

Figure 17: Ground mounted PV resource assessment method

**Less constrained areas are initially identified on a regional basis covering areas of Monmouthshire, Blaenau Gwent, Torfaen, Caerphilly and Newport (excluding areas within the Brecon Beacon National Park), in order to identify cross boundary opportunities for solar PV development.*

***Whilst the Toolkit (Welsh Government, 2015) indicates 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.*

4.3.4 The high-level constraints considered in this assessment are detailed in Appendix 1.

Box 5: Note on land areas

The less constrained land areas are identified using a 2m by 2m resolution.

The areas (km^2) of the land identified are calculated using GIS to the nearest square metre.

Box 6: Notes with respect to high-level constraints assessment

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

When identifying local search areas for development and assessing individual planning applications, the local planning authority may identify additional constraints that require consideration.

4.3.5 The Toolkit (Welsh Government, 2015) suggests including flood warning areas as a constraint within the mapping exercise.

4.3.6 Technical Advice Note (TAN) 15 Development and Flood Risk (Welsh Government, 2004) does not consider renewable energy developments, and their impact on flood risk or the impact of flooding on the developments themselves.

4.3.7 The Welsh Government (2019c) held a consultation on an updated TAN 15, which closed on the 17th January 2020. At the time of writing (June 2020) a response has not yet been published. Within the consultation documents, it is proposed to include renewable energy generation developments within the "Less Vulnerable Development" category, which is defined as "*development where the ability of occupants to decide if risks and consequences are acceptable is greater than that in the highly vulnerable category."* (Welsh Government, 2019g, p.11). The proposed national policy requirements are that *"Plan allocations or applications for less vulnerable development can only proceed subject to justification in accordance with [the details in Table 18] and acceptability of consequences…"* (Welsh Government, 2019g, p.12). To inform the acceptability of flood consequences, a flood consequence assessment would need to be undertaken for a proposal, and the developer would need to demonstrate that the risks and effects of flooding are manageable and meet the required criteria within the TAN 15.

Table 18: Proposed justification criteria within draft TAN 15

Flood zone	Proposed justification criteria
Zone 1	All types of development are acceptable in principle. Planning authorities may develop locally specific planning policies for localised areas at risk of flooding.
Zone 2	Development will be justified in Zone 2 if it complies either with clauses 1, 3 and 4, or with clauses 2, 3 and 4: 1. It is located in an area benefitting from flood defence infrastructure; OR 2. It will assist, or be part of, a local authority initiative or strategy to sustain an existing settlement and is identified in an adopted Development Plan as a result of consideration through the SFCA; **AND,** 3. It conforms with the placemaking policies of PPW and meets the definition of previously developed land; **AND**, 4. The potential consequences of a flooding event for the particular type of development have been considered, and found to be acceptable in accordance with the criteria contained in Section 11.
Zone 3	Less vulnerable development, including essential transport and utilities infrastructure will **only** be justified if it can be demonstrated that: a) The scheme is allocated (or part of an allocation) or identified in an adopted Development Plan, as a result of consideration through the SFCA, with evidence to justify why it is necessary to locate the development in zone 3; **AND** b) The potential consequences of a flooding event for the particular type of development have been considered, and found to be acceptable in terms of the criteria contained in Section 11.

(Welsh Government, 2019g, p.23)

4.3.8 With respect to the replacement local development plan (RLDP), Monmouthshire Planning Authority should adhere to the guidance provided within the new TAN 15 when it is published. Within the RLDP, MCC is required to identify *"spatial policies in their development plan which identify the most appropriate locations for development. There should be a presumption in favour of development 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, 2018b, p.92). This assessment refers to these identified areas as "Local Search Areas". When identifying Local Search Areas for solar PV developments within the study area, it is advised that areas outside the flood plains are initially identified.

4.3.9 It is understood that Welsh Government is in the process of creating a New Flood Risk Map for Wales which will replace the Development Advice Maps set out in Technical Advice Note 15. For the purposes of this assessment, the October 2019 Development Advice Maps for zones C1 and C2 are used (Welsh Government, 2020b).

4.3.10 Additional constraints, including grid infrastructure and landscape value are considered in Section 9.

Results

4.3.11 The results of the assessment are summarised in Table 19 and Figures 18 and 19, with details provided regarding:

- the area of land and associated potential capacity following the initial constraints assessment, including identifying areas within Development Advice Map Zones C1 and C2 (excluding land that would accommodate less than 0.5 MW of solar PV across the region)
- the remaining area of land following the visual inspection of urban areas using aerial imagery, and removal of land considered unlikely to be developed for PV, e.g. areas used

as school playing fields, graveyards, gardens and allotments. Areas covering car parks are retained due to the potential for solar canopies.

Table 19: Calculation of indicative solar power and energy generation capacities

	Total land area (hectares)	Indicative capacity (MW), based on 1.75 hectares is required for 1 MW	Estimated annual energy generation (MWh p.a.)
Less constrained area identified from GIS constraints exercise (including areas within the Development Advice Map Zones C1 and C2), identified in Figure 18	17,865 hectares	10,208 MW	8,942,879 MWh
Less constrained area identified from GIS constraints exercise (excluding areas within the Development Advice Map Zones C1 and C2), identified in Figure 18	15,019 hectares	8,582 MW	7,517,975 MWh
Less constrained area following high-level visual refinement, identified in Figure 19	14,521 hectares	8,297 MW	7,268,581 MWh

(Data in table are rounded and may not appear exact)

4.3.12 There is 35 MW of existing ground mounted solar PV capacity in Monmouthshire. If all of this is located within the less constrained areas, the remaining high-level capacity within the study area is 8,262 MW.

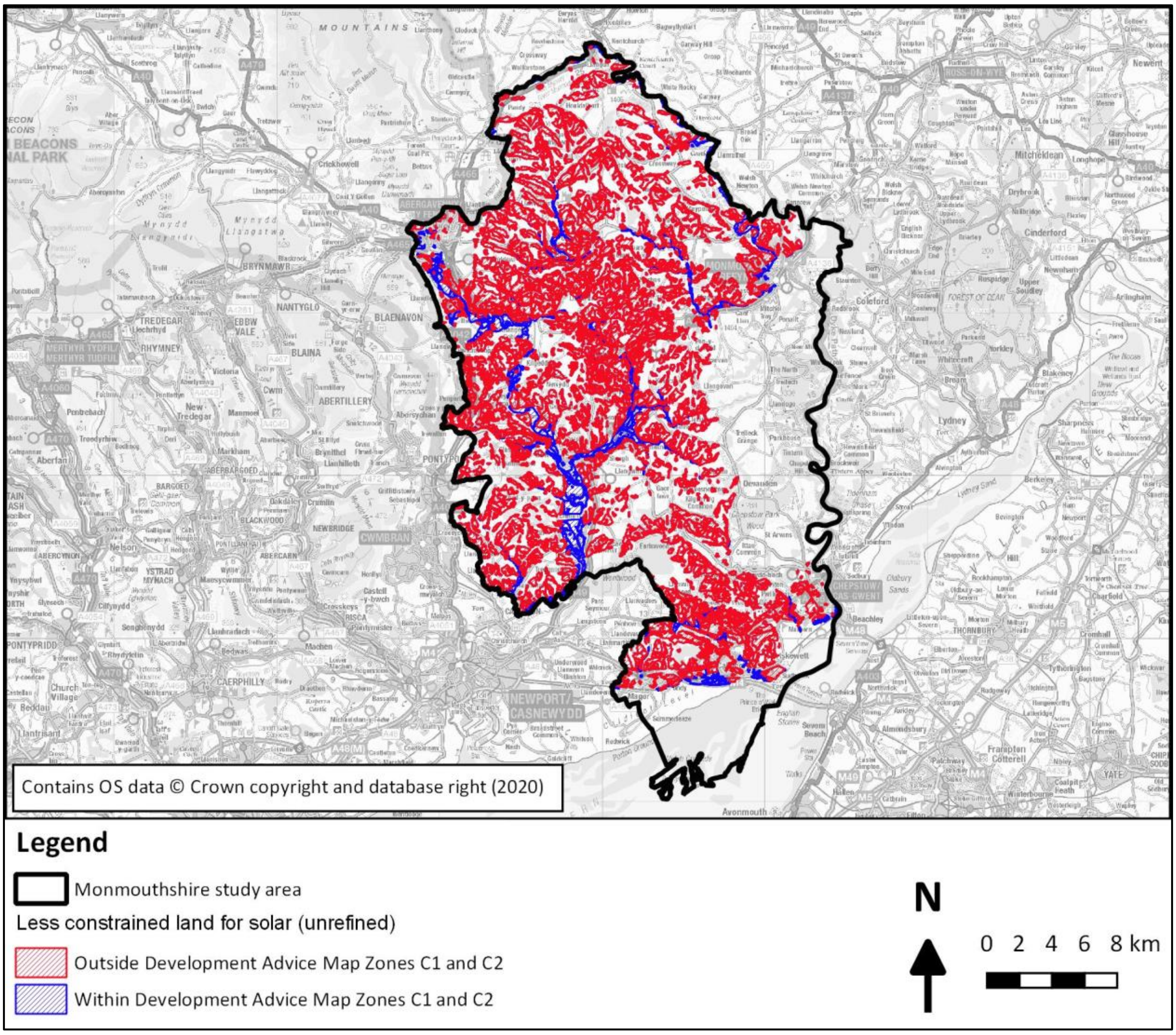


Figure 18: Unrefined areas of less constrained land for ground mounted solar PV following the initial constraints assessment with areas within Development Advice Map zones C1 and C2 identified

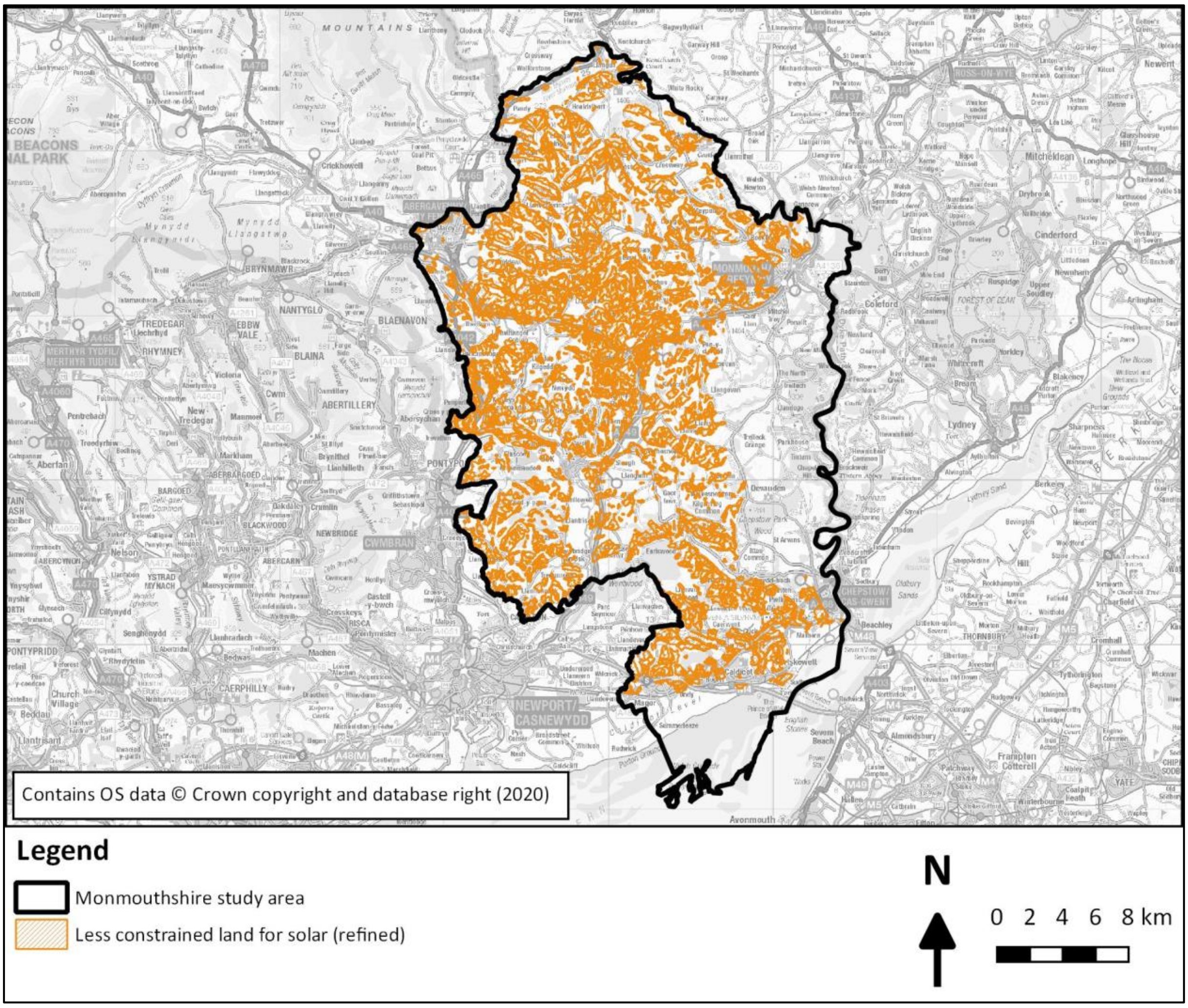


Figure 19: Areas of less constrained land for ground mounted solar PV following the high-level refinement exercise and excluding areas within Development Advice Map zones C1 and C2

4.3.13 84% of the less constrained land initially identified in GIS lies outside of the development advice zones. Whilst it is possible to develop solar farms on flood plains, these require site specific assessments to understand the potential risk to the project and to the surrounding land, and are anticipated to be more expensive to develop. Due to the potential constraints posed by flooding, and the large amount of land identified outside of the development advice zones, the less constrained areas outside of these zones are progressed to the aerial imagery refinement exercise. The refinement exercise results in a further reduction in the land identified of 3%.

4.3.14 The details provided in Section 4.2, regarding the overlap of land with areas identified as less constrained for wind, are repeated in Table 20 and Figure 20.

Table 20: Area overlap between less constrained wind and solar areas

Cluster (see Figure 14 for locations)	**Area (km^2)**	**Turbine no.**	**Turbine capacity (MW)**	**Potential wind generation (MWh p.a.)**	**Solar capacity (MW)**	**Potential solar generation (MWh p.a.)**
1	0.2	1	2	4,730	13.0	11,351
2	0.002	1	2	4,730	0.1	111
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	0.00004	1	2	4,730	0.002	2
6	0.04	1	2	4,730	2.4	2,124
7	0.0005	1	2	4,730	0.03	25
8	-	-	-	-	-	-
9	0.00009	1	2	4,730	0.01	5
10	0.002	1	2	4,730	0.1	83
11	0.007	1	2	4,730	0.4	328
12	0.0001	1	2	4,730	0.01	6
13	0.02	1	2	4,730	1.1	1,006
14	0.03	1	2	4,730	1.7	1,446
15	-	-	-	-	-	-
16	-	-	-	-	-	-
Total	**0.3**	**11**	**22**	**52,034**	**19**	**16,485**

(Data in table are rounded and may not appear exact)

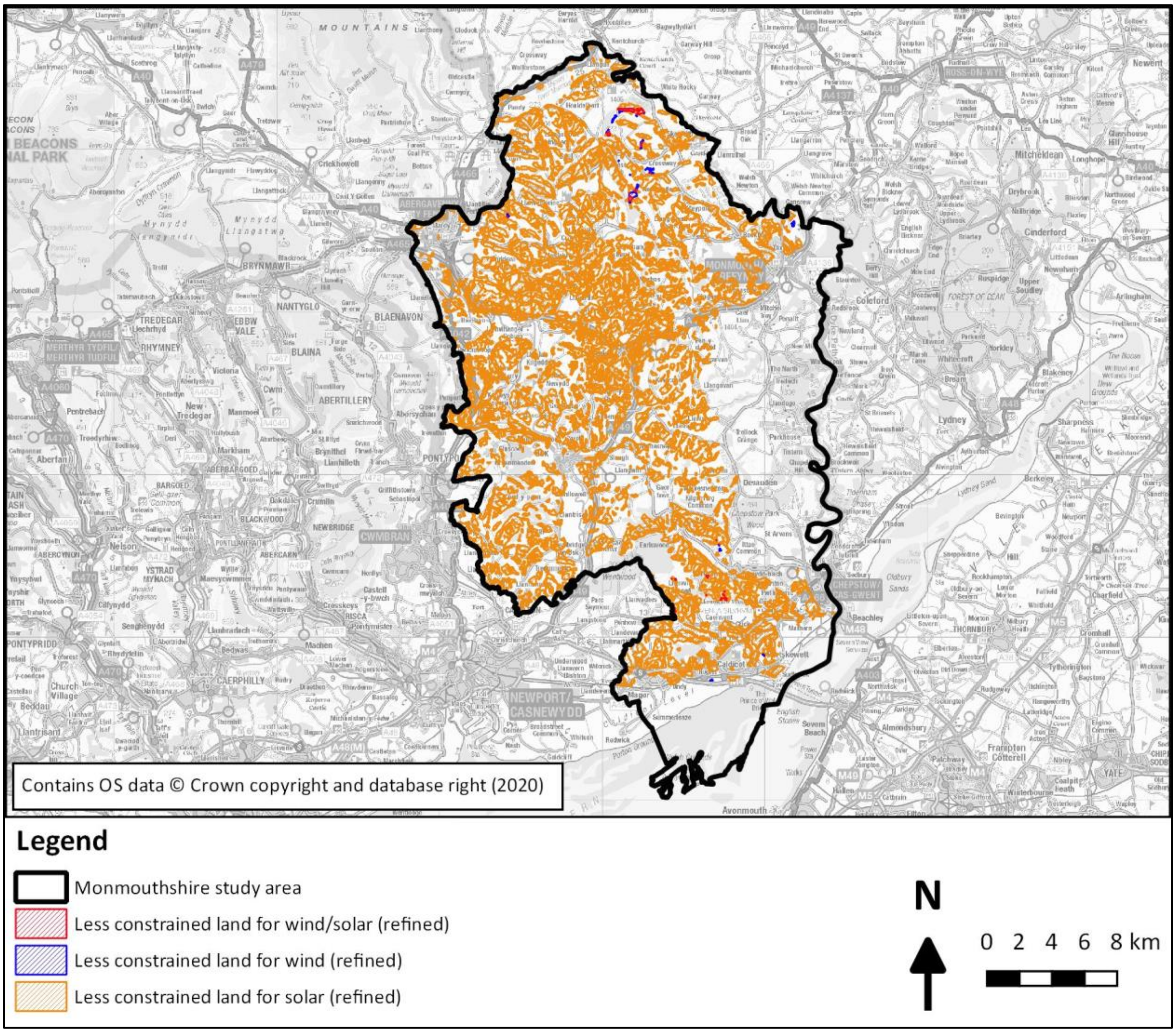


Figure 20: Refined less constrained land for wind alongside refined less constrained land for solar

4.3.15 Table 21 provides an estimation of the reduced potential for solar if the area overlap between less constrained wind and solar areas is utilised for wind rather than solar. It is suggested that this area is assumed to be used for wind rather than solar, due to the high solar resource identified and low wind resource identified.

Table 21: Solar capacity calculation accounting for wind/solar overlap

Capacity of refined less constrained areas based on 1.75 hectares per MW (MW)	8,297
Solar capacity of wind/solar less constrained land overlap (MW)	19
Reduced capacity of less constrained areas if the less constrained land overlap is used for wind (MW)	8,279
Potential solar energy generation if the less constrained land overlap is used for wind (MWh p.a.)	7,252,095

(Data in table are rounded and may not appear exact)

Conclusions

4.3.16 At a high-level, a very large proportion of land within the Monmouthshire study area is considered suitable for ground mounted solar PV development. The land is distributed throughout the study area excluding the large area of land covered by the Wye Valley Area of Outstanding Natural Beauty (AONB) in the east of the study area. The total estimated capacity is 8,297 MW, including existing developments (Table 19), this is reduced to 8,279 MW if the areas identified as also less constrained for wind developments are excluded. This equates to 7,252 GWh p.a. (Table 21) or almost three times the estimated current energy needs of the study area and over four times the lower estimated energy needs for 2033 (comparing results to those in Table 7). This is equivalent to the amount of electricity used to power over 2,417,000 typical homes for a year (it should be noted there are other users of electricity apart from residential properties such as industry, commercial, transport etc.).

4.3.17 It may be possible to design developments so that both technologies can be accommodated, therefore one development will not necessarily preclude another, although the total installed capacity is likely to be reduced.

4.3.18 In reality, it is unlikely that the full land area identified as less constrained for solar PV would be developed due to additional considerations including cumulative impact, landscape impact, allowance for hedgerows and woodland not included in the constraints assessment, grid capacity and competition with other land uses, including agricultural land, recreational land and further land developments. The interactions with additional constraints are considered further in Section 9.

4.3.19 The addendum to the previous Renewable Energy and Efficiency Study undertaken for Monmouthshire (Camco, 2012) identified a lower resource potential for ground mounted solar PV than is estimated in this assessment. The previous assessment assumed that only 1% of the less constrained land identified for solar PV could actually be used. The assessment acknowledged that this is a *"somewhat arbitrary figure, but reflects the fact that solar farms have to compete with other land uses and will require unshaded flat land or land inclined to the south"* (Camco, 2012, p. 14).

4.4 Biomass Energy Resource

Introduction

4.4.1 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.

4.4.2 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 produced from sustainable sources.

4.4.3 This assessment considers the potential contribution the study area could make to the national biomass fuel resource, 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)

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

Method

4.4.5 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 21 and Figure 22.

Sustainable forestry and woodland management

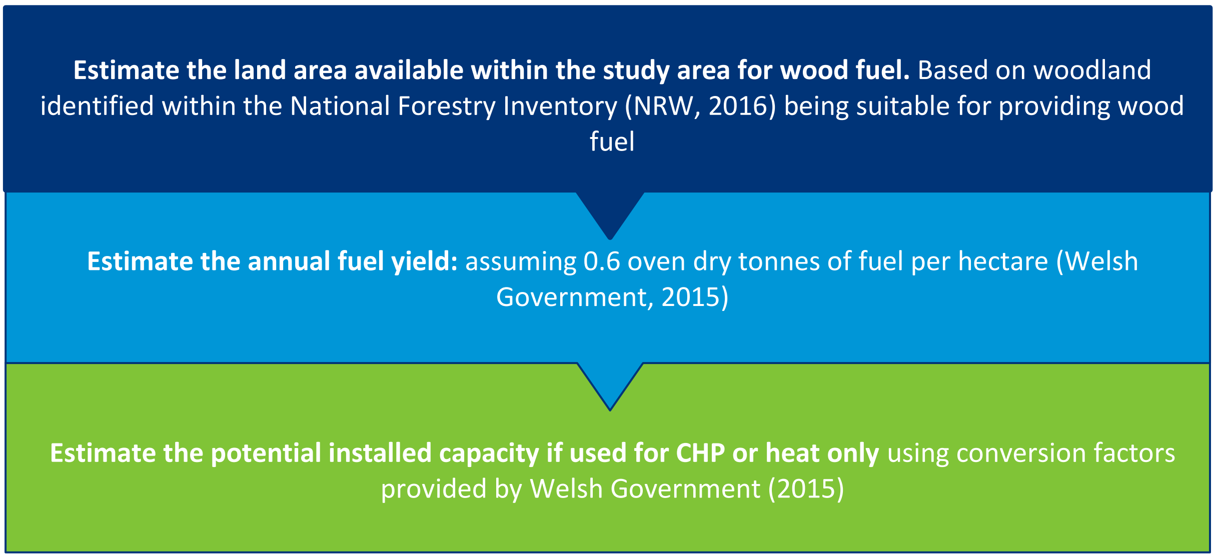


Figure 21: Method for estimating energy resource available from wood

Growing of "woody" energy crops

Establish theoretical maximum land area available for energy crops within the study area: Assuming agricultural land other than grade 5 is suitable and excluding SSSIs, woodland contained in the National Forestry Inventory and areas within 100m of scheduled monuments (due to their small footprint and to provide further protection).

Establish practical land area available for energy crops: On the basis that 10% of the 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: using 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 22: Method for estimating energy resource available from "woody" energy crops

Box 7: Note on land areas

The theoretical maximum land available for energy crops is estimated using a 2m by 2m resolution.

The total woodland and land areas available for energy crops is estimated by calculating the sum of all of the individual land areas identified. The individual land areas are calculated using GIS to the nearest square metre.

Results

4.4.6 The estimated energy resource from biomass is identified in Figure 23 and summarised in Table 22. The amount of resource available is based on the land area that is used for growing woody energy crops and the amount of national forestry which is sustainably managed. Figure 23 identifies all of the land that is theoretically suitable for growing woody energy crops. As per the method, only 10% of this land is considered to be used for energy crops due to land use competition and other factors. Figure 23 also identifies all of the woodland contained in the National Forestry Inventory (NRW, 2016). These land areas are provided in Table 22, and used to estimate the biomass resource in tonnes of fuel. Table 22 then provides estimates of the energy generated from the biomass fuel if it is used to generate:

- heat only (in boilers) or
- both heat and electricity (using combined heat and power plants).

Depending on the level of resource available a combination of these energy uses may be implemented.

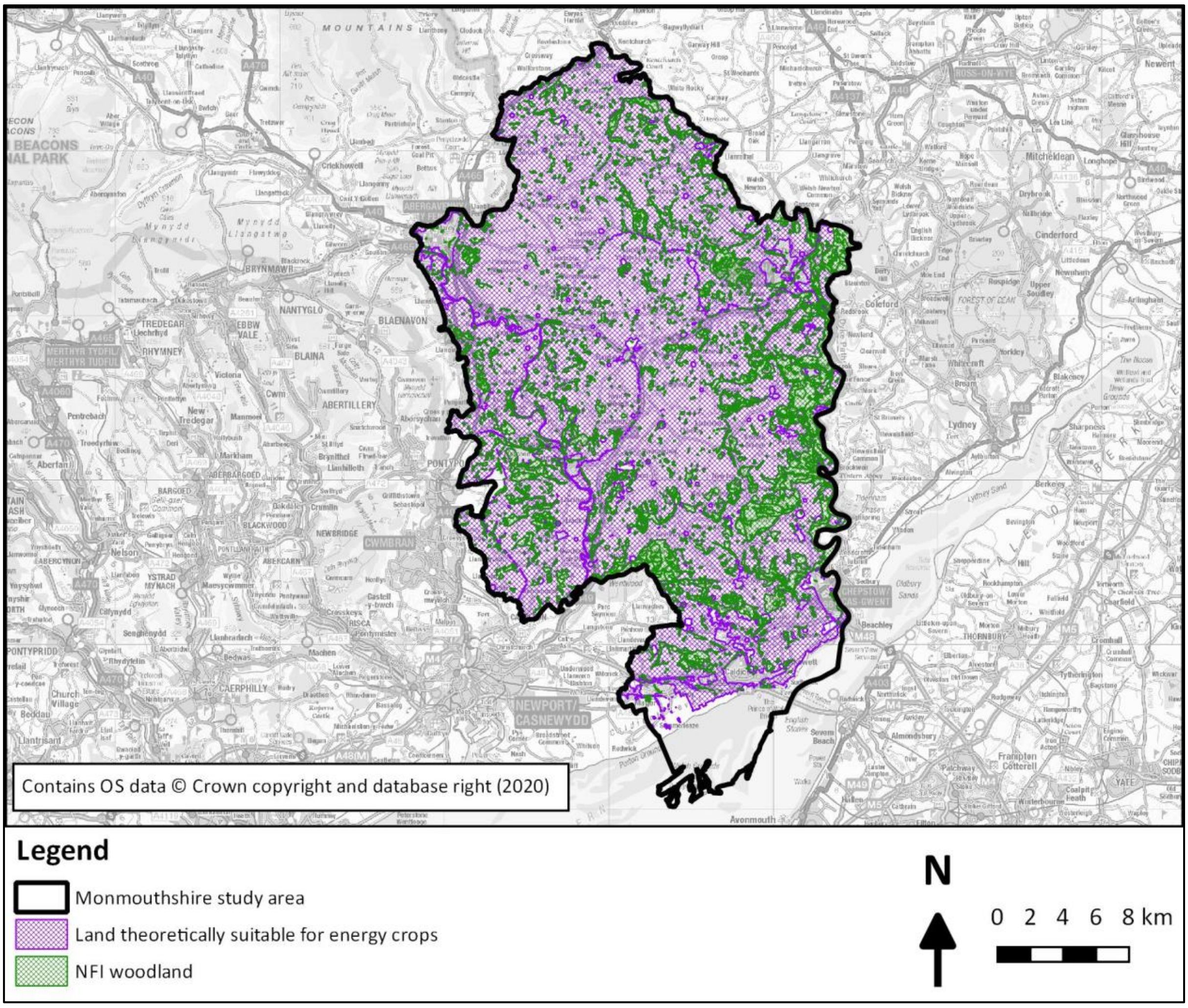


Figure 23: Woodland within the National Forestry Inventory and land theoretically suitable for growing energy crops within the study area

Table 22: Summary of potential biomass energy resource available within the Monmouthshire study area

Resource type		Sustainable forestry and woodland management	Woody energy crops	Total
Theoretical suitable land available for energy crops (calculated in GIS using ellipsoidal geometry)			54,018 hectares	
Practical land area available		11,217 hectares	5,402 hectares	16,619 hectares
Oven dry tonnes per hectare (Welsh Government, 2015)		0.6	12	n.a.
Amount of energy crops (oven dry tonnes per annum)		6,730	64,822	71,553
Heat only energy generation	**Required oven dry tonne per 1MW$_{th}$**	660	660	660
	Boiler capacity (MW$_{th}$)	10.2	98.2	108.4
	Capacity factor (Welsh Government, 2015, p.154)	30%	30%	n.a.
	Estimated annual useful heat yield* (MWh$_{th}$)	26,799	258,110	284,909
Combined Heat and Power (CHP) energy generation	**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 (MW$_{e}$)	1.1	10.8	11.9
	CHP thermal capacity (MW$_{th}$)	2.2	21.6	23.9
	Electrical capacity factor (Welsh Government, 2015)	90%	90%	n.a.
	Thermal capacity factor (Welsh Government, 2015)	50%	50%	n.a.
	Estimated annual electricity yield (MWh$_{e}$)	8,844	85,176	94,020
	Estimated annual useful heat yield (MWh$_{th}$)*	9,826	94,640	104,467

(Data in table are rounded and may not appear exact)

The estimated annual **useful heat yield assumes that not all of the heat generated is able to be used (or is "useful"), and therefore assumes that additional heat is generated but is wasted (Welsh Government, 2015).*

4.4.7 The area of land estimated to be available for energy crops has decreased from 57,910 hectares in the previous Renewable Energy Assessment (Camco, 2012) to 54,018 hectares in this assessment, while the area of land available for sustainable forestry has decreased from 13,751 hectares to 11,217 hectares. This has resulted in a lower overall estimate of resource availability in the current assessment. The previous Renewable Energy Assessment (Camco, 2012) only considered sustainable forestry as a heat only option, it is included as an option for CHP in the current assessment as per the advice in the Toolkit (Welsh Government, 2015). The reductions in land available may be due to differing underlying assumptions or changes in land use since the previous assessment in 2012. This assessment used the National Forestry Inventory (NRW, 2016), to inform the extent of woodland available for biomass (areas classified as non-woodland are excluded from the overall area). Additional smaller pieces of woodland are present within the study area which are not part of the NFI dataset which could provide additional resource.

4.4.8 The CHP calculations provided in Table 22 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_e which is comparable to the capacity that would be generated from all of the biomass resource within the study area. If additional biomass is collected from the areas of Monmouthshire that are located within the National Park, a larger capacity of biomass plant could theoretically be developed. In order to maximise the benefits of utilising the biomass with a large CHP plant, use of the heat generated should be maximised, by connecting it to a large heat load or district heat network. Section 7 concludes that there is limited opportunity for heat networks within the study area. Section 3 identifies 18 MW_e of existing biomass power generation and 18 MW_{th} of existing biomass heat (only) generation within the study area, the resource identified could be utilised as a fuel within these plants, and other smaller scale biomass boilers dispersed throughout the study area.

4.4.9 If it is exploited to its full capacity, the total thermal capacity of the resource calculated is 108 MW_{th} and with approximately 285 GWh_{th} p.a. heat energy generated, which is approximately eight times the total heat demand of the anchor heat loads identified in Section 7 and provided in Figure 24. Based on the average typical domestic consumption of gas (Ofgem, 2020) and using a gas boiler efficiency of 80%, the biomass energy resource in the study area equates to the needs of approximately 28,900 homes.

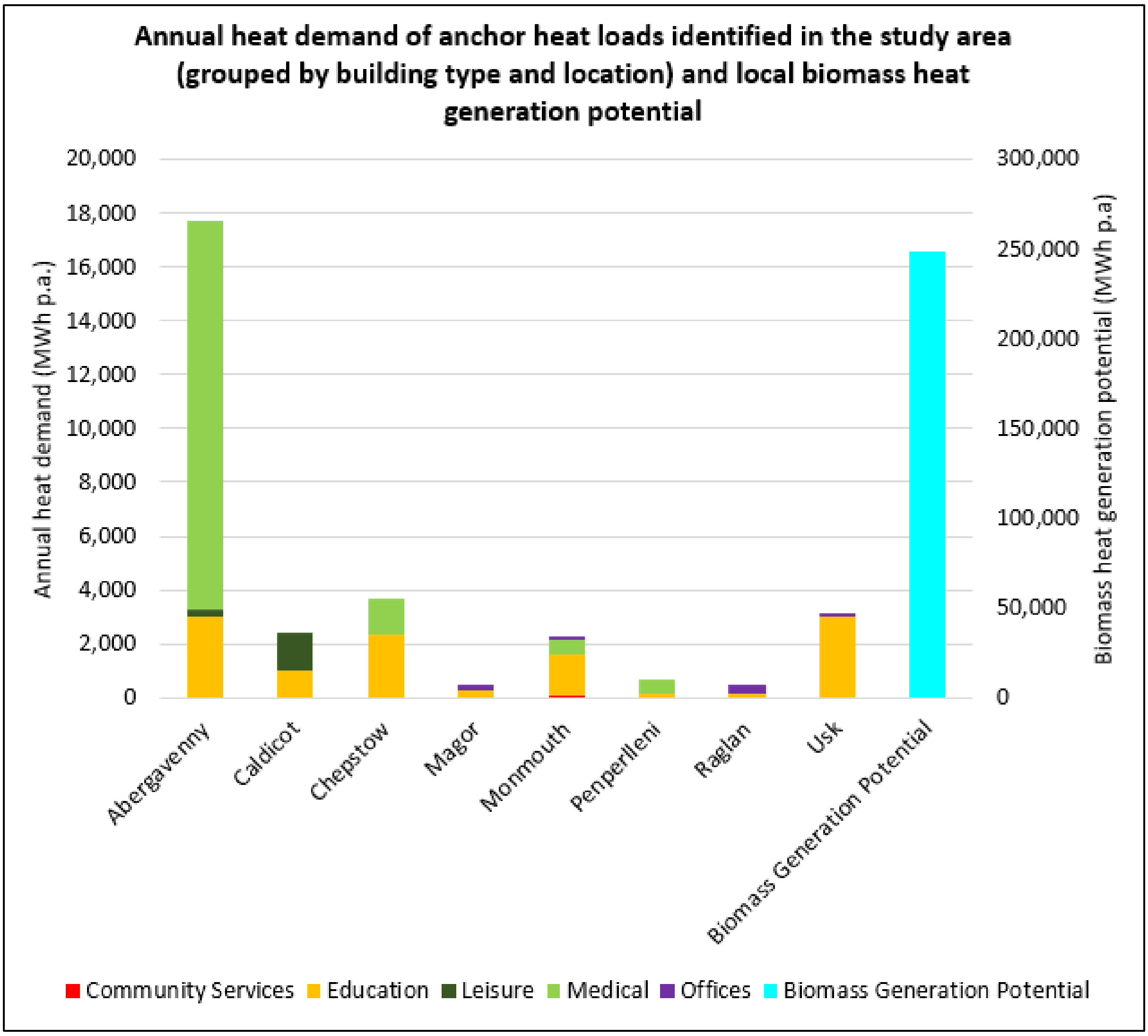


Figure 24: Comparison of biomass heating resource available and anchor heat loads identified in Section 7

4.4.10 An issue to be considered when contemplating 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. As such, it would be advisable to encourage uptake of biomass heating in areas of lower density housing and in the more rural areas of Monmouthshire, with heat networks and heat pumps targeted in the higher density urban areas.

4.4.11 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 the Monmouthshire study area of 102 GWh per annum; a 9% increase to the CHP electricity yield value calculated in Table 22.

Conclusions

4.4.12 The assessment has indicated that the Monmouthshire study area has sufficient biomass resource to enable a large conventional (steam turbine) CHP plant to be developed and fuelled from local resources. The baseline assessment in Section 3 identified 18 MW_e of biomass power and 18 MW_{th} of biomass heat (only) generators already operational within the study area. It is not known where these existing plants source their fuel, but the identified resource could be used to ensure plants have as low a carbon footprint as possible. The resource could also be utilised within smaller commercial and domestic biomass boilers, especially in homes and buildings, and for industrial uses where heat generated from heat pumps may not be considered suitable.

4.4.13 Unlike wind and solar farms, accessing biomass fuel through growing woody energy crops and managing local woodlands does not require planning consent. Deployment of larger scale biomass boilers or combined heat and power plants would require planning consent. To encourage use of locally grown fuel, MCC could adopt a supportive stance towards infrastructure required for wood fuel processing plants.

4.4.14 Slightly lower land areas and associated resource potential are identified in this assessment in comparison to the previous Renewable Energy and Energy Efficiency Study (Camco, 2012). However, the current assessment considers use of the fuel from both woody energy crops and sustainable forestry and woodland management in both combined heat and power plants and boilers, whereas the previous study only considered energy crops for CHP use and woodland for heat only use.

4.5 Energy from Waste and Anaerobic Digestion

4.5.1 Welsh Government (2010) has set targets to achieve 70% waste recycling by 2025 and to reduce the impact of waste in Wales to within Wales' 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 (2019f) 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 25). Energy recovery from waste should be preferred over landfill but only where measures to prevent, reuse or recycle waste are not applicable.

4.5.2 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.

4.5.3 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).

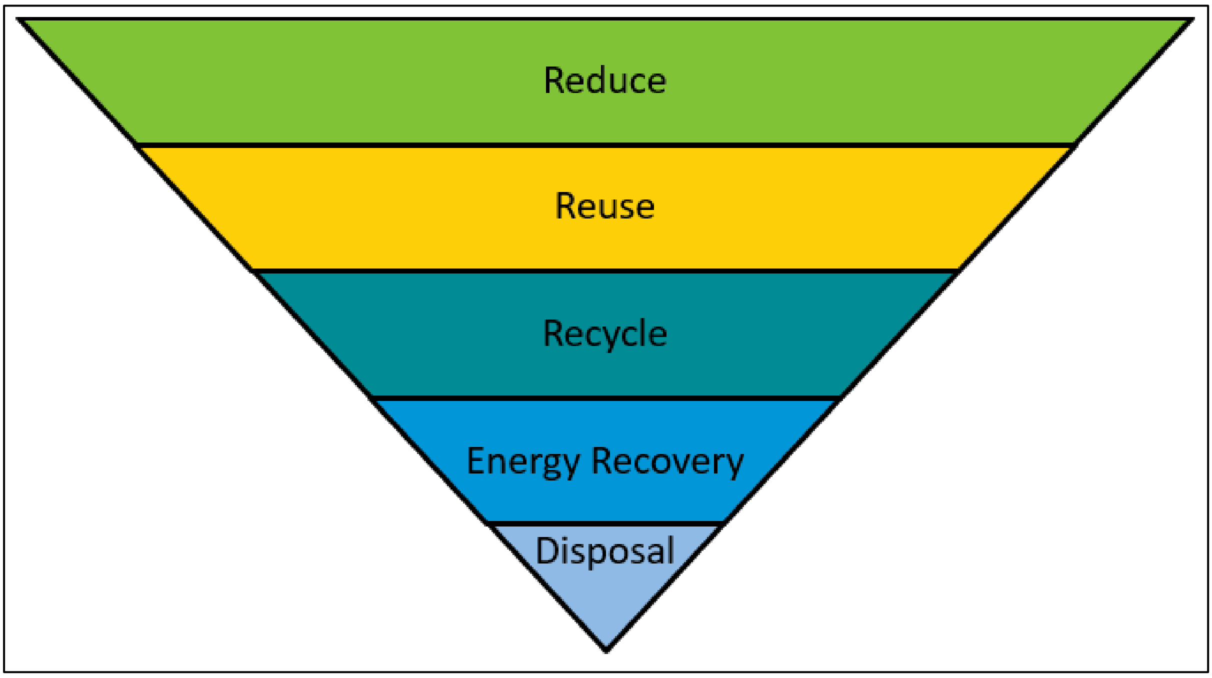


Figure 25: Waste hierarchy

Method

4.5.4 The methods used to determine the energy available from municipal solid waste and commercial and industrial waste and organic waste within the study area are summarised in Figure 26 and Figure 27. With the energy estimates from municipal and commercial & industrial waste based on direct combustion and organic waste based on anaerobic digestion (AD).

4.5.5 Whilst the study area for this assessment is focussed on the area of Monmouthshire outside of the National Park, waste collected within the whole county area is included within the assessment of resource potential from municipal and solid waste, food waste and sewage waste. This is because it is considered unlikely that an energy from waste plant, food waste AD plant, or sewage plant would be constructed within the National Park, as these tend to be large-scale in nature, and there is a *"general national presumption against the provision of large-scale renewable energy projects within the Park"* (Brecon Beacons National Park Authority, 2013, p.43). It is considered that there may be potential for small on-farm anaerobic digestion plants to be located within the National Park. As such, the energy generation potential from animal manures is estimated for both the county area as a whole and the study area. The estimate of potential within the study area is based on reducing the overall county potential by the land area that is located within the National Park (~17%).

4.5.6 Welsh Government (2016a) provide details of the quantity of organic waste collected in Monmouthshire in the year 2014-15 separated into "Green Garden Waste Only" and "Mixed Garden and Food Waste". The assessment assumes that 50% of the "Mixed Garden and Food Waste" tonnage is food waste and is suitable for processing via AD, and applies an annual reduction rate of 1.5% to estimate the 2033 annual tonnage of food waste collected, in line with Welsh Government targets (Welsh Government, 2015). 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.

4.5.7 The Toolkit (Welsh Government, 2015) provides a calculation method for estimating the energy potential from biogas produced via AD if it is used to generate heat in a boiler with an 80% efficiency (see Box 8) 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.

Box 8: Notes on heat only energy use calculation for organic waste sources

The Toolkit (Welsh Government, 2015) only provides 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 are calculated from the CHP energy output calculations assuming 30% electrical efficiency and 80% biomass boiler heat efficiency (Welsh Government, 2015, p.167).

4.5.8 Details regarding the current waste management processes for residual waste and food waste are provided in Appendix 2.

Municipal solid waste and commercial & industrial waste

Establish the current (2018-19) and 2033-34 projected Municipal Solid Waste and Commercial & Industrial waste management processes and amounts within the county from data provided by Welsh Government (2019a), and assuming a tonnage reduction of 1.5% p.a. (Welsh Government, 2015)

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 proportion of thermal and electrical renewable energy generation, based on 35% of the resource as suggested by the Toolkit (Welsh Government, 2015)

Figure 26: Method for estimating energy resource from Municipal Solid Waste and Commercial and Industrial Waste

Organic waste

Establish the most up-to-date (2014-15) and 2033-34 projected Food Waste processes and amounts within the county from data provided by Welsh Government (2016a), and assuming a tonnage reduction of 1.5% p.a. (Welsh Government, 2015)

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

Establish the quantity of livestock manure available within the county from Welsh Government (2019h) data on livestock numbers and conversion factors (Welsh Government, 2015) and estimate the resource potential within the county and study area

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

Figure 27: Method for estimating the potential energy generation from organic waste

Box 9: Note on current and projected waste quantities

The most up-to-date total municipal waste tonnage details are for the year 2018-2019, and include commercial and industrial waste collected (Welsh Government, 2019a). The most up-to-date food waste tonnage details are for the year 2014-15 (Welsh Government, 2016a). A 1.5% annual reduction in annual waste tonnages is assumed to the end of the RLDP period for both waste streams, in line with Welsh Government targets. 70% of the total waste collected is assumed to be recycled with the remainder available for energy from waste via incineration (Welsh Government, 2015).

Organic farm waste is estimated from livestock numbers. The most up-to-date details on livestock numbers are for 2017 (Welsh Government, 2019h). The calculations are based on livestock numbers remaining constant until the end of the RLDP period.

Welsh Water (2020) provided details of the average annual sewage sludge (tonnes of dry solids per annum) collected at Welsh Water's sites in the county area between 2015 and 2019. The calculations are based on sewage sludge amounts remaining constant at this annual average until the end of the RLDP period.

Results

Municipal solid waste and commercial and industrial waste

4.5.9 Table 23 provides the estimation of the renewable energy generation potential from total municipal waste generated/collected (including commercial and industrial) waste collected in the county, as per the method. Table 23 provides estimates of the energy generated from the waste fuel if it is used to generate:

- heat only (in boilers) or
- both heat and electricity (using combined heat and power plants).

4.5.10 Energy from waste plants tend to be large centralised generators therefore only one of the energy uses outlined above would be likely to be used for the waste. Waste is not considered a renewable resource. The Toolkit (Welsh Government, 2015) considers the biodegradable component of the waste to be renewable and estimates that this is equal to 35% of the resource. The renewable component of the resource is calculated on this basis in Table 23.

Table 23: Estimated energy resource from residual, bulky and commercial & industrial waste

Waste		Total Municipal Waste Collected/Generated
Total waste quantity 2018-19 (tonnes p.a.)		47,781
Anticipated waste quantity in 2035 (tonnes p.a.)		38,089
Assumed proportion of waste that is available for energy recovery (Welsh Government, 2015)		30%
Anticipated waste quantity available for energy recovery in 2035 (tonnes p.a.)		11,427
Heat only energy generation	**Quantity of waste (tonnes) required per 1 MW_{th} (Welsh Government, 2015)**	1,790
	Boiler capacity (MW_{th})	6.4
	Capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (MWh_{th})	27,960
	Biodegradable (renewable) proportion (Welsh Government, 2015)	35%
	Estimated renewable heating capacity (MW_{th})	2.2
	Estimated annual renewable heat yield (MWh_{th})	9,786
CHP energy generation	**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 (MW_e)	1.1
	CHP thermal capacity (MW_{th})	2.2
	Electrical capacity factor (Welsh Government, 2015)	90%
	Thermal capacity factor (Welsh Government, 2015)	50%
	Estimated annual electricity yield (MWh_e)	8,729
	Estimated annual useful heat yield (MWh_{th})*	9,699
	Biodegradable (renewable) proportion (Welsh Government, 2015)	35%
	Estimated renewable CHP electrical capacity (MW_e)	0.4
	Estimated renewable CHP thermal capacity (MW_{th})	0.8
	Estimated annual renewable electricity yield (MWh_e)	3,055
	Estimated annual renewable heat yield (MWh_{th})	3,395

(Data in table are rounded and may not appear exact)

The estimated annual **useful heat yield assumes that not all of the heat that is generated is able to be used (or is "useful"), and therefore assumes that additional heat is generated but is wasted (Welsh Government, 2015).*

4.5.11 The energy yield potential from waste collected within the county area 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 30 times larger than the capacity calculated in Table 23. This plant processes approximately 350,000 tonnes of waste from Torfaen, Newport, Monmouthshire, Cardiff, Vale of Glamorgan and Caerphilly (Viridor, no date).

4.5.12 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 the financial viability for processing smaller waste quantities.

4.5.13 Monmouthshire County Council's (MCC's) current waste management contract for residual waste is in place until 2041. As such, there may be little scope for MCC to amend the current waste destination within the RLDP 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

4.5.14 Estimates of the organic waste generated in the county that could be processed using AD to produce energy are separated into individual waste streams in Table 24, Table 25, Table 26 and Table 27, as per the method. Tables 24-27 provide estimates of the energy generated from the organic waste streams if it is used to generate:

- heat only (in boilers) or
- both heat and electricity (using combined heat and power plants), or
- biomethane (which can be used as an alternative to natural gas)

Depending on the level of resource available a combination of these energy uses may be implemented.

Table 24: Energy generation potential from cattle and pig manure

Whole Monmouthshire County Area	**Number of cattle**		52,387
	Annual tonnes of manure generated per head of cattle (based on cattle being housed for 6 months of the year)		6
	Estimate of cattle manure available for anaerobic digestion (wet tonnes p.a.)		314,322
	Number of pigs		3,301
	Annual tonnes of manure generated per pig (based on pigs being housed for 6 months of the year)		0.6
	Estimate of pig manure available for anaerobic digestion (wet tonnes p.a.)		1,981
	Total manure available		316,303
	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		79,076
	Heat only energy generation	**Tonnes of manure required per 1MW_{th} (Welsh Government, 2015)**	47,000
		Boiler capacity (MW_{th})	1.7
		Capacity factor (Welsh Government, 2015)	50%
		Estimated annual useful heat yield (MWh_{th})	7,369
	CHP energy generation	**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 (MW_e)	0.4
		CHP thermal capacity (MW_{th})	0.5
		Electrical capacity factor (Welsh Government, 2015)	90%
		Thermal capacity factor (Welsh Government, 2015)	50%
		Estimated annual electricity yield (MWh_e)	2,771
		Estimated annual useful heat yield (MWh_{th})	2,309
	Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh)**	9,027
Monmouthshire Study Area (Land outside of the National Park)	**Heat only energy generation**	**Boiler capacity (MW_{th})**	1.4
		Estimated annual useful heat yield (MWh_{th})	6,128
	CHP energy generation	**CHP electricity capacity (MW_e)**	0.3
		CHP thermal capacity (MW_{th})	0.4
		Estimated annual electricity yield (MWh_e)	2,304
		Estimated annual useful heat yield (MWh_{th})	1,920
	Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh)**	7,507

(Data in table are rounded and may not appear exact)

4.5.15 Whilst the electrical/heating capacity provided in Table 24 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 plants listed on The Official Information Portal on Anaerobic Digestion (2020) 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 treating the waste, and providing a fertiliser, which can displace the need for chemical fertilisers resulting in further carbon emissions saving.

Table 25: Estimated energy generation potential from poultry litter

Whole Monmouthshire County Area	**Number of birds**		1,303,387
	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.)		41,057
	Heat only energy generation	**Boiler capacity (MW_{th})**	17.9
		Capacity factor	50%
		Estimated annual useful heat yield (MWh_{th})	78,471
	CHP energy generation	**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 (MW_e)	3.7
		CHP thermal capacity of poultry litter resource (MW_{th})	5.6
		Electrical capacity factor	90%
		Thermal capacity factor	50%
		CHP electrical generation per annum from poultry litter (MWh p.a.)	29,426
		CHP thermal generation per annum from poultry litter (MWh p.a.)	24,522
	Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh)**	96,126
Monmouthshire Study Area (Land outside of the National Park)	**Heat only energy generation**	**Boiler capacity (MW_{th})**	14.9
		Estimated annual useful heat yield (MWh_{th})	65,252
	CHP energy generation	**CHP electricity capacity (MW_e)**	3.1
		CHP thermal capacity (MW_{th})	4.7
		Estimated annual electricity yield (MWh_e)	24,469
		Estimated annual useful heat yield (MWh_{th})	20,391
	Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh)**	79,934

(Data in table are rounded and may not appear exact)

4.5.16 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 (2020) 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.

Table 26: Estimated energy generation potential from food waste

Waste		Food and garden waste
Food waste and garden waste quantity in 2014-15 (tonnes p.a.)		7,881
Anticipated food waste and garden waste quantity in 2033 (tonnes p.a.)		5,914
Estimated food waste quantity in 2033 (tonnes p.a.)		2,957
Heat only energy generation	**Boiler capacity (MW_{th})**	1.4
	Capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (MWh_{th})	6,217
CHP energy generation	**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 (MW_e)	0.3
	CHP thermal capacity of available food waste (MW_{th})	0.4
	Electrical capacity factor (Welsh Government, 2015)	90%
	Thermal capacity factor (Welsh Government, 2015)	50%
	CHP electrical generation per annum from available food waste (MWh_e)	2,331
	CHP thermal generation per annum from available food waste (MWh_{th})	1,943
Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh)**	7,615

(Data in table are rounded and may not appear exact)

4.5.17 Food waste collected in Monmouthshire is currently processed at the Severn Trent AD plant located at Stormy Down in Bridgend county borough. The AD plant at Stormy Down processes approximately 50,000 tonnes of food waste per year and has a capacity of 3 MW_e (Agrivert, 2020). 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) is investigating the possibility of upgrading the biogas to biomethane and injecting this into the gas network. The food waste contract with Severn Trent is in place until 2033 (with the option to extend for another five years), as such it is unlikely that the waste destination will change until the end of the plan period and, therefore, unlikely that there would be sufficient food waste feedstock for a food waste AD plant to be proposed for planning within the RLDP period.

Table 27: Estimated energy generation potential from sewage

Sewage sludge collected at Welsh Water's sites in Monmouthshire county (tonnes of dry solids per annum)		183
Heat only energy generation	**Boiler capacity (MW_{th})**	0.07
	Capacity factor (Welsh Government, 2015)	50%
	Estimated annual useful heat yield (MWh_{th})	296
CHP energy generation	**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)**	13,000
	CHP electrical capacity of sewage sludge in 2033 (MW_e)	0.01
	CHP thermal capacity of sewage sludge in 2033 (MW_{th})	0.02
	Electrical capacity factor (Welsh Government, 2015)	90%
	Thermal capacity factor (Welsh Government, 2015)	50%
	CHP electrical generation per annum from sewage sludge in 2033 (MWh_e)	111
	CHP thermal generation per annum from sewage sludge in 2033 (MWh_{th})	92
Energy used as biomethane	**Estimated annual energy content of biomethane, before end use (MWh p.a.)**	363

(Data in table are rounded and may not appear exact)

4.5.18 Welsh Water has confirmed that sewage sludge is transported outside of the county 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 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).

4.5.19 Whilst the sewage sludge is used to generate renewable energy, the Toolkit (Welsh Government, 2015, p.164) advises that energy generated from waste at a facility outside of the authority's area should not count as contributing to their renewable energy targets (the area where the energy is generated should claim the generation towards targets), and, therefore, energy potential from this source is not considered further in this assessment.

Conclusions

4.5.20 Due to the capacity of existing plants in South Wales, and the scale of waste collected in Monmouthshire, it is considered unlikely that a traditional energy from waste plant would be developed in Monmouthshire within the RLDP 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. The current residual waste management contract extends beyond the end of the development plan period, providing limited opportunities to consider the deployment of a local advanced conversion technology generator within the study area during the RLDP period.

4.5.21 The current food waste management contract is due to end in 2033, providing a small opportunity for consideration of smaller more localised food waste AD plant to be developed within Monmouthshire during the plan period to start accepting waste at the end of the plan period.

4.5.22 The previous Renewable Energy and Energy Efficiency Study (Camco, 2012) identified a much greater level of commercial and industrial waste in Monmouthshire than the current assessment; both in terms of residual commercial and industrial waste and food commercial and industrial waste. The current assessment only used data on the municipal collected commercial and industrial waste (alongside other municipal collected waste). The previous assessment indicates that there may be more waste resource available in the local area, which could increase the potential for energy from waste and food waste AD plants to be developed, however these would rely on waste contracts outside of those held by the local authority.

4.5.23 The resource potential in the previous assessment (Camco, 2012) estimated similar energy generation potential from farm waste associated with pigs and cattle but a lower resource potential from poultry.

4.5.24 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.

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

4.6 Hydropower Energy Resource

Introduction

4.6.1 Hydropower refers to the generation of power from running water. It is one of the oldest exploited sources for generation of electricity. Hydro schemes benefit from being more predictable in comparison with some other renewable sources of energy.

4.6.2 The baseline energy assessment identifies approximately 234 kW of existing hydro-electric projects installed within the whole of Monmouthshire county area (including the National Park) consisting of 11 installations, with 150 kW of this capacity associated with the hydro-electricity scheme at Osbaston Weir in Monmouth.

4.6.3 MCC has provided feasibility studies for two potential hydropower projects on the Cwm Llanwenarth (TGV Hydro, 2012a, 2012b):

- 28 kW project on the Cwm Llanwenarth, south-east of Govilon (intake: SO 25582 12910 / turbine: SO 26042 13451)
- 14 kW project on the Cwm Llanwenarth, north of Keepers Pond (intake SO 25471 21140 / turbine: SO 25320 11774)

4.6.4 Both projects are located outside of the study area within the National Park and therefore are not considered further.

Method

4.6.5 The Toolkit states *"there is currently no fully satisfactory way for local authorities to assess the potential hydropower resource in their areas"* (Welsh Government, 2015, p.55). The method used in this assessment is summarised in Figure 28.

4.6.6 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 in 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, 2020).

Figure 28: Method for estimating energy resource from hydropower

Results

4.6.7 The results of the assessment are provided in Table 28. Three of the consented hydropower stations within Monmouthshire county area are identified within the study area. A review of the Environment Agency (2015) river obstruction data indicates that only the Osbaston Weir consented hydropower development is located at the site of an existing barrier contained within the Environment Agency (2015) dataset. A review of the planning documentation for the other sites reveals that they are also located at existing barriers (although not identified within the Environment Agency (2015) data:

- Traligael is located at a 200-year-old mill house and the works were associated with an existing weir. From the details provided the turbine is estimated to be 7.5 kW.
- The site at Furnace Cottages proposed to take water from the Beaufort Pond Dam in the Angiddy Valley. The proposal expected to generate just 192 kWh p.a. so is estimated to have a generation capacity of 0.06 kW.

4.6.8 Figure 29 locates:

- The Environment Agency (2015) "win-win" opportunities
- The existing installations
- The additional sites identified in the feasibility studies provided by MCC (TGV Hydro, 2012a, 2012b)

4.6.9 NRW has previously been consulted by Carbon Trust (in 2019) regarding the potential for further hydropower developments in Wales. NRW 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.

4.6.10 NRW has 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. With the increased importance of energy storage this may become an emerging technology during the RLDP period.

Table 28: Hydropower potential and existing generation assets within Monmouthshire county

Number of barriers / opportunities identified (Environment Agency, 2015), additional proposals / existing plants	51
Total power potential	1.7 MW
Number of opportunities identified as "win-win", identified in Figure 29	14
Power potential of "win-win" opportunities (includes Osbaston Weir)	1.3 MW
Operational hydropower stations	0.158 MW (Osbaston Weir is registered as 0.15 MW on the RO register, but the Environment Agency (2015) dataset suggested a power of 0.195 MW)
Additional opportunities identified greater than 10 kW	0 MW
Power potential of "win-win" opportunities, additional opportunities identified greater than 10 kW and operational hydropower stations	1.3 MW
Estimated annual energy generation	4,150 MWh p.a.

(Data in table are rounded and may not appear exact)

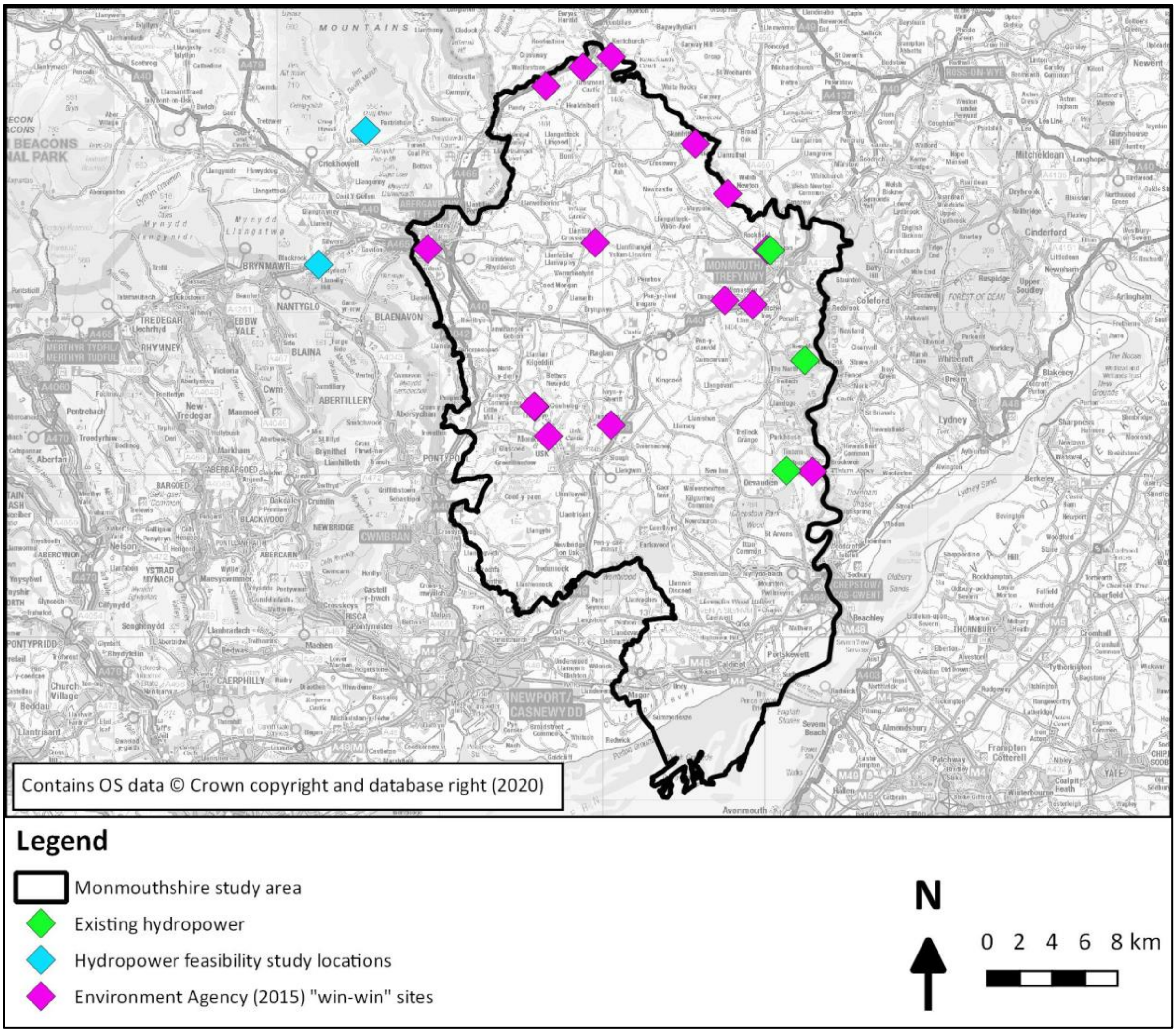


Figure 29: Identified hydropower resource within the study area

Conclusions

4.6.11 Whilst the scale of hydropower resource within Monmouthshire is relatively small, the Environment Agency (2015) data suggests there is some potential for hydropower proposals to emerge during the RLDP period.

4.6.12 The results identify a similar overall resource as was identified in the previous Renewable Energy and Energy Efficiency Study (Camco and CDN, 2010).

4.6.13 It is recommended NRW's advice is incorporated into any planning policy or guidance. NRW has specifically identified that barrier removal in lower catchment rivers and streams may be preferable to hydropower installations, and, therefore, it may be more advantageous to exploit hydropower resource in more upper catchment areas. It is recommended that further advice is sought from NRW when drafting the wording of any planning policies relating to hydropower developments.

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

5. Building Integrated Renewables (roof-top solar PV and heat pumps)

5.1 Introduction

5.1.1 Building integrated renewables (BIR) are often, but not always, “microgeneration”. Microgeneration capacity is defined as electricity generating capacity of 50kW or less, and heat generating capacity of 45kW or less (Energy Act, 2004).

5.1.2 Building integrated renewables, refers to any renewable generation asset which provides energy directly to a building. A large industrial building may have a large wind turbine integrated with it via a private wire. Building integrated renewables developments are sized in relation to the energy demand and infrastructure associated with the building as well as the area available for the renewable energy generation asset.

5.1.3 National Grid ESO (2019b) identified 5% of the UK’s 2018 generation capacity as microgeneration.

5.1.4 The Toolkit (Welsh Government, 2015) identifies the following technologies as being categorised as building integrated renewables:

- Solar photovoltaic (PV) panels (excluding solar PV farms that are land mounted and covering an area >3 acres (or 0.5MW) and providing <10% of a buildings’ electricity demand via a private electricity wire)
- Solar hot water panels
- Micro building-mounted wind turbines
- Small free standing, normally single wind turbines
- Micro scale biomass heating (i.e. wood chip or pellet boilers or stoves)
- Ground and air source heat pumps (ASHPs)

5.1.5 Due to the site-specific nature, low market share, historically low uptake and potential to compete for space with other more relevant technologies, the scope of this assessment is limited to:

- Roof-mounted solar PV
- Heat pumps

5.1.6 Section 3 identifies 13.58 MW of roof-top solar PV and 3.5 MW of heat pumps, generating 11,894 MWh of electricity and 4,103 MWh of net thermal benefit (i.e. heat energy generated minus the electricity demand associated with the heat pumps), already operational within the study area (Table 9).

5.1.7 Future uptake of low or zero carbon (LZC) technologies in new buildings is likely to be influenced by building regulations and planning requirements. Uptake in existing buildings is at the discretion of the building owner, which may be more related to financial viability and the desirability of LZC technologies to owners and occupiers of residential and non-residential properties.

5.1.8 The simplified method provided within the Toolkit (Welsh Government, 2015) is based on a future date of 2020. Given that the target study date for Monmouthshire is 2033, an amended method is used in this assessment to estimate potential building-integrated uptake. The potential for future uptake is split into domestic and non-domestic sectors.

5.2 Roof-top Solar PV

5.2.1 As with 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 can generate electricity to 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 closer match of demand and supply.

Method

5.2.2 The Toolkit (Welsh Government, 2015) describes a methodology to calculate solar PV uptake to 2020. This assessment period is to 2033 and, therefore, a different approach is required. The overall method followed is summarised in Figure 30.

Identify the current number of properties in the study area by type using Local Land and Property Gazetteer (LLPG) data and project the total number of properties to 2033 using data from LLPG and MCC

Estimate the current installed capacity of roof-top solar PV and average installation size in Monmouthshire using the FIT register (Ofgem 2020a) and planning application data

Estimate the maximum theoretical resource for roof-top solar PV in 2033 by multiplying the number of buildings in each category by the relevant suitability factor and average local installation size

Estimate potential uptake in rooftop solar PV in the study area, using data provided by the National Grid ESO (2019b) relating to the Community Renewables scenario and accounting for the proportion of commercial/residential buildings within the study area

Compare the maximum theoretical resource with the capacity derived from the data provided by the National Grid ESO (2019b) relating to the Community Renewables scenario

Figure 30: Method for estimating roof-top PV potential

5.2.3 DECC's *Renewable and Low-carbon Energy Capacity Methodology* (DECC, 2010) provides a method for estimating the maximum roof-top solar PV potential in an area based on estimates of roof-top solar PV suitability in new and existing buildings.

5.2.4 The number of existing installations, number of generators, and total and average installed capacity (MW) are obtained from Ofgem's feed-in tariff register (Ofgem 2020a). The data allows the separation of domestic generation and non-domestic sources (commercial, industrial, and community) and serves as the starting point for the analysis. The capacity of ground mounted solar PV systems is excluded from the analysis using planning application details (BEIS, 2020a, MCC, 2020b) to remove the estimated capacity of ground mounted solar PV from the feed-in tariff data.

5.2.5 DECC's *Renewable and Low-carbon Energy Capacity Methodology* (DECC, 2010) provides Government assumptions on the number of roofs that are considered suitable for solar systems, for both existing roof space and new developments. The average generation capacity per individual system is also provided. The analysis in this assessment, however, uses data from the Feed-in Tariff register (Ofgem, 2020a) to calculate the actual average individual system sizes for Monmouthshire for each sector (domestic, commercial and industrial).

5.2.6 While the DECC (2010) methodology suggests a 50% roof-top solar suitability for new developments, this assessment assumes 85% of new developments will be suitable for roof mounted solar PV systems, as:

- the DECC methodology has not been updated since 2010, and;
- it is likely building regulations and planning requirements will encourage a wider uptake of LZC technologies (see Section 10 for further details on the Welsh Government Building Regulation consultation)

5.2.7 The roof-top suitability percentages for solar PV used in the assessment are summarised in Table 29.

Table 29: Summary of rooftop solar PV suitability assumptions

Rooftop suitability (%)	Existing buildings	New developments
Household	25%	85%
Commercial	40%	Non-domestic building numbers are assumed to remain static across the replacement LDP period. Non-domestic buildings on RLDP strategic development sites are to be considered separately, when the sites are identified.
Industrial	80%	

5.2.8 The maximum potential solar PV capacity is estimated by multiplying:

- The number of existing buildings and new developments;
- The respective factors for roof-top suitability for existing buildings and new developments;
- The current average individual capacity, estimated using data from the Feed-in Tariff register (Ofgem, 2020a)

5.2.9 The above calculation identifies the total capacity that would be made available if all assumed suitable buildings installed a solar PV system with a capacity equal to the current county average.

5.2.10 Data regarding existing buildings is taken from the Local Land and Property Gazetteer (LLPG). Further details regarding use of LLPG data in this assessment is provided in Appendix 3.

5.2.11 As the uptake of renewable energy in existing buildings is likely to be at the discretion of the building owner, in addition to following the DECC (2010) methodology to estimate the maximum potential capacity within the study area, the National Grid ESO (2019a) Community Renewables Future Energy Scenario data is used to estimate potential uptake by 2033.

5.2.12 As detailed in Section 2, the Future Energy Scenarios provide potential future pathways for our energy system (National Grid ESO, 2019a). They are not forecasts or predictions but provide credible pathways for how the energy system may evolve over the next 30 years.

5.2.13 Within the detailed data provided by National Grid ESO (2019b), electricity generation capacity is separated into transmission capacity, distributed 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).

5.2.14 It is considered the majority of microgeneration in the Monmouthshire study area will be from roof-mounted solar PV installations. Figure 31 provides the National Grid ESO (2019b) electricity generation capacity trends for the Community Renewables scenario (separated into transmission, distributed and micro capacity). The growth rates suggested for the level of micro generation across the UK, summarised in Figure 31 are used to inform the potential uptake of roof-top solar PV in the Monmouthshire study area to 2033.

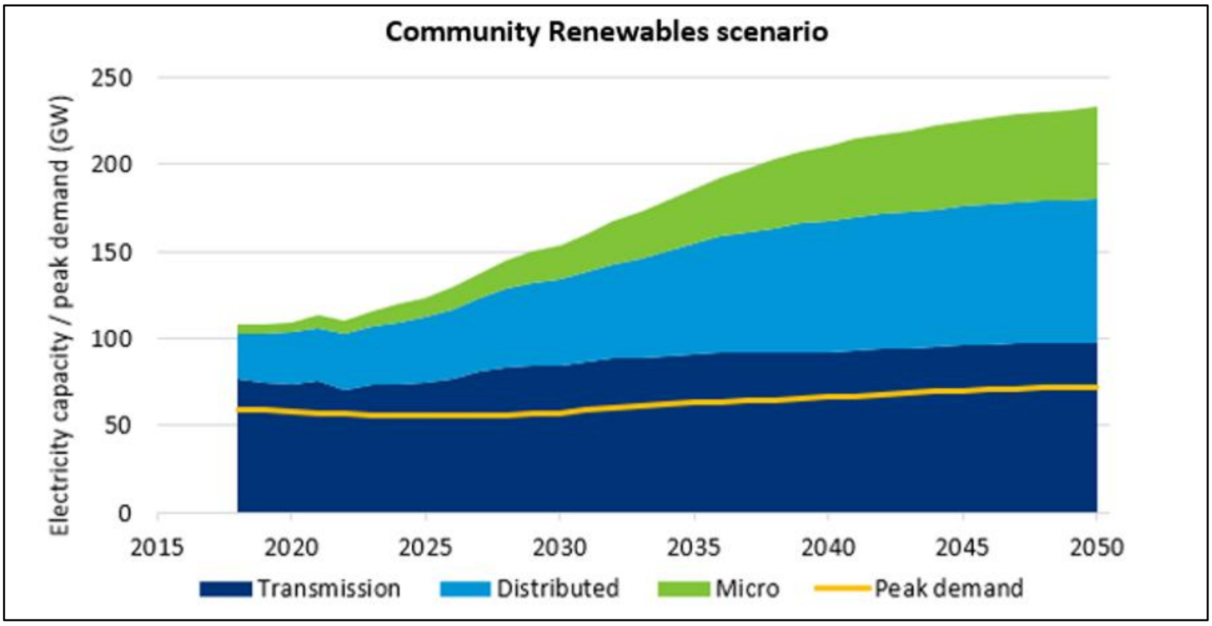


Figure 31: National Grid ESO (2019a) electricity capacity trends for the Community Renewables scenarios (separated into transmission, distributed and micro capacity)

(National Grid ESO, 2019b)

Results

Current number of properties and 2033 forecast

5.2.15 The number of residential buildings currently in the Monmouthshire study area (40,949 units) is established from the LLPG data. The housing requirement for the RLDP has not yet been established, so the assessment assumes a continuation of the Adopted LDP housing rate of 450 per annum giving a total requirement of 6,750 for the 15 year Plan period. 799 completions have taken place over the first two years of the Plan leaving 5,951 units to be delivered over the remaining 13 years of the Plan period. It is assumed that just the first year of completions (443 units) is included in the LLPG data, due to the date of accessing the data, and therefore the total number of dwellings expected in Monmouthshire at the end of the RLDP period (2033) is 47,256. This represents a cumulative growth over the plan period of 15%. Of the 6,750 new dwellings to be built over the plan period (including those already completed), 2,602 are understood to have already gained planning consent or completed.

5.2.16 Data on commercial and industrial buildings is also obtained from LLPG data, which identifies 3,414 commercial buildings and 952 industrial buildings within the study area. This figure is kept constant over the time horizon for this assessment, and the proposed RLDP strategic development sites are to be considered separately when they are identified.

Current installed capacity

5.2.17 The current installed capacity of roof-top solar PV within Monmouthshire county is shown in Table 30.

Table 30: Current assumed installed capacity of roof-top solar PV within Monmouthshire

	Domestic	Commercial & Community	Industrial
Number of installations, 2020	3,476	73	6
Installed capacity, 2020 (kW)	11,467	2,993	237
Average individual capacity, 2020 (kW)	3.3	41.0	39.6

(Data in table are rounded and may not appear exact)

5.2.18 The maximum theoretical resource within the study area is provided in Table 31. As the LPA have more control over the potential to integrate PV into new developments without planning consent the maximum theoretical potential in new, non-consented, developments is highlighted.

Table 31: Maximum theoretical resource of roof-top solar PV within Monmouthshire study area in 2033

	Household	Commercial & Community	Industrial	Total
Roof-top solar PV maximum theoretical capacity in 2033 (MW)	51.5 *(10.4 MW from new, non-consented developments)*	56.0	30.1	**137.6**
Roof-top solar PV maximum theoretical generation in 2033 (MWh p.a.)	45,075 *(9,100 MWh from new, non-consented developments)*	49,045	26,397	**120,517**

(Data in table are rounded and may not appear exact)

Comparison with National Grid ESO's (2019a) Future Energy Scenarios

5.2.19 The cumulative growth rate for microgeneration capacity under the Community Renewables scenario is shown in Table 32.

Table 32: Cumulative growth rate for National Grid ESO (2019a) Future Energy Scenarios

Year	Community Renewables
2033	460%

5.2.20 Applying the above growth rate to the current installed capacity identifies the predicted growth path for rooftop solar PV uptake following the National Grid ESO (2019a) Community Renewables scenario. As the current installed capacity relates to the whole county, the resultant capacities are reduced by approximately 8% to account for the proportion of the county's buildings that are located within the study area. Table 33 provides the projections for the study area.

Table 33: 2033 installed capacity projections assuming growth in roof-mounted PV follows the National Grid ESO (2019a) Future Energy Scenarios

Year	Community Renewables (MW)
2033	62.5
Year	**Community Renewables (MWh p.a.)**
2033	54,713

(Data in table are rounded and may not appear exact)

Conclusions

5.2.21 The estimated maximum theoretical energy generation from building integrated solar PV, is comparable to approximately 33% of the current (2017) electricity demand of the study area (when compared to results in Table 7 in Section 2).

5.2.22 As the uptake of roof-top solar PV is at the discretion of the building owner, it is considered unlikely the maximum resource potential will be achieved within the plan period. Section 2 identified that the National Grid ESO (2019a) Community Renewables scenario is more locally focused and therefore is a good scenario to consider when considering ambitious pathways for Monmouthshire. The Community Renewables projection indicates that approximately 45% of the theoretical maximum resource in the study area would need to be utilised to achieve the growth rates modelled (National Grid ESO, 2019b). This level of deployment is considered far more achievable within the RLDP period.

5.3 Heat Pumps Uptake Assessment

5.3.1 Heat pumps can provide both heating and cooling and are commonly found in commercial and residential settings. They can be both gas and electrically driven, but most commonly use electricity. Where a domestic fridge extracts heat from inside the fridge and rejects it outside, heat pumps work in reverse to transfer energy from a low temperature source such as ambient air, water, ground or waste heat and raise it to a higher useful temperature. This is made possible using a thermodynamic refrigeration cycle.

5.3.2 What makes a heat pump so efficient is that the quantity of thermal energy transferred is often much greater than the external energy used to drive the refrigeration cycle. The cycle is reversed where cooling is required. The ratio of heat transferred into the building versus energy used to drive the refrigeration process is known as the Coefficient of Performance, or COP. Meaning that a standard space heating system with a COP of 3.0 is capable of providing 3 kWh of heat for every 1 kWh of supplied electricity.

5.3.3 Heat pumps are not necessarily zero carbon, as they require some electricity to drive the refrigeration cycle and raise heat to useful temperatures. However, the energy extracted from the external environment is considered to be renewable (The Carbon Trust, 2018b).

5.3.4 The financial case for heat pumps is improved if properties are not able to access the gas network and where there is a source of renewable electricity generation nearby. Heat pumps are also (at the time of writing) eligible for incentive payments (Domestic and Non-Domestic Renewable Heat Incentives) though this would not necessarily apply for the entire period of the RLDP (to 2033). Most buildings are suitable for the deployment of at least one of the heat pump options though constraints, such as a lack of space, may limit the potential in existing properties.

5.3.5 As stated by National Grid ESO (2019a, p.32) *"…all the main technologies available to decarbonise heating in [Great Britain] today involve some additional cost, consumer disruption and energy infrastructure development. As a result, decarbonising heating will require co-ordination at a national scale, with clear policy and resourcing. The variety of technologies also means there is no one leading pathway to decarbonise heat. The best choice is likely to vary across the country, depending on factors such as existing infrastructure, geography and housing stock…"*. As a result of this, decarbonisation of heating during the RLDP period is likely to be slow, with major decarbonisation taking place from 2030 onwards, as depicted in Figure 32, which shows the National Grid ESO (2019a) Community Renewables scenario for heating technology roll-out, with key growth shown for air source heat pumps, hybrid heat pumps, and district heating, and reductions in gas boilers. The numbers derived using the Community Renewables scenario are likely to represent an ambitious but achievable level of deployment to expect during the plan period, with greater deployment in the late 2030s and 2040s.

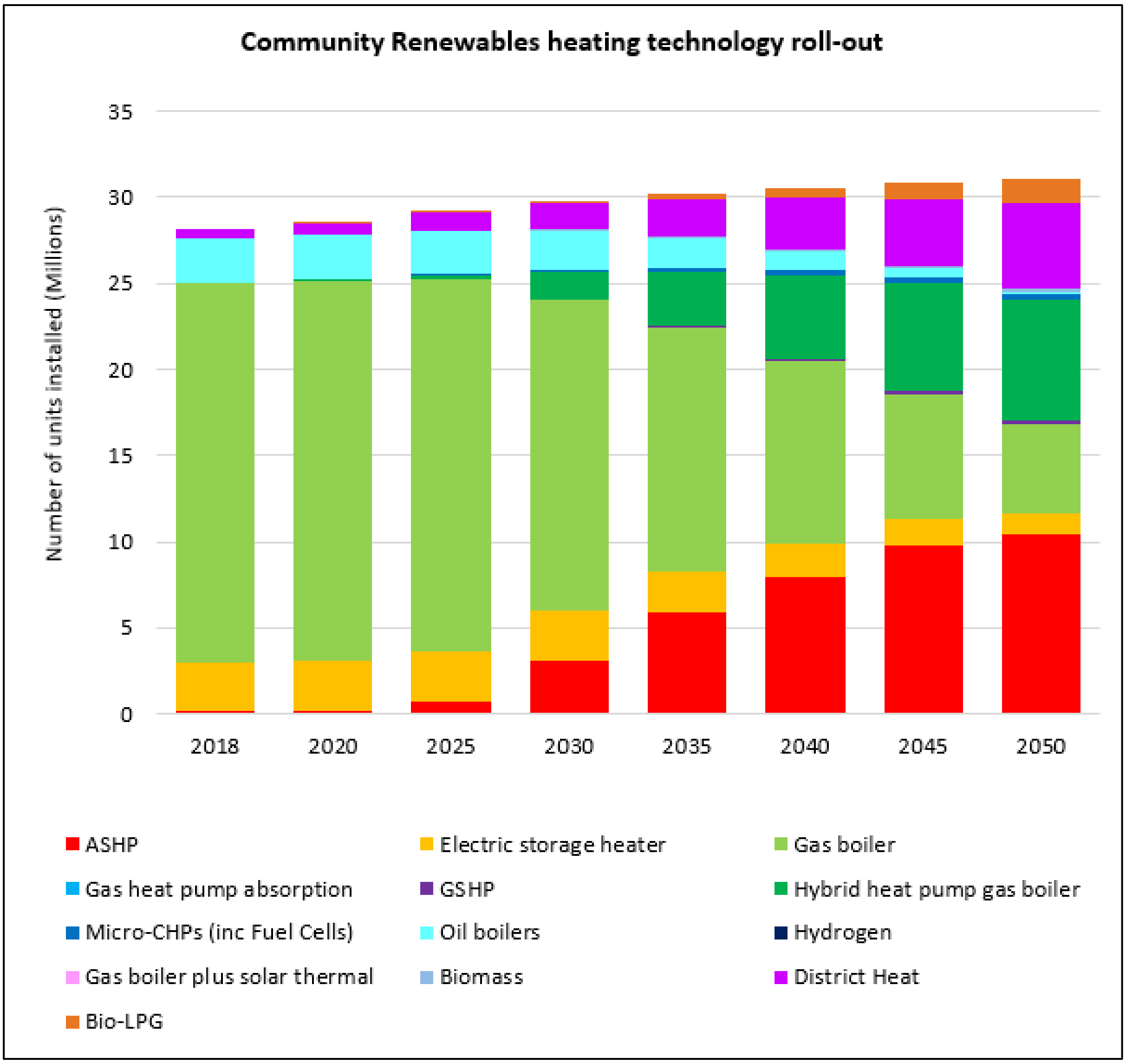


Figure 32: Community Renewables heating technology roll-out

(National Grid ESO, 2019b)

Method

5.3.6 The Toolkit (Welsh Government, 2015) describes a methodology to calculate heat pump uptake to 2020. The RLDP period is to 2033 and, therefore, as with the roof-top solar PV assessment, a different approach is required. The overall method followed is summarised in Figure 33.

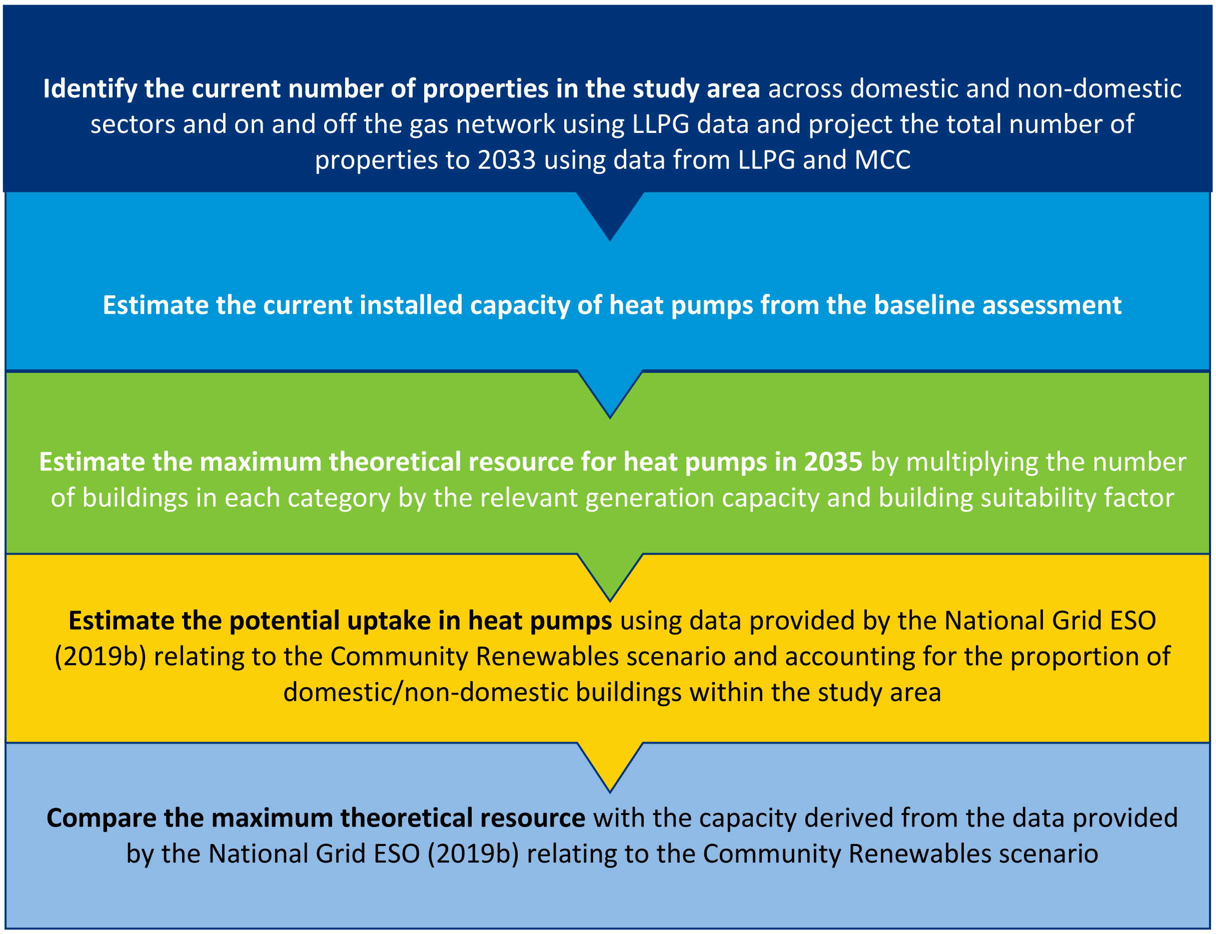


Figure 33: Method for estimating heat pump uptake

5.3.7 DECC's *Renewable and Low-carbon Energy Capacity Methodology* (DECC, 2010) provides a range of estimates for heat pump suitability in new and existing buildings depending on if the building is connected to the gas network. Whilst heating from gas is likely to still be present in the heating mix up to 2050 (as shown in Figure 32), this is expected to reduce over time. It is more challenging to convert an existing heating system, as such it is recommended that MCC discourage any expansion of the existing gas network.

5.3.8 This assessment looks to estimate maximum potential capacity. It is considered likely that all new buildings could be made suitable for a heat pump, as such, the suitability factor used for new developments is 100%, regardless of whether the developments have gained planning consent or not. In reality, alternative low carbon heating options may also be considered, e.g. heat networks and biomass. The suitability factors used in the assessment for heat pump building suitability are summarised in Table 34.

Table 34: Summary of heat pump suitability assumptions

Heat pump suitability (%)	Existing buildings	New developments
Residential (off-gas network)	100%	100%, regardless of whether the developments have gained planning consent or not
Detached/Semi-detached	75%	
Terraced	50%	
Flats	25%	
Commercial & industrial buildings (off gas)	75%	Non-domestic property numbers are assumed to remain static. Non-domestic buildings on RLDP strategic development sites are to be considered, when the sites are identified.
Commercial & industrial buildings (on gas)	75%	

5.3.9 Typical thermal capacities for residential (5 kW) and commercial (100 kW) buildings are obtained from the DECC (2010) methodology. The maximum theoretical capacity is estimated by multiplying each combination of suitability factors and average generation capacity by the number of existing buildings and new developments.

5.3.10 As the uptake of renewable energy in existing buildings is likely to be at the discretion of the building owner, in addition to following the DECC (2010) methodology to estimate the maximum potential capacity within the study area, the National Grid ESO (2019a) Community Renewables Future Energy Scenario data is used to estimate potential uptake by 2033.

5.3.11 As detailed in Section 2, the Future Energy Scenarios provide potential future pathways for our energy system (National Grid ESO, 2019a). They are not forecasts or predictions but provide credible pathways for how the energy system may evolve over the next 30 years.

5.3.12 Within the detailed data provided by National Grid ESO (2019b), suggested heating system changes are identified as shown in Figure 32. The Community Renewables' growth rate for heat pump roll-out (including all heat pump types identified in Figure 32) is used to inform the potential uptake of heat pumps in the study area in 2033. The growth rate is applied to the current installed capacity of heat pumps, and as per the roof-top solar PV assessment, the potential capacity within the study area is derived by multiplying the potential uptake within the county by the proportion of the county's commercial, industrial and residential buildings which are within the study area (92%).

5.3.13 Local Land and Property Gazetteer (LLPG) data is used in this assessment to identify the number of existing residential properties and non-domestic (commercial and industrial) buildings. Further details regarding this data and how it is used is provided in Appendix 3.

Results

Current number of properties and 2033 forecast

5.3.14 As with the roof-top PV assessment, the number of residential buildings currently in the Monmouthshire study area (40,949 units) is established from the LLPG data. The housing requirement for the RLDP has not yet been established, so the assessment assumes a continuation of the Adopted LDP housing rate of 450 per annum giving a total requirement of 6,750 for the 15 year Plan period. 799 completions have taken place over the first two years of the Plan leaving 5,951 units to be delivered over the remaining 13 years of the Plan period. It is assumed that just the first year of completions (443 units) is included in the LLPG data, due to the date of accessing the data, and therefore the total number of dwellings expected in Monmouthshire at the end of the RLDP period (2033) is 47,256. This represents a cumulative growth over the plan period of 15%. Of the 6,750 new dwellings to be built over the plan period (including those already completed), 2,602 are understood to have already gained planning consent or completed

5.3.15 Data on commercial and industrial buildings is also obtained from LLPG data, which identifies 3,414 commercial and 952 industrial buildings within the study area. These figures are kept constant over the time horizon for this assessment, and the non-domestic buildings on proposed RLDP strategic development sites are to be considered separately, when the sites are identified.

5.3.16 Table 35 summarises the respective number of buildings and suitability factors for each category within the study area.

Table 35: Number of building types and suitability factors

	Average generation capacity (kW)	Existing building HP suitability	New building HP suitability	Number of existing buildings	Number of new buildings
Residential (off gas network)	5	100%	100%	6,316	6,307 (4,148 buildings have not got planning consent)
Detached/Semi-detached (on gas network)	5	75%		21,751	
Terraced (on gas network)	5	50%		8,570	
Flats (on gas network	5	25%		4,312	
Commercial (off gas network)	100	75%	75%	703	Non-domestic property numbers are assumed to remain static. Non-domestic buildings on RLDP strategic development sites are to be considered separately, when the sites are identified.
Commercial (on gas network)	100	75%	75%	2,711	
Industrial (off gas network)	100	75%	75%	153	
Industrial (on gas network)	100	75%	75%	799	

Maximum theoretical heat pump capacity

5.3.17 The results of heat pump capacity are shown in Table 36 for 2033. As the LPA have more control over the potential to install heat pumps into new developments the maximum theoretical potential in new, non-consented developments is highlighted.

Table 36: Maximum theoretical heat pump capacity

	Household	Commercial	Industrial	Total
Total heat pump capacity (MW)	171.5 *(new development potential: 31.5 MW)*	256.1	71.4	498.9
Net thermal benefit assuming a COP of 3 (MWh p.a.)	200,308 *(new development potential: 36,833 MWh)*	299,066	83,395	582,769

(Data in table are rounded and may not appear exact)

Comparison with National Grid Future Energy Scenarios

5.3.18 Table 37 provides the results of applying the Community Renewables' (National Grid ESO, 2019b) heat pump growth rate (to 2033) to the current installed heat pump capacity of the study area as a whole (i.e. across both non-domestic and domestic sectors).

Table 37: Comparison with Community Renewables Scenario (from National Grid Future Energy Scenarios)

Capacity (MW)	Net thermal benefit assuming a COP of 3 (MWh p.a.)
97	113,793

(Data in table are rounded and may not appear exact)

Conclusions

5.3.19 The maximum theoretical heat pump capacity, if all suitable buildings are installed with the DECC (2010) typical heat pump capacities, is over five times greater than the capacity estimated using the National Grid ESO (2019b) scenarios. This is a lower difference than identified in neighbouring local authorities, due to the relatively high existing capacity of heat pumps already installed.

5.3.20 It is recognised that heat is a challenging sector to decarbonise. Integrating low or zero carbon heating into existing properties is more challenging than into new properties. As such, planning policy should ensure new properties are built so they are compatible with low carbon heating solutions, and ideally have low carbon heating installations installed at the time of completion. The developer should be able to determine, decide and evidence the most suitable low carbon heating solution (e.g. individual heat pumps, hydrogen, district heat network) for their development.

6. Comparison of Potential Renewable and Low Carbon Energy Generation Resource and Energy Demand

6.1 Introduction

6.1.1 Whilst additional to the Toolkit (Welsh Government, 2015) requirements, to put the potential energy resource within the Monmouthshire study area, i.e. not including areas within the Brecon Beacons National Park, into context, the resource potential identified in Sections 4 and 5 is compared to the energy demand estimations calculated in Section 2.

6.1.2 PPW 10 notes that: renewable energy targets *"should be calculated from the resource potential of the area and should not relate to a local need for energy"* (Welsh Government, 2018b, p. 90).

6.2 Method

6.2.1 The energy demand estimated in Section 2 is compared against the total heat and power resource identified and the energy from the different technology types.

6.2.2 The thermal generation potential and electricity demand associated with heat pumps is provided separately. Currently there is a limited number of heat pumps installed in the study area. It is also considered that the BEIS 2033 estimation presents a relatively low level of heat pump roll-out. When comparing the heat pump potential with these scenarios, the heat generation can be considered to offset the non-electric heating energy demand, whereas the electricity demand for the heat pumps would present an additional electricity demand. The National Grid's Community Renewables scenario includes a high heat pump roll-out. As such, the electricity demand for these heat pumps will be included within the electricity demand for this scenario and the heat pump net thermal generation as an electric heat generation type should not be compared against the non-electric heat demand.

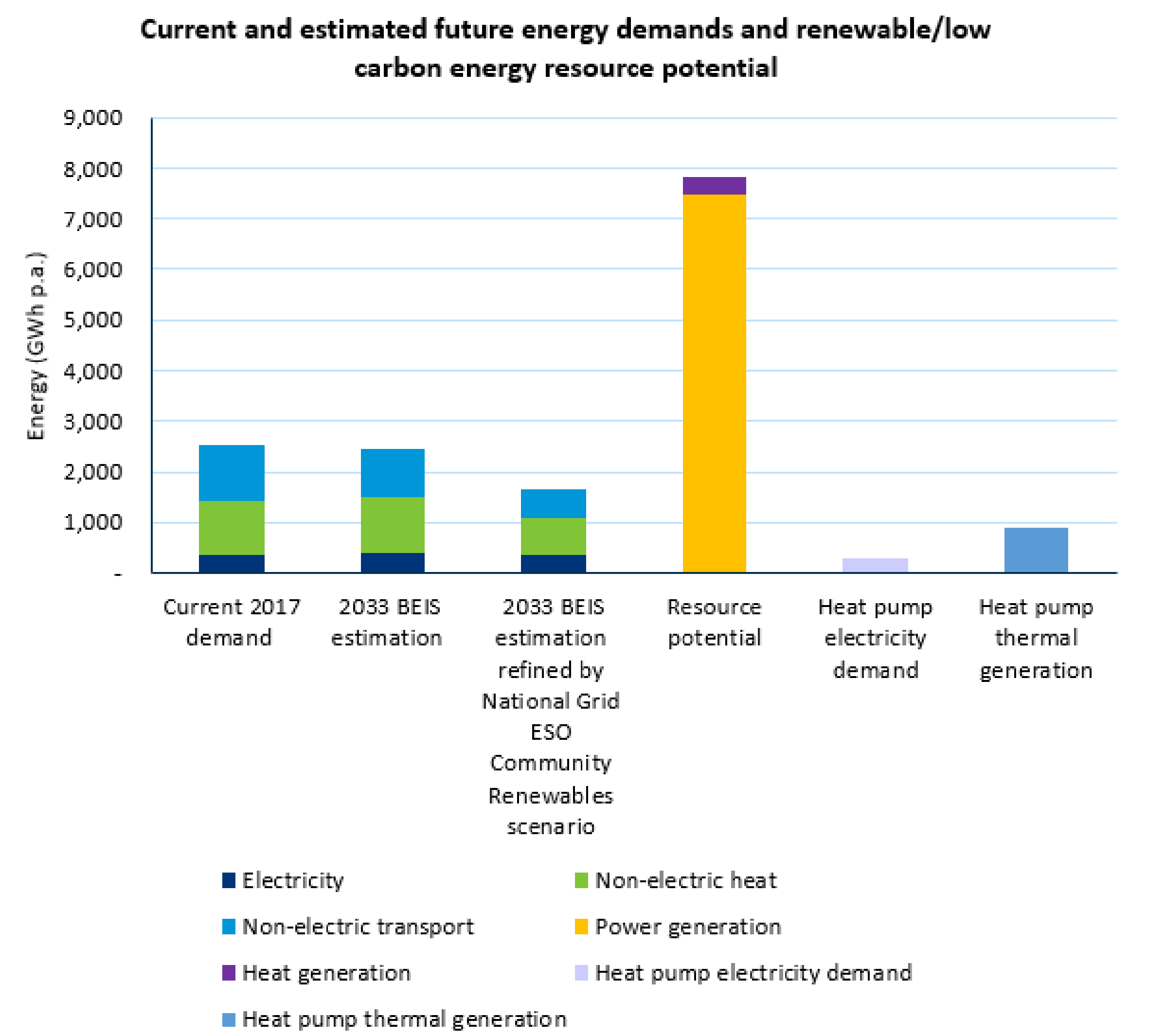
6.2.3 A final graph showing the proportion of potential energy generation from different technology sources includes the net thermal benefit of the heat pumps only. The net thermal benefit is shown as the energy generated by the heat pump minus the assumed energy demand, assuming a coefficient of performance of 3. Note that as per Section 2 the energy demands provided are based on the gross energy demand from the fuel providing the energy and do not account for conversion efficiencies as provided in the energy generation values.

6.3 Results

6.3.1 The results are provided in Figure 34, Figure 35 and Figure 36. They show that the Monmouthshire study area could theoretically generate approximately three times its current total energy demand (electricity, non-electric heat and non-electric transport), excluding heat pump generation. This assumes that all of the ground mounted solar PV and wind resource identified in the study area is utilised (assuming the wind/solar overlap area is used for wind) and that these areas do not impact on the potential land available for growing woody energy crops. It is unlikely that all of the potential identified in the area would be utilised due to competition with other land uses, cumulative landscape impact and grid constraints, however suitably high targets should be established, as discussed further in Section 10.

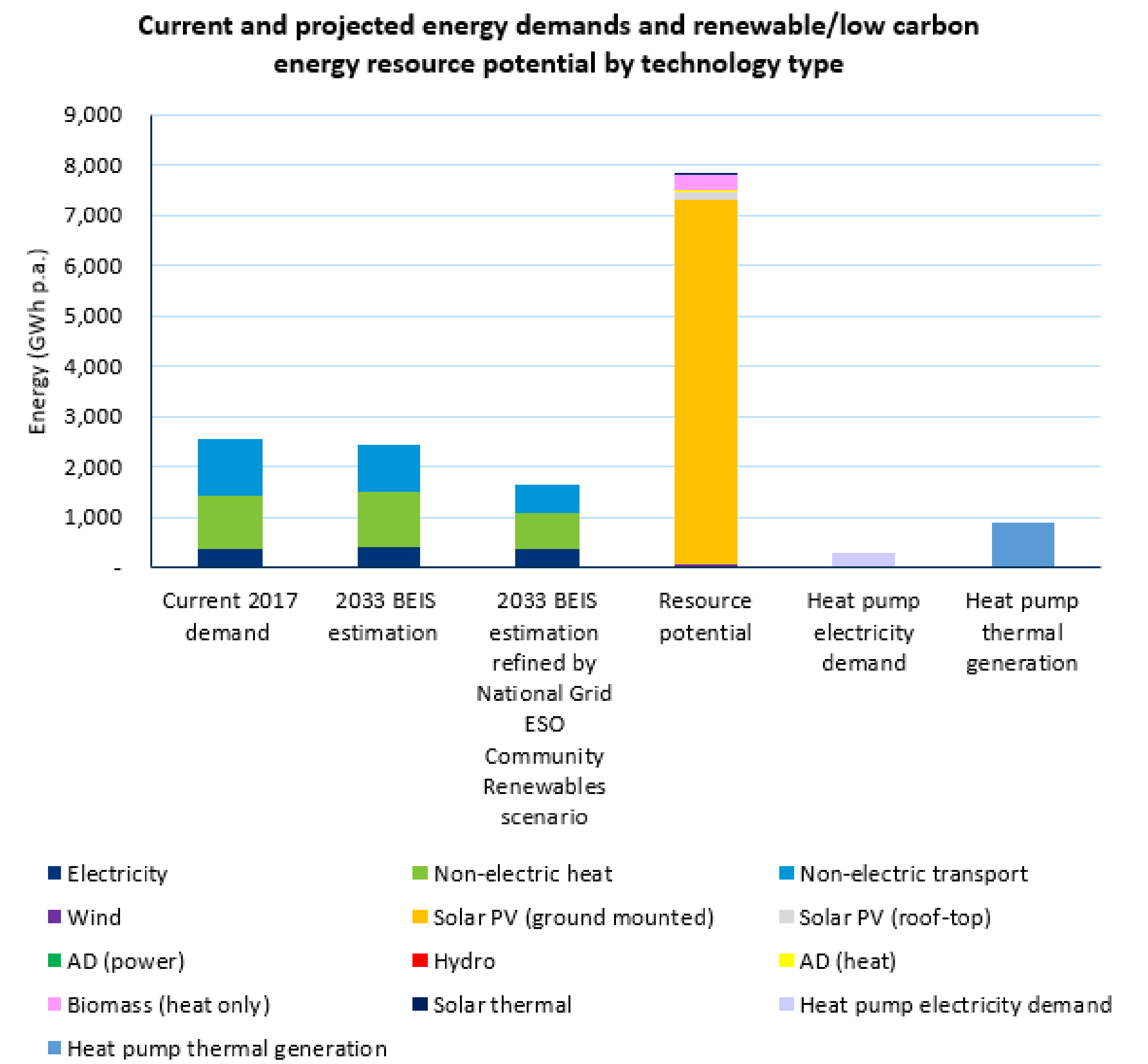
6.3.2 With respect to Welsh Government's target of providing 70% of electricity demand from renewable sources by 2030, 70% of the lower 2033 estimated electricity demand for the Monmouthshire study area is equivalent to approximately 4% of the ground mounted solar PV generation potential identified.

6.3.3 Values of 0% in Figure 36 are as a result of rounding to the nearest percentage.



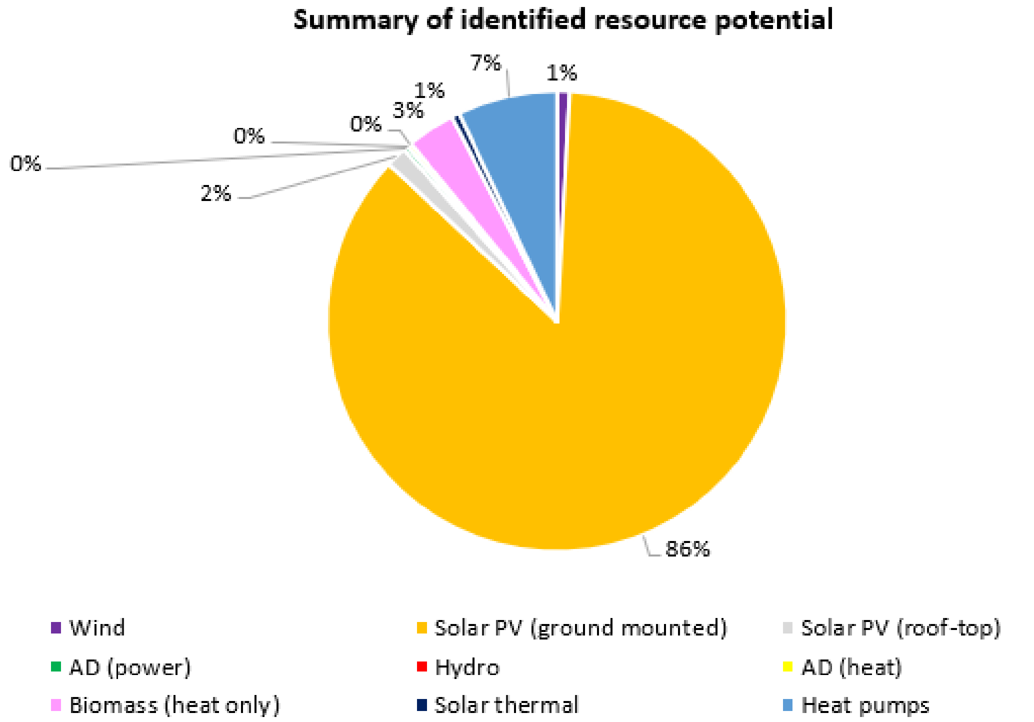
Wind: assumes that the wind/solar overlap areas is available for wind
Solar PV (ground mounted): assumes that the wind/solar overlap areas is not available for solar PV
Solar PV (roof-top): provides the estimated maximum potential resource calculated
AD (power/heat): based on calculations from pigs, cattle and poultry only and assuming use within a CHP plant
Heat pumps: provides the estimated maximum potential. The heat pump thermal generation is the total generation potential from heat pumps.
Biomass: assumes all local resource is used within biomass boilers (existing biomass (CHP) generation is excluded)
Solar thermal: based on existing installations only
Energy from Waste: excluded as considered unlikely to be able to be exploited locally within the Plan period

Figure 34: Summary of current and estimated future energy demand and renewable and low carbon energy generation potential by technology type identified in the study area



Wind: assumes that the wind/solar overlap areas is available for wind
Solar PV (ground mounted): assumes that the wind/solar overlap areas is not available for solar PV
Solar PV (roof-top): provides the estimated maximum potential resource calculated
AD (power/heat): based on calculations from pigs, cattle and poultry only and assuming use within a CHP plant
Heat pumps: provides the estimated maximum potential. The heat pump thermal generation is the total generation potential from heat pumps.
Biomass: assumes all local resource is used within biomass boilers (existing biomass (CHP) generation is excluded)
Solar thermal: based on existing installations only
Energy from Waste: excluded as considered unlikely to be able to exploited locally within the Plan period

Figure 35: Summary of current and estimated future energy demand and renewable and low carbon energy generation potential of power and heat identified in the study area



Wind: assumes that the wind/solar overlap areas is available for wind
Solar PV (ground mounted): assumes that the wind/solar overlap areas is not available for solar PV
Solar PV (roof-top): provides the estimated maximum potential resource calculated
AD (power/heat): based on calculations from pigs, cattle and poultry only and assuming use within a CHP plant
Heat pumps: provides the estimated maximum potential. Provides thermal benefit only (i.e. heat generation minus electricity demand)
Biomass: assumes all local resource is used within biomass boilers (existing biomass (CHP) generation is excluded)
Solar thermal: based on existing installations only
Energy from Waste: excluded as considered unlikely to be able to be exploited locally within the Plan period

Figure 36: Summary of identified resource potential within the study area

6.4 Conclusions

6.4.1 Whilst the estimated energy generation potential from renewable and low carbon energy sources within the Monmouthshire study area exceeds the estimated current and higher 2033 energy demands, it is considered impractical for all the identified ground mounted solar PV to be exploited due to grid capacity, landscape, visual and cumulative impacts, competition with other land uses, and market forces. A suitable proportion of the potential solar PV identified should be targeted.

6.4.2 Energy exploitation from all 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 unlikely that the time of generation from renewable and low carbon sources 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.

7. Heat Network Opportunities

7.1 Introduction

7.1.1 The majority of heating solutions used in Welsh homes and businesses are private heating systems, generating heat on-site for a single heat user. Heat networks connect individual heat demands (separate buildings) to one heat generation source, and can, in the right location, provide a more efficient method of heat delivery, than individual heating systems. In the transition to low carbon heating, it can also provide a smoother transition from fossil fuel generation to low carbon and renewable energy generation. An entire network of heat users can be transitioned to low carbon heating with one system change, larger-scale, renewable and recovered heat sources can be utilised, and large thermal stores can be integrated to reduce pressure on the energy generation networks.

7.1.2 Heat networks can be fuelled from traditional fossil fuel sources, biomass, waste heat, hydrogen and low-grade heat in the air, water or ground (using heat pump technologies).

7.1.3 The potential biomass fuel sources within the study area are discussed in Section 4, and indicate there is 285 GWh p.a. of potential heat generation if used with a boiler (Table 22). If the heat network is fuelled from fossil fuel or biomass sources, the heat network can be connected to a Combined Heat and Power (CHP) plant; generating both heat and electricity. If the electricity is able to be used on site or via a private electricity network, this can improve the financial viability of the system, as it can offset imported electricity costs, within which the wholesale electricity generating price makes up approximately a third of the overall cost. Excess generated electricity which is not used via the private electricity network can be sold on the wholesale market and exported to the distribution network for use elsewhere. Excess heat generated, that is not immediately required by the demand loads on the heat network, is stored within a thermal store or else is wasted.

7.1.4 The heat pump roll-out considered in Section 5 is focused on individual heat pumps serving separate buildings. Heat pumps typically make use of latent heat in the ground, air, or water and concentrate this heat to deliver it through a heating system at a higher temperature. They require an energy input to drive the pumps, however they deliver more heat energy output than the energy that is input. The ratio between the energy input and output is called the coefficient of performance (COP).

7.1.5 Heat pump technology can also be utilised in heat networks; both small and large-scale in nature. For example, Wandsworth Riverside apartments in London are served by a heat network connected to three ground source heat pumps, which can provide heating in the winter and cooling in the summer.

7.1.6 Heat pumps typically provide heat at a lower temperature than gas boilers, and therefore benefit from heat distribution systems which use large surface areas, i.e. larger radiators or underfloor heating. The higher the temperature of the latent heat source, the higher the temperature of the heat that can be delivered efficiently through the heating system.

7.1.7 Heat pumps can be used with sources of waste heat, e.g. from industrial processes or waste water, there is also increasing research into the use of minewater. A minewater heat network is in operation in Heerlen in the Netherlands since 2008 (Verhoeven et al., 2014), and there is an operational minewater heat pump providing heat to a farm complex in Crynant, Neath.

7.1.8 Within South Wales, the Seren research project has assessed the heating potential of the South Wales coal-field and has suggested that disused mines could provide the potential to heat at least 20,000 homes (Seren, 2015). Research into the practicalities of accessing and distributing this heat is ongoing, with Bridgend County Borough Council pioneering efforts by developing a minewater heat network project in the Upper Llynfi Valley.

7.1.9 The capital costs of heat networks are relatively high and therefore require high, dependable heat demands to be financially viable. As such, heat networks tend to be built around several high heat users, to support financial viability and provide practical opportunities for utilising heat. These high heat users are referred to as "point loads" or "anchor heat loads"; *"existing buildings with an energy demand that could provide economically viable and practical opportunities for utilising heat. It is known as an "anchor" load because further opportunities (e.g. from nearby buildings) may arise for connecting nearby buildings to the original anchor heat load."* (Welsh Government, 2015, p.75). A network connecting these anchor heat loads can provide further opportunities for nearby smaller heat loads to connect into the network. These smaller heat loads are known as a cluster (Welsh Government, 2015). Anchor heat loads tend to be public sector buildings, due to their longer-term occupancy patterns than private sector buildings. A cluster of buildings tend to be a mix of social housing and non-residential buildings, which provide an additional opportunity due to their:

- Complementary energy demand profile
- Planned development programme
- Commitment to reduce CO_2 emissions

(Welsh Government, 2015, p.76)

7.1.10 A high-level heat opportunity mapping exercise is undertaken, which looks to identify and understand the nature of the existing and future energy demand and infrastructure, in order to identify:

- Key public sector anchor heat loads, which could provide the initial loads on which a heat network is designed and built
- Residential heat density and concentrations of nearby commercial loads, as areas of high-density energy demand, whilst likely to pose more challenges with respect to heat network installations, are also likely to lead to more financially viable heat networks,
- Waste heat sources, which could be utilised to develop a low/zero carbon heat network
- Other factors for consideration; presence of the gas network, social housing location, deprivation and local authority land ownership, which could help to assist with developing a business case for a heat network in a particular area.

7.1.11 From this mapping, areas with the highest potential for heat network development within the study area are identified.

Box 10: Note on mapping of areas of deprivation

The Toolkit (Welsh Government, 2015) suggests mapping fuel poverty data using the Fuel Poverty Maps for Wales. The Wales Index of Multiple Deprivation (WIMD) maps (Welsh Government, 2020b) is used instead of the Fuel Poverty Maps (Welsh Government, 2009b) to map general deprivation. These WIMD maps are used instead of the fuel poverty maps as they are more recent in publication and cover a wider range of deprivation indicators. The WIMD maps assess and rank all the Lower Super Output Areas (LSOAs) in Wales in relation to different types of deprivation (e.g. income, employment, etc.) and an overall deprivation ranking. The overall ranking is used in this assessment. Within the assessment, the ranks are then categorised as the LSOA is within the 10%/20%/30%/50% most deprived or 50% least deprived LSOAs within Wales.

7.1.12 To inform the draft National Development Framework (Welsh Government, 2020e), Welsh Government plotted the heat requirements of the majority of buildings within Wales to identify areas with high heat demand (more than 3 MW per km^2). This data was used to identify towns and cities in Wales which provided the most potential for viable district heat networks (Welsh Government, 2020b). It is proposed within the draft policy document that these areas are designated as "Priority Areas for District Heat Networks", and within these areas *"…planning authorities should identify opportunities for District Heat Networks and plan positively for their implementation"* (draft policy 16, Welsh Government, 2020e, p.93).

7.1.13 In addition to draft policy 16, the draft NDF states that *"Planning authorities should explore and identify opportunities for District Heat Networks, particularly in the Priority Areas, and, where possible, seek to develop city or town-wide District Heat Networks in as many locations as possible."* (Welsh Government, 2020e, p.93).

7.1.14 The draft NDF does not identify any priority area for heat networks within Monmouthshire. As such, any potential heat networks within the county are likely to be small in scale, or focussed around new strategic development sites.

7.1.15 MCC has appointed Sustainable Energy to investigate the potential for district heat networks in 'The Vale of Usk' Region. MCC is the lead authority on a joint initiative with a range of stakeholders to determine the potential for district heat networks within 'The Vale of Usk' region. The Vale of Usk covers Monmouthshire and the rural areas of Newport (the wards of Caerleon, Graig, Langstone, Llanwern, Marshfield). Funding for this work has been secured from the Heat Network Delivery Unit (within the Department for Business, Energy and Industrial Strategy) and the LEADER measure of the Welsh Government Rural Communities – Rural Development Programme 2014 – 2020.

7.1.16 Sustainable Energy consultancy has been appointed to provide:

- An energy mapping and modelling study of The Vale of Usk area to identify potentially useful heating, cooling and power demand loads and potentially useful heat supply opportunities for the purposes of district energy scheme development.
- Use the outputs of energy mapping to inform the development of an energy master plan for The Vale of Usk area encompassing the short and long term which identifies, evaluates, and prioritises potential district heating scheme opportunities.
- To identify an initial core scheme and full potential scheme over the long term together with potential phasing, timeline, key dependencies and constraints.

Box 11: Notes with respect to high-level heat opportunity mapping

This Section provides the results of a high-level heat opportunity mapping exercise. Whilst it relies on some actual energy consumption data, it also uses benchmarks to estimate the heat demand of buildings, which the local authority does not have access to. The viability of a heat network depends on the nature and density of heat loads and sources within a geographical area. The suitability of the heat clusters identified for a district heat network will need to be determined following further detailed feasibility assessment based on a greater understanding of individual heat demands.

7.2 Method

7.2.1 The method undertaken is summarised in Figure 37.

Identify potential anchor heat loads: Potential anchor heat loads are identified from the Local Land Planning Gazetteer data for the Monmouthshire study area, and the categories provided by the Toolkit (Welsh Government, 2015)

Establish heat demands of anchor heat loads, from public sector energy data, or details provided on Energy Performance Certificates and benchmarks provided by BEIS (2016)

Estimate residential heat demand density, identify social housing and commercial properties in close proximity to anchor heat loads. Residential heat demand is estimated at the output area level using sub-national statistics on gas consumption for 2018 (BEIS, 2019d). Social housing property numbers are based on postcode data provided by MCC, commercial property information is informed by LLPG data

Identify existing district heating, CHP schemes, sources of waste heat, areas of deprivation and local authority owned land

Undertake initial assessment of potential viability of opportunity areas identified

Figure 37: Method for identifying key district heating opportunities

Box 12: Identifying anchor heat loads

Potential anchor heat loads are initially identified from Monmouthshire's LLPG dataset, using the categories suggested in the Toolkit (Welsh Government, 2015). MCC provided energy demand details for Council buildings, which are used to identify high energy demand sites within the local authority's building portfolio (buildings with a heat demand greater than 100 MWh p.a.). Energy demand details from the local health board are used to inform the energy demand of medical sites. The heat demand for other potential anchor heat loads is estimated using data provided in their Energy Performance Certificates (EPCs). Where the EPCs provide heat demand estimates these are used. If heat demand estimates are not provided, the building's floor area is taken from the EPC and used with the mean hot water and heating demands of the different building use types provided in the BEIS (2016) Building Energy Efficiency Survey to provide an estimate for the annual energy demand. Any potential anchor heat loads that do not have data from any of the sources stated are not considered further. The rationale for using the BEIS (2016) Building Energy Efficiency Survey details as benchmarks in comparison to others is provided in Appendix 5.

7.3 Results

7.3.1 The assessment identifies 39 potential anchor heat loads (with heat demands greater than 100 MWh p.a.), separated into eight areas (see Figure 38). Areas in which three or more anchor heat loads are within 500 m of each other are considered for their heat network potential. The areas are as follows:

- Abergavenny
- Caldicot
- Chepstow
- Magor
- Monmouth
- Usk

7.3.2 Figure 38 shows the location of the anchor heat loads, Figure 39 graphs the demand of the anchor heat load groups. Table 38 provides details of the individual heat loads identified, with demands greater than 300 MWh p.a. identified. The heat network potential of the eight areas is summarised in Table 39.

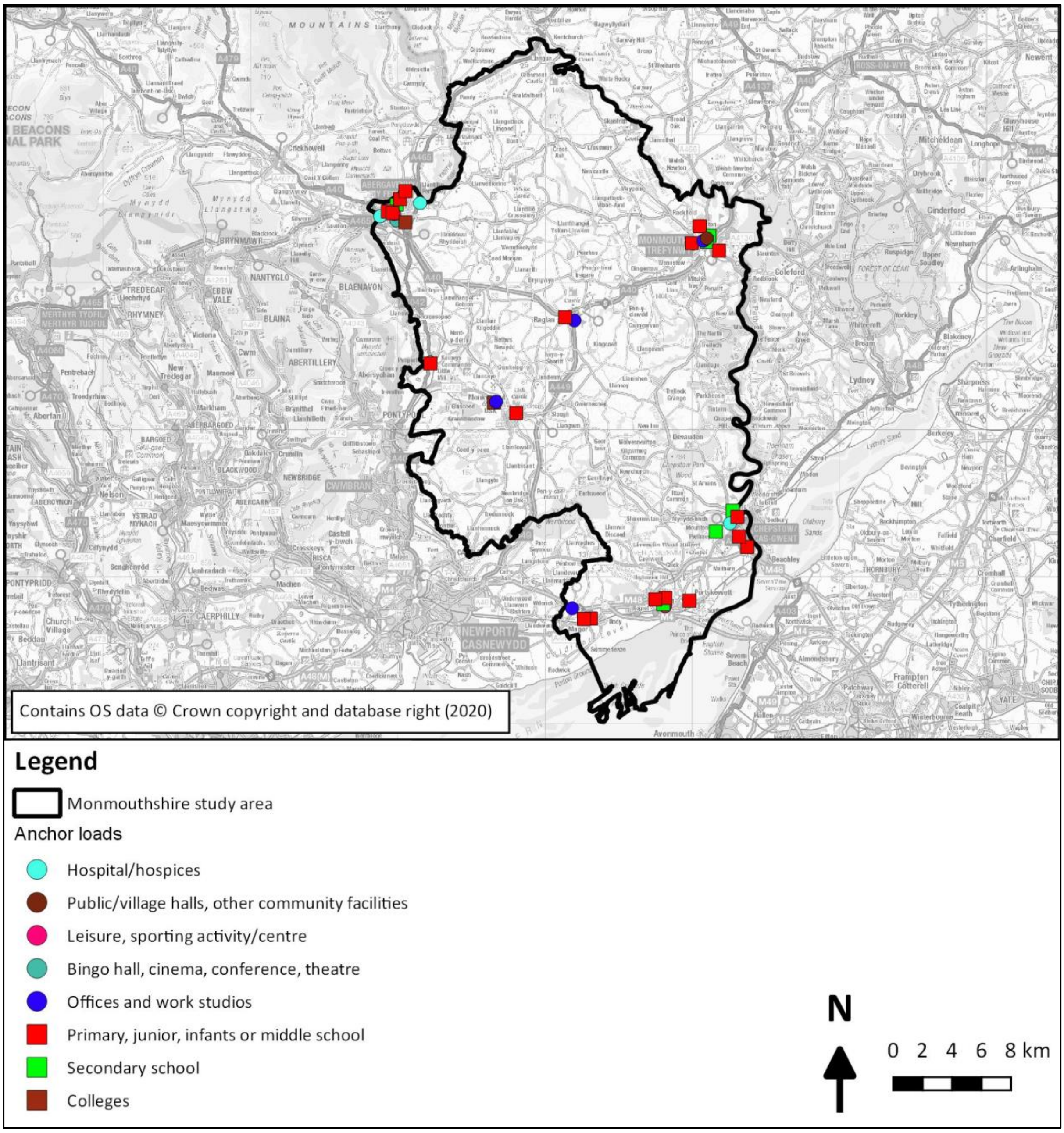


Figure 38: Anchor heat loads identified

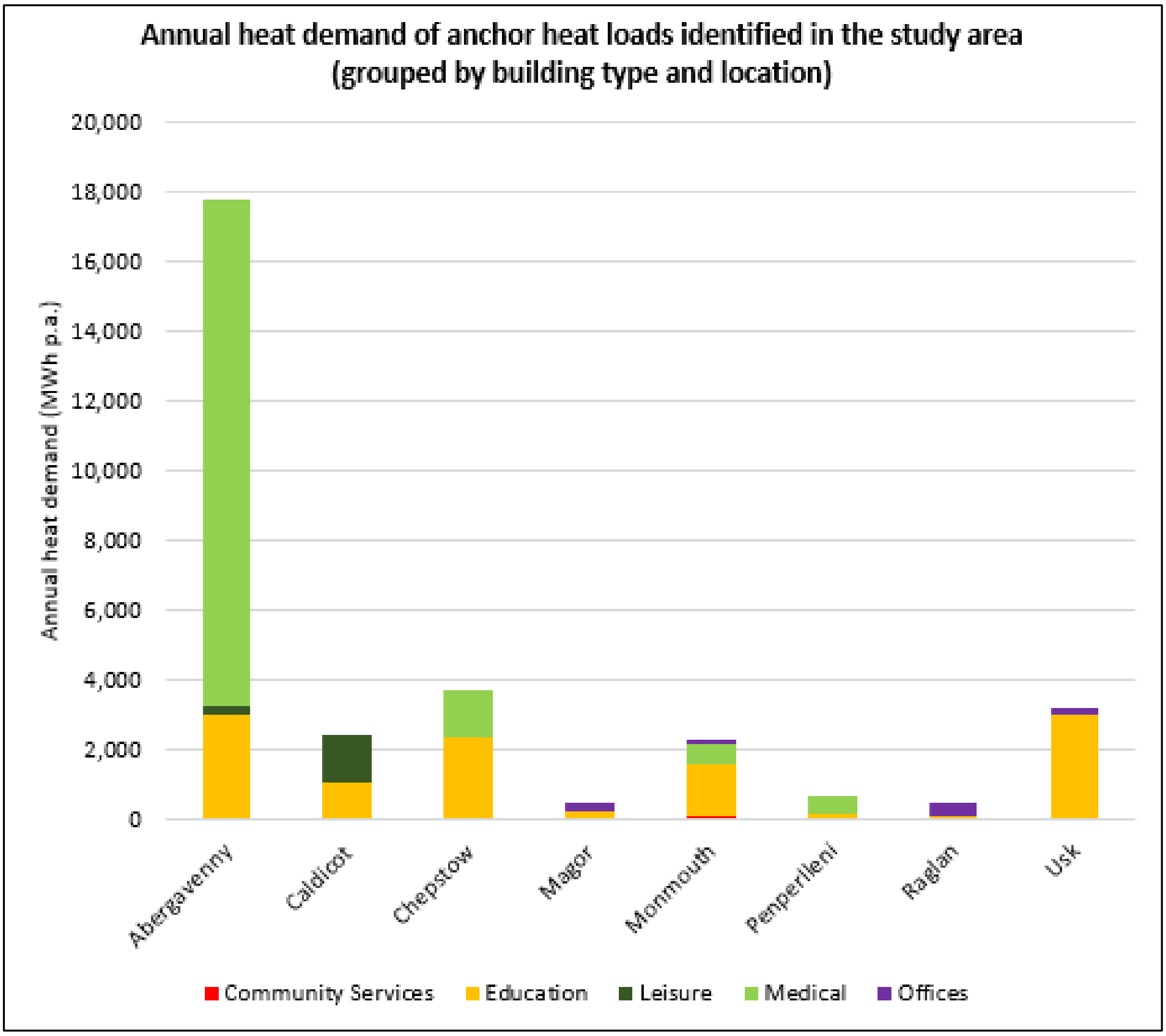


Figure 39: Anchor heat loads grouped by location and secondary BLPU classification

Figure 39: Anchor heat loads grouped by location and secondary BLPU classification

**Magor, Penperlleni and Raglan contain just two anchor heat loads within 500m of each other and therefore are not considered further.*

Table 38: Annual heat demand at identified anchor heat loads (loads over 300 MWh p.a. highlighted)

Abergavenny	Nevill Hall Hospital	King Henry VIII Comprehensive School	Maindiff Court Hospital	Cantref Primary School	Deri View Primary School	Abergavenny Borough Theatre	The Dance Centre
	13,499 MWh	2,238 MWh	993 MWh	221 MWh	156 MWh	144 MWh	143 MWh
Abergavenny	Training Unit - Coed Glas	Llantilio Pertholey Church in Wales Primary School	Our Lady & St Michael's Roman Catholic Primary School				
	140 MWh	115 MWh	105 MWh				
Caldicot	Caldicot Leisure Centre	Caldicot Comprehensive School	Castle Park Primary School	Dewstow Primary & Nursery School	Archbishop Rowan Williams Church in Wales Primary School		
	1,374 MWh	663 MWh	129 MWh	122 MWh	107 MWh		
Chepstow	Chepstow Comprehensive School	Chepstow Community Hospital	Mounton House Special School	Thornwell Junior & Primary School	Pembroke Primary & Junior School	The Dell Primary School	
	1,727 MWh	1,343 MWh	193 MWh	187 MWh	122 MWh	111 MWh	
Magor	Innovation House	Undy Primary School	Magor Church in Wales Primary School				
	200 MWh	127 MWh	110 MWh				
Monmouth	Monmouth Comprehensive School	Monnow Vale Health & Social Care Facility	Monmouth Boys School Site	Overmonnow Primary School with Special Needs Unit	Monmouthshire County Council Offices	Osbaston Church in Wales School	Kymin View Primary School
	843 MWh	591 MWh	249 MWh	169 MWh	119 MWh	106 MWh	102 MWh
Monmouth	Monmouth Library						
	101 MWh						
Usk	Coleg Gwent Agricultural College	County Hall Democratic Centre	Usk Controlled Voluntary Primary School				
	2,874 MWh	170 MWh	120 MWh				

Table 39: Heat network opportunity summary

Location	Total annual anchor heat load (MWh p.a.)	Indicative kWh/m² p.a. of anchor heat loads (based on uniform heat density distribution)	Output area residential heat density within 500m anchor heat loads	Approx. no. of social housing properties within 500m of anchor heat loads	Approx. no. of commercial properties within 500m of anchor heat loads	Gas network coverage (by LSOA)	Proximity to area of deprivation	Potential sources of waste heat within 500m of an anchor heat load
Abergavenny	17,754	250m radius: Generally 0-10 kWh/m², 50-100 kWh/m² around Nevill Hall Hospital 500m radius: Area between Nevill Hall Hospital and Cantref Primary School 10-25 kWh/m²	Average: 16 kWh/m² Max: 45 kWh/m² Min: 0.2 kWh/m²	1,046	662	Generally within 0-20% off-gas area Near to 40-60% and 80-100% off-gas area.	Coincides with areas defined as 20% / 50% most deprived	Nevill Hall Hospital CHP, Homemakers Community Recycling, Abergavenny Substation, Pen Y Fal Water Pumping Station, C&P Lester Fashion & Textile Artists, Abergavenny Fine Food Ltd. factory/ind. Units, Spudbox, The Chocolate Factory,
Caldicot	2,395	0-10 kWh/m²,	Average: 14 kWh/m² Max: 28 kWh/m² Min: 0.2 kWh/m²	495	104	0-20% off gas area near to 20-40% off-gas area	Coincides with areas defined as 50% most deprived	Portskewett Former Refuse Tip
Chepstow	3,684	0-10 kWh/m²,	Average: 16 kWh/m² Max: 40 kWh/m² Min: 0.2 kWh/m²	706	515	0-20%/20-40% off-gas area	Near to area defined as 30% most deprived	Sewage Pumping Kiosk
Magor	437	0-5 kWh/m²	Average: 12 kWh/m² Max: 27 kWh/m² Min: 0.1 kWh/m²	114	92	0-20% off-gas area	50% least deprived	Inbev UK Ltd Effluent Treatment Plant,
Monmouth	2,280	0-5 kWh/m²	Average: 12 kWh/m² Max: 30 kWh/m² Min: 0.4 kWh/m²	488	677	0-20% off-gas area	Coincides with areas defined as 30% most deprived	The Pump House/ Wyesham Sewage Works, Mayhill Ind Est., Valley Enterprise Park, Wonastow Road Ind. Est., Mayhill Water Treatment Works, Lock Hancocks & Co Ltd.
Usk	3,164	250m radius: 0-5 kWh.m² / 10-25 kWh/m² 500m radius: 0-5 kWh/m²	Average: 12 kWh/m² Max: 47 kWh/m² Min: 0.1 kWh/m²	50	84	40-60% off-gas area / 0-20% off-gas area	50% least deprived	Usk 66 kV substation

7.3.3 Commercial property and anchor load locations are based on the grid referenced locations provided in the LLPG dataset. Commercial property data excludes data with the following secondary classifications within the LLPG dataset: Storage, Transport, Utilities, Information and ATMs as these are assumed to have minimal (if any) heating requirements. Further details regarding use of the LLPG data is provided in Appendix 3.

7.3.4 Appendix 4 contains the following maps:

- Figure 54: Anchor heat loads and residential heat demand
- Figure 55: Anchor heat loads and gas network coverage
- Figure 56: Anchor heat loads and the Wales Index of Multiple Deprivation
- Figure 57: Anchor heat loads and potential sources of waste heat and existing heat sources

7.3.5 The anchor heat loads are located within the larger settlements within Monmouthshire: Abergavenny, Monmouth, Caldicot, Chepstow, Magor and Usk (anchor heat loads are also identified in Penperllleni and Raglan, however just two loads are within 500m of each other within each location and as such are considered insufficient for heat network development). The anchor loads are also generally located alongside additional smaller commercial heat loads (with heat demands assumed to be less than 100 MWh p.a.) and areas of denser residential heat demand, with all areas containing residential heat densities greater than 10 kWh/m^2 (see Figure 54). The highest number of commercial properties are within 500m of the anchor heat loads in Abergavenny, Monmouth and Chepstow. All areas coincide with output areas that contain social housing properties, with the highest number of social housing properties found within 500m of the anchor heat loads in Abergavenny, Monmouth, Chepstow and Caldicot. All areas are located near to land that is owned by MCC, which could provide potential energy centre locations.

7.3.6 With respect to gas network coverage, the majority of the settlements and anchor loads are located in areas of relatively high levels of gas network coverage, with the exception of Usk (40-60% off gas) and Raglan (20-40% off gas) (see Figure 55). Presence of the gas network will make it more challenging to develop a heat network in the current energy market due to the relatively low cost of gas as a heating fuel.

7.3.7 Abergavenny contains a lower super output area (LSOA) which is classified as being in the 20% most deprived LSOAs within the WIMD dataset (see Figure 56). Monmouth and Chepstow coincide with LSOAs which are classified within the 30% most deprived LSOAs within the dataset. Studies show that those living in more deprived areas are more likely to suffer from fuel poverty (DECC, 2014b). The development of a heat network in deprived areas could provide the opportunity for the local authority to exercise some control over the energy costs of local residents to help improve overall well-being. For example, Islington Council has delivered a 10% saving on energy bills to tenants who are connected to their Bunhill heat network, providing fixed heating bills at least 33% lower than the government threshold for fuel poverty (ADE, 2020). It is worth noting that Bunhill is an area of high-density housing well-suited to a heat network with the network connecting 860 dwellings, two leisure centres and four office blocks (ADE, 2020).

7.3.8 No existing district heat networks are identified in Monmouthshire. An existing Combined Heat and Power (CHP) plant at Nevill Hall Hospital in Abergavenny is understood to be operational. There could be potential to increase the size of the CHP at the Nevill Hall Hospital site to meet a larger demand of networked buildings.

7.3.9 Two biomass power generators (Trostrey/Usk biomass generators) are identified within the study area from the renewables obligation register. It is unclear whether the heat generated from these stations is fully utilised, but they may provide opportunity to utilise waste heat within a new district heat network. The biomass plants are considered to be located too far from the identified heat loads (approximately 3 km north of the heat loads in Usk) to facilitate a financially viable connection to the groups of anchor heat loads identified in this assessment. There may be some potential to utilise the excess heat to satisfy smaller heat loads in closer proximity to the plants, but this would require further investigation.

7.3.10 Additional potential sources of waste heat and CHP are identified within the study area (see Figure 57) based on the following categories identified in LLPG data:

- Factories/manufacturing
- Incinerators and waste transfer stations
- Landfill sites
- Mineral/ore working, quarries and mines
- Power stations/energy production sites
- Recycling plants
- Waste management sites
- Water/sewage treatment works

Potential waste heat sources are identified close to each of the areas. Utilising waste heat in a district heat network represents a good use of resources which are otherwise being wasted, and can offset the need to source heat from other resources. If MCC (or another district heat network developer) is interested in progressing a district heat network in the areas identified, the potential sites of waste heat should be further investigated to understand if they are sources of waste heat and, if so, the scale of heat supply available.

7.3.11 MCC has not yet determined the location of their new strategic development sites. These sites may present potential for a heat network on their own, or if located near to the other anchor heat loads, may add to the potential financial viability of heat networks in those location. It is more straight forward to design a district heat network into a new development than retrofit it to an existing development. As such, MCC should encourage developers to consider district heat networks when designing strategic development sites, alongside other low carbon heating solutions.

7.3.12 Heat networks have traditionally been located in areas of high heat density due to high capital costs. Within these traditional heat network areas, core heat densities of the anchor heat loads would be expected to be greater than 50 kWh/m^2 p.a. (across the geographic area of the heat network) to ensure financial viability (IEA, 2008). The International Energy Agency (IEA, 2008) undertook a study into district heating distribution in areas with low heat demand density, and concluded that areas with a heat density of 10 kWh/m^2 p.a. could have financially viable district heating systems if more careful planning was undertaken to reduce costs and heat loss (e.g. changes in system design utilising low pressure and low temperature systems with direct connection to radiators). A recent study by the Energy Technologies Institute (ETI, 2018) has similarly identified potential methods of reducing district heat network costs, which may help to facilitate greater potential for heat network development. The heat density of 10 kWh/m^2 p.a. is considered to be the current limit of financial viability.

7.3.13 To provide an initial indication of viability, heat maps of the anchor heat loads are generated in GIS using a Kernel Distribution Estimator (KDE). The KDE estimates the density of heat within a given radius of the anchor heat load location (which is provided as a single grid referenced point). The KDE uses a model function through which “distance decay effect” can be taken into account, i.e. *"the longer the distance between a point and location [...], the less that point is weighted for calculating the overall density"* (Xie and Yan, 2008, p.9). A number of forms of model functions, known as kernel functions, can be used to measure the "distance decay effect", including Rectangular/Uniform, Gaussian, Quartic, Triangular, and Epanechnikov. The distributions of these functions are illustrated in Figure 40.

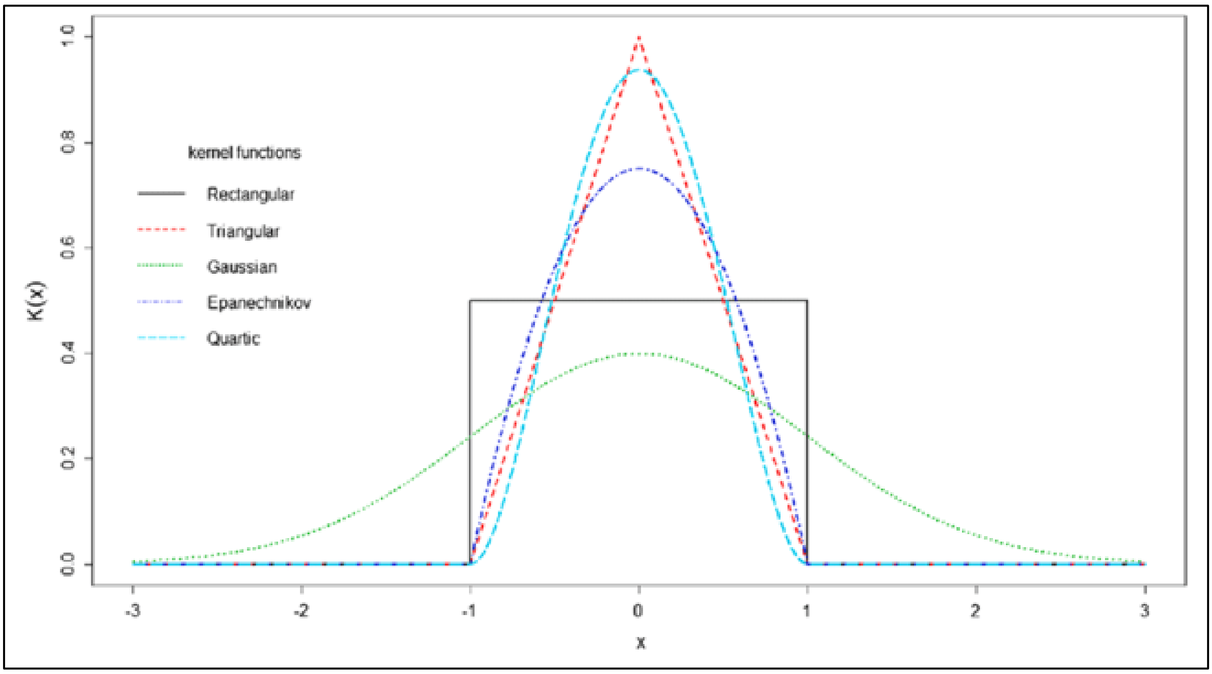


Figure 40: Example kernel function distribution curves

(Wang et al., 2019)

7.3.14 Three heat maps are provided using a rectangular/uniform kernel function, which assumes that the heat density is consistent across the radius around the point. The three maps generated use different radii, as follows:

- 250m radius (Figure 41)
- 500m radius (Figure 42)
- A variable radius of 250m for loads with a heat demand of less than 1 GWh p.a. and 500m for loads with a heat demand greater than 1 GWh p.a. (Figure 43).

7.3.15 Assuming a 250m radius of influence, identifies two areas of heat density demands of 10-25 kWh/m^2 p.a. This potential only involves two heat anchor loads in each example and is very limited in area. It is considered more likely, and appropriate, to consider the development of a heat network where it is advantageous for three or more anchor heat loads to be connected.

Figure 41: Anchor heat load density using Kernel Density (Uniform) calculation method – 250m radii

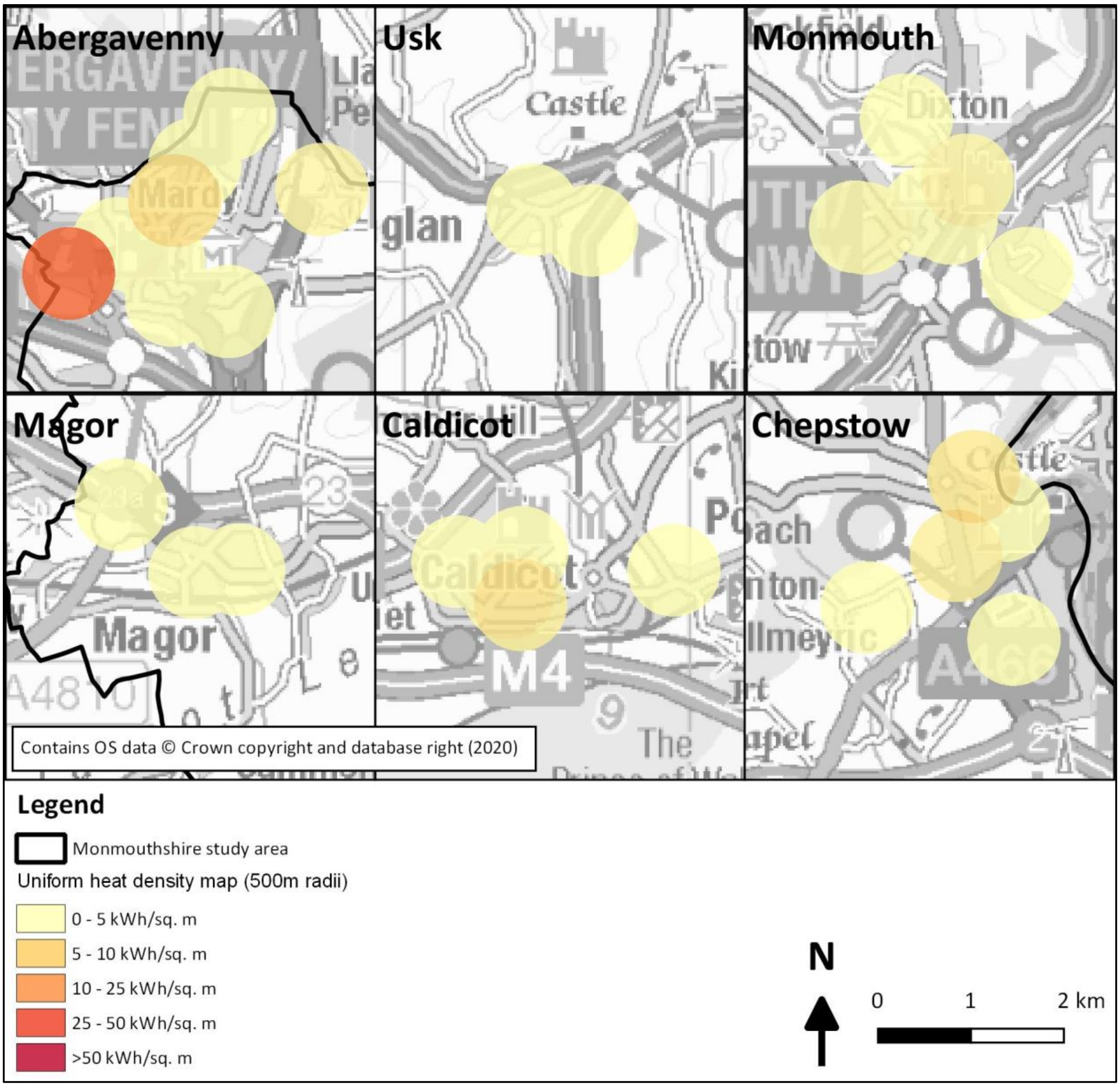


Figure 42: Anchor heat load density using Kernel Density (Uniform) calculation method – 500m radii

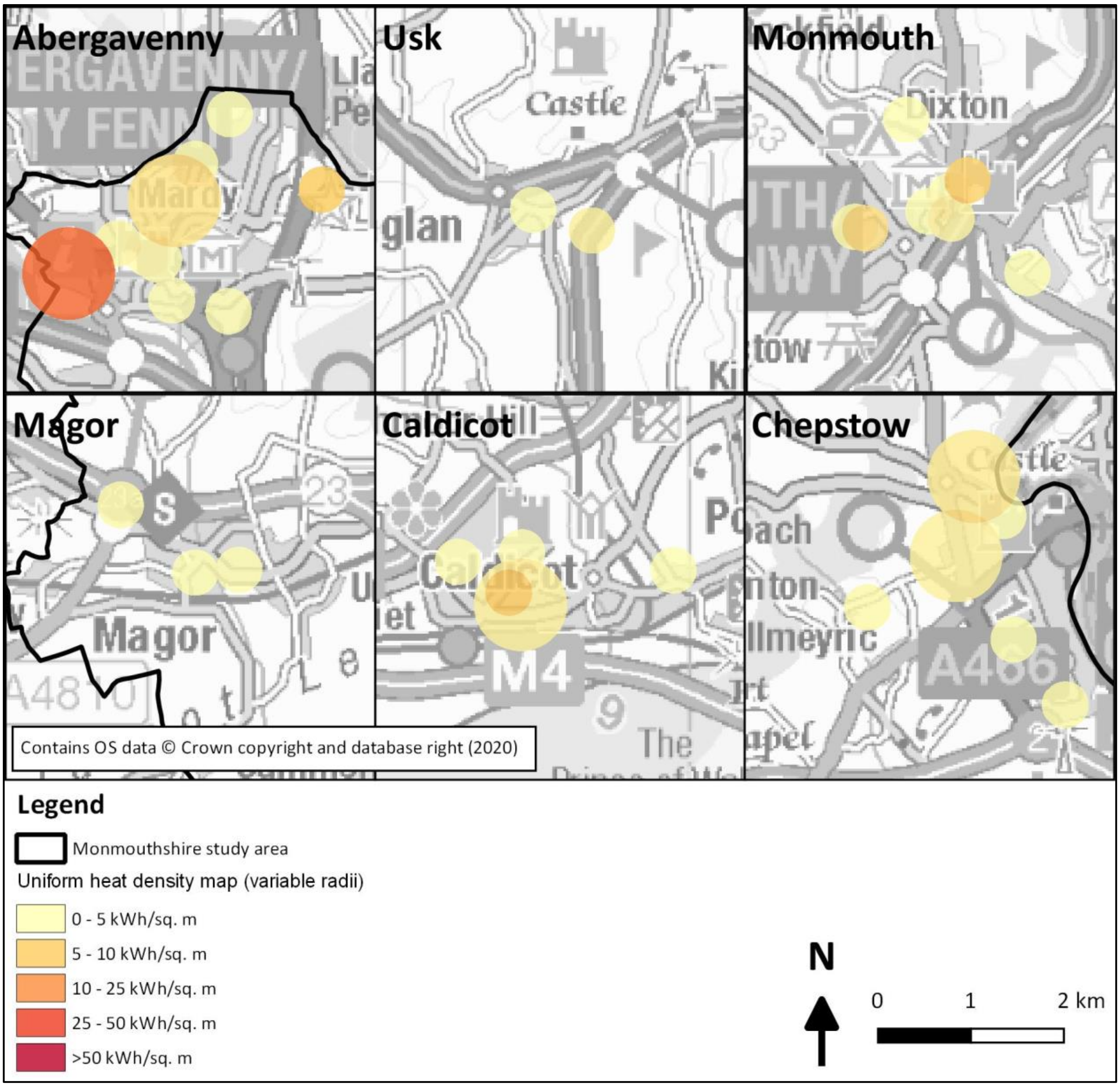


Figure 43: Anchor heat load density using Kernel Density (Uniform) calculation method – variable radii

7.3.16 Figure 44 provides a fourth Kernel Density map assuming a quartic function with the variable radii provided in Figure 43. A quartic kernel function assumes that the heat demand has greater influence closer to the point of the demand, as per the distribution curve shown in Figure 40.

7.3.17 A quartic distribution identifies additional areas with potential demand greater than 10 kWh/m^2, the greatest additional potential being in Monmouth due to the proximity of the loads. However, in general the opportunities are limited in terms of the number of loads connected and the area covered indicating limited opportunity for heat network development.

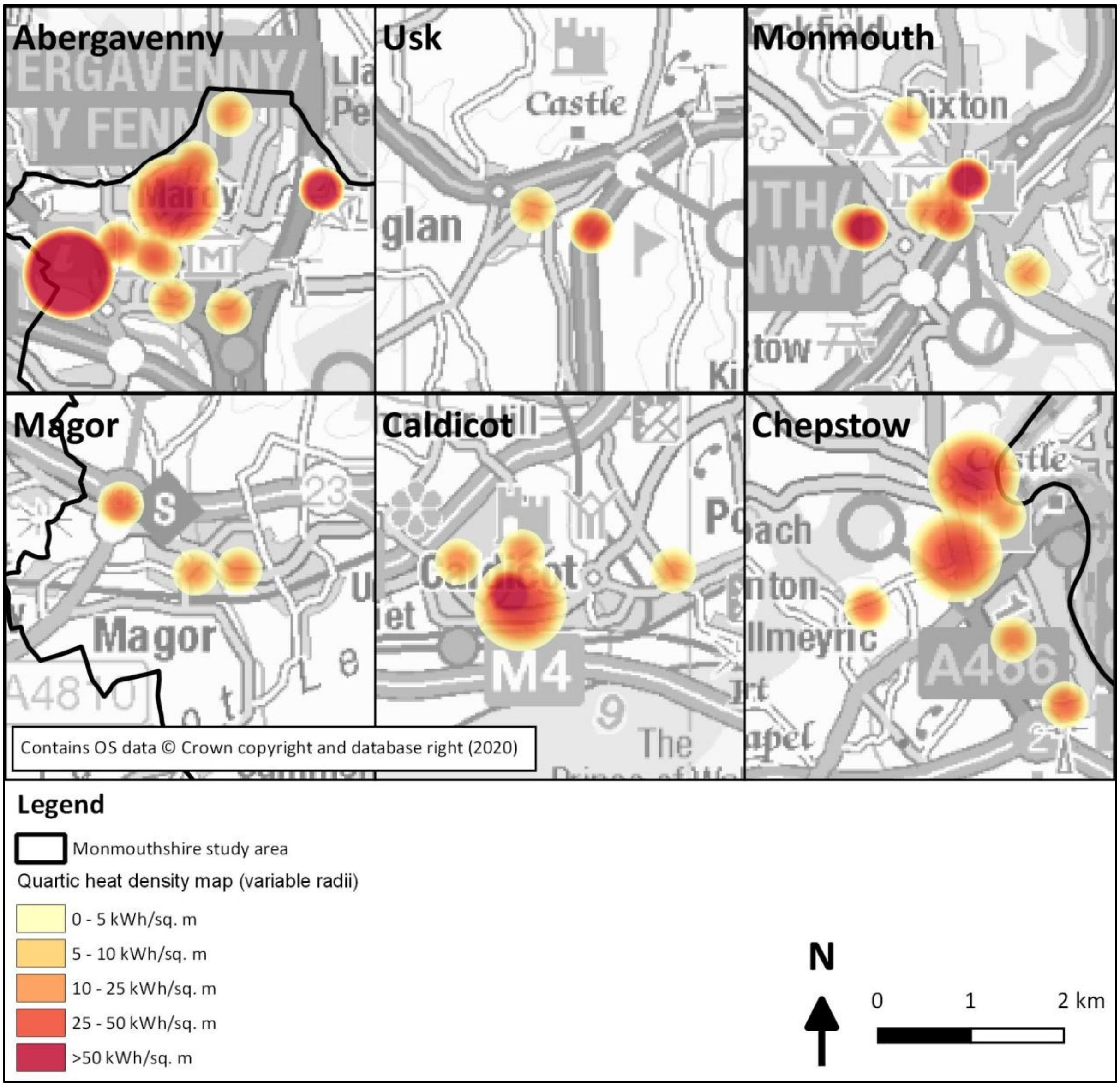


Figure 44: Anchor heat load density using Kernel Density (Quartic) calculation method – variable radii

7.4 Conclusions

7.4.1 While the heat mapping exercise identifies groups of anchor heat loads within eight settlements within the study area, and some potential to achieve heat demands of greater than 10 kWh/m^2, in general there is very little potential for financially viable traditional heat networks (50 kWh/m^2 and greater). This corresponds with the Welsh Government's own heat mapping for the National Development Framework, which did not identify any priority heat networks within Monmouthshire.

7.4.2 MCC has not yet identified their RLDP strategic development sites. It is more straight forward to design a district heat network into a new development than retrofit it to an existing development. As such, MCC should encourage developers to consider district heat networks when designing strategic development sites alongside other low carbon heating solutions.

7.4.3 As referenced in Section 7.1, Sustainable Energy consultancy has been appointed to investigate the potential for district heat networks in 'The Vale of Usk' Region (Monmouthshire and rural areas of Newport). The outputs of this investigation may identify potential for heat networks which are not identified within this Renewable and Low Carbon Energy Assessment. MCC's LPA should review the outputs of this additional assessment when considering planning policies relating to low carbon heat.

7.4.4 Further heat network opportunities may become available as technology and business model innovations are explored and developed, e.g. a project looking at the potential for utilising heat in waste water to provide heating to homes in Caldicot (Cenex, 2020).

8. Strategic Development Sites

8.1 Introduction

8.1.1 The Toolkit (Welsh Government, 2015) suggests that local authorities consider the integration of renewable energy into strategic developments within the LDP. Welsh Government has an ambition to reduce the carbon emissions associated with new developments from 2020 onwards. This carbon reduction is expected to be achieved through a mixture of high fabric efficiency alongside low carbon heating and/or renewables (Welsh Government, 2019d). Integration of renewable energy is most likely to be achieved on an individual building level, through installation of roof-top solar PV, but may also be achieved via private networks connected to local wind turbines or solar farms.

8.1.2 MCC has not yet selected candidate strategic development sites for the next RLDP. The housing requirement for the RLDP has not yet been established, so the assessment assumes a continuation of the Adopted LDP housing rate of 450 per annum giving a total requirement of 6,750 for the 15 year Plan period. Of the 6,750 new dwellings to be built over the plan period (including those already completed), 2,602 are understood to have already gained planning consent or completed on large sites (ten units or greater) and a further 1,204 homes are estimated to come forward on small sites over the Plan period, based on past delivery rates. Whilst the small sites do have potential to incorporate renewable energy generation, strategic scale renewable energy integration options may be more difficult to achieve.

8.1.3 When the candidate strategic development sites are identified, this assessment will be updated with the following tasks completed:

- The overall energy demands of all planned new developments will be estimated.
- A high-level assessment of the existing grid infrastructure that could serve the new developments will be completed.
- An assessment of the strategic development sites' potential suitability for district heating, in addition to overall power needs of the developments if heating requirements are met via heat pump technology, will be undertaken.
- The potential for electricity generation from roof-top PV will be estimated and compared to the energy demand estimates.
- The potential for the strategic development sites to be provided with power generated from local wind or solar farms by mapping their locations against the less constrained areas identified in Sections 4 will be assessed.

9. Further Appraisal of Wind and Ground Mounted Solar

9.1 Introduction

9.1.1 The Toolkit (Welsh Government, 2015, p.93) states that *"a local authority should identify spatially, areas that may be particularly suitable for larger scale renewable energy development"* so that *"it sends an invitation to potential developers that the local authority is interested in seeing suitable development in those sites and that there is a greater likelihood of securing planning consent for applications in those areas"*.

9.1.2 Planning Policy Wales 10 states; *"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, 2018b, p.92). The working draft NDF identifies Pre-Assessed Areas for Wind (see Figure 2), where there is a presumption in favour of large-scale (10 MW and greater) wind developments in these areas (Welsh Government, 2020e). The renewable energy areas identified in the RLDP should relate to sub-10 MW development. Within the working draft NDF no Pre-Assessed Areas for Wind are identified within Monmouthshire, however MCC should review the final adopted NDF, in case this changes.

9.1.3 It is suggested that the identified areas, where there is a presumption in favour of development and an acceptance of landscape change, are referred to within the RLDP as "Local Search Areas", which is the terminology used in this assessment.

9.1.4 Within this Section, the less constrained areas in Sections 4.2 and 4.3, are reviewed and prioritised with respect to additional constraints, to aid identification of Local Search Areas by the local planning authority following publication of the assessment.

9.1.5 Whilst the assessment is based on the less constrained areas, it is recommended that the Local Search Areas identified within the RLDP are identified as broad areas (similar to the draft NDF) which encompass the less constrained areas assessed.

Box 13: Pre-assessed Areas and Local Search Areas

It is anticipated that The National Development Framework, *Future Wales – The National Plan 2040* (NDF, currently in draft form) will identify areas where there is a presumption in favour for large scale wind (capacities in excess of 10 MW). The Replacement Local Development Plan should identify "Local Search Areas" for development of renewable energy with capacities of less than 10 MW.

It is recommended that MCC ensure that any sub-10 MW developments do not preclude the potential for larger developments within the areas identified in the national development framework. Therefore, if RLDP Local Search Areas are identified within NDF Pre-Assessed Wind Areas, development of sub-10 MW wind generation projects should only be permitted if they would not preclude or detrimentally impact the development of larger projects within these areas identified. A developer looking to develop a sub-10 MW project within these areas should demonstrate why their development does not preclude potential for larger developments, e.g. their particular site may not be suitable for a larger development due to access restrictions, grid capacity restrictions, ecology issues etc.

As development plan designations, Local Search Areas will be presented within the RLDP Proposals map. Welsh Government have indicated that any spatial designations in the eventual NDF will also carry development plan status (differing from the Strategic Search Areas in TAN 8) so could theoretically also be shown on the RLDP proposals map; albeit that they would not be available for comment or scrutiny through the RLDP examination process.

9.2 Method

9.2.1 The method for prioritising areas for solar/wind development opportunities is provided in Figure 45 with further details provided regarding the prioritisation exercise criteria provided below.

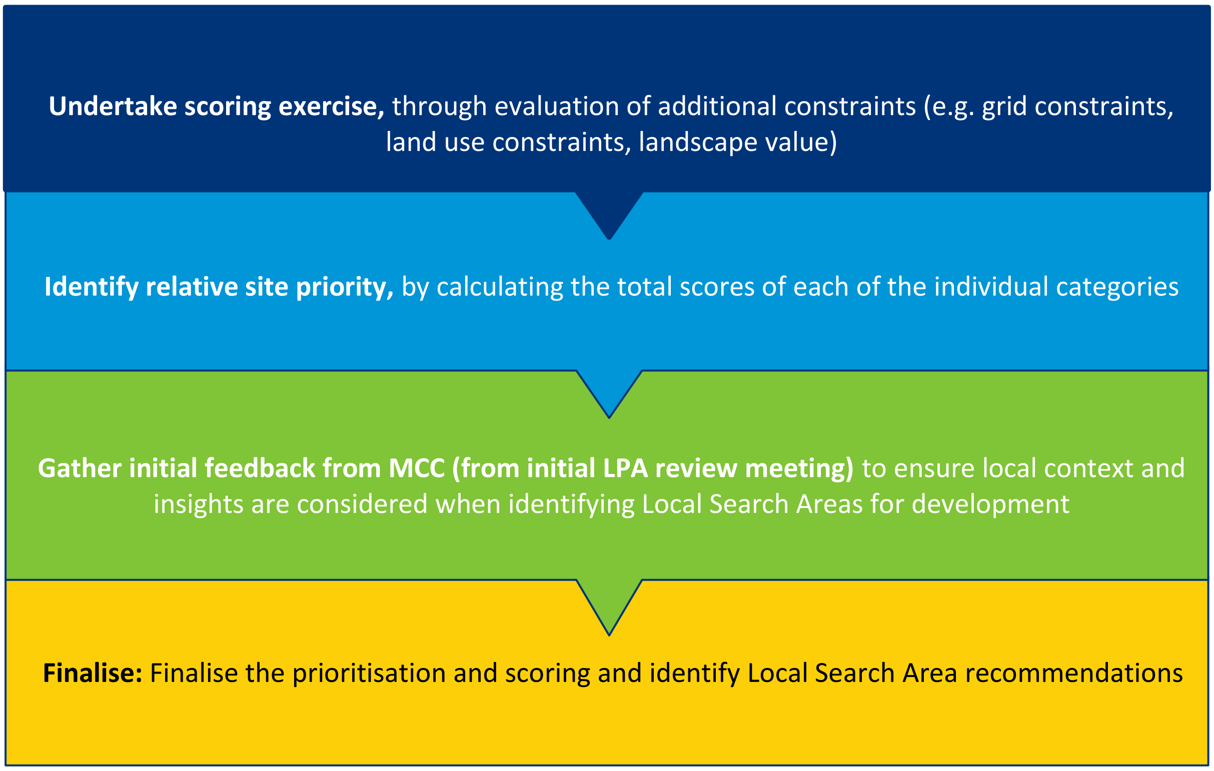


Figure 45: Method for identifying Local Search Area recommendations

Prioritisation exercise criteria

9.2.3 To support identification of Local Search Areas for wind and solar, the less constrained areas identified in Sections 4.2 and 4.3 are evaluated with respect to:

- Local landscape value (wind and solar)
- Cumulative impact (wind and solar)
- Grid constraints (wind and solar)
- Wind resource (wind)
- Other land use: aviation constraints (wind) and agricultural land classification (solar).

9.2.4 The less constrained wind sites are assessed according to their clusters (identified in Figure 46), and the solar sites are assessed according to their geographical area (identified in Figure 47).

9.2.5 The large number and concentration of less constrained areas for ground mounted solar makes it difficult to identify specific geographical groupings. Landmap Visual Sensory Aspect Areas (NRW, 2020) are used to help inform groupings, with neighbouring aspect areas amalgamated where similar landscape character types are identified, or similar rating values are assigned. Figure 48 identifies the underlying areas which are used to inform the less constrained solar area groupings on this basis. Some areas cross group borders and as such one groups is selected over another for scoring purposes.

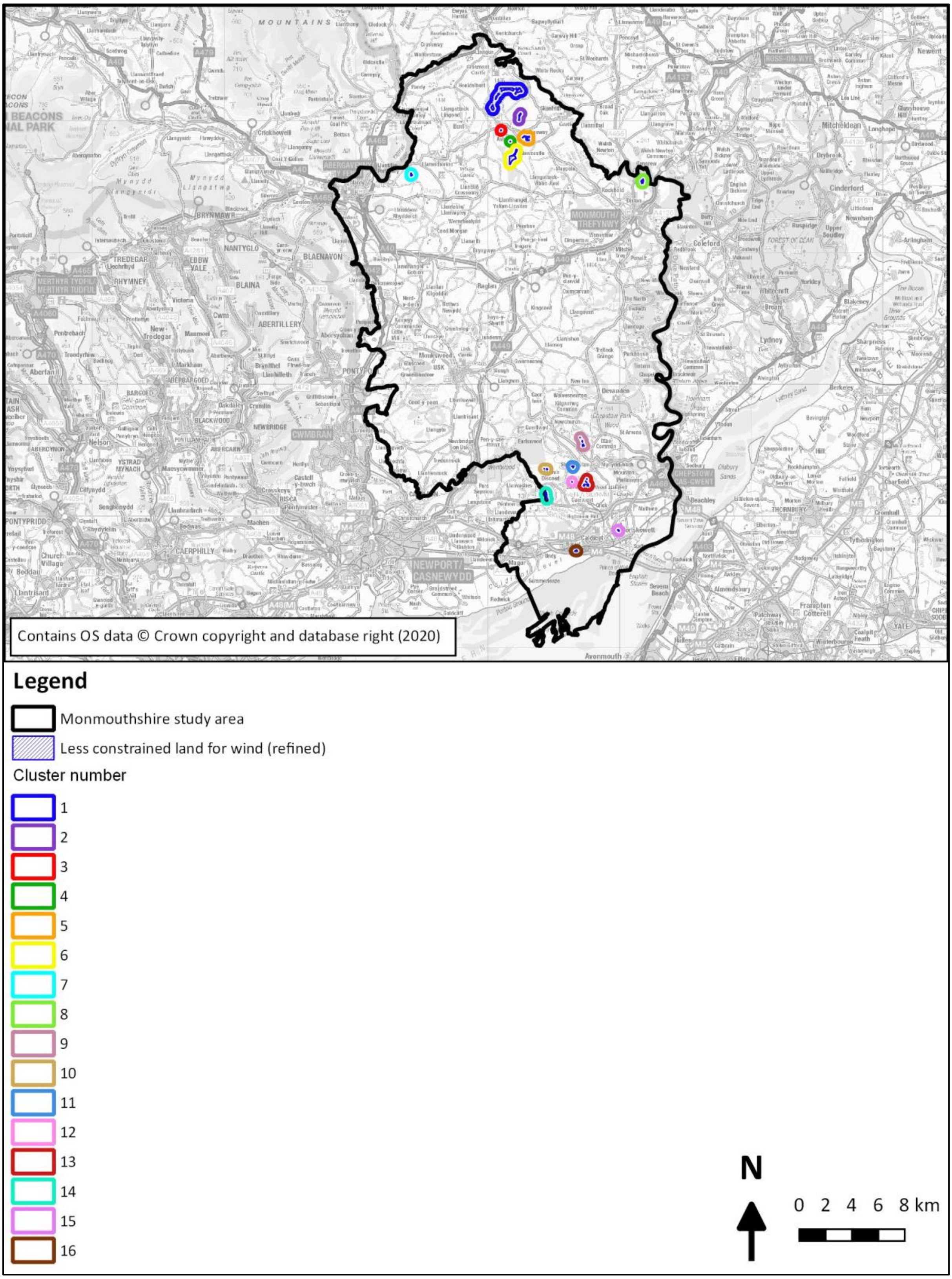


Figure 46: Less constrained land for wind (refined) and grouped by cluster locations

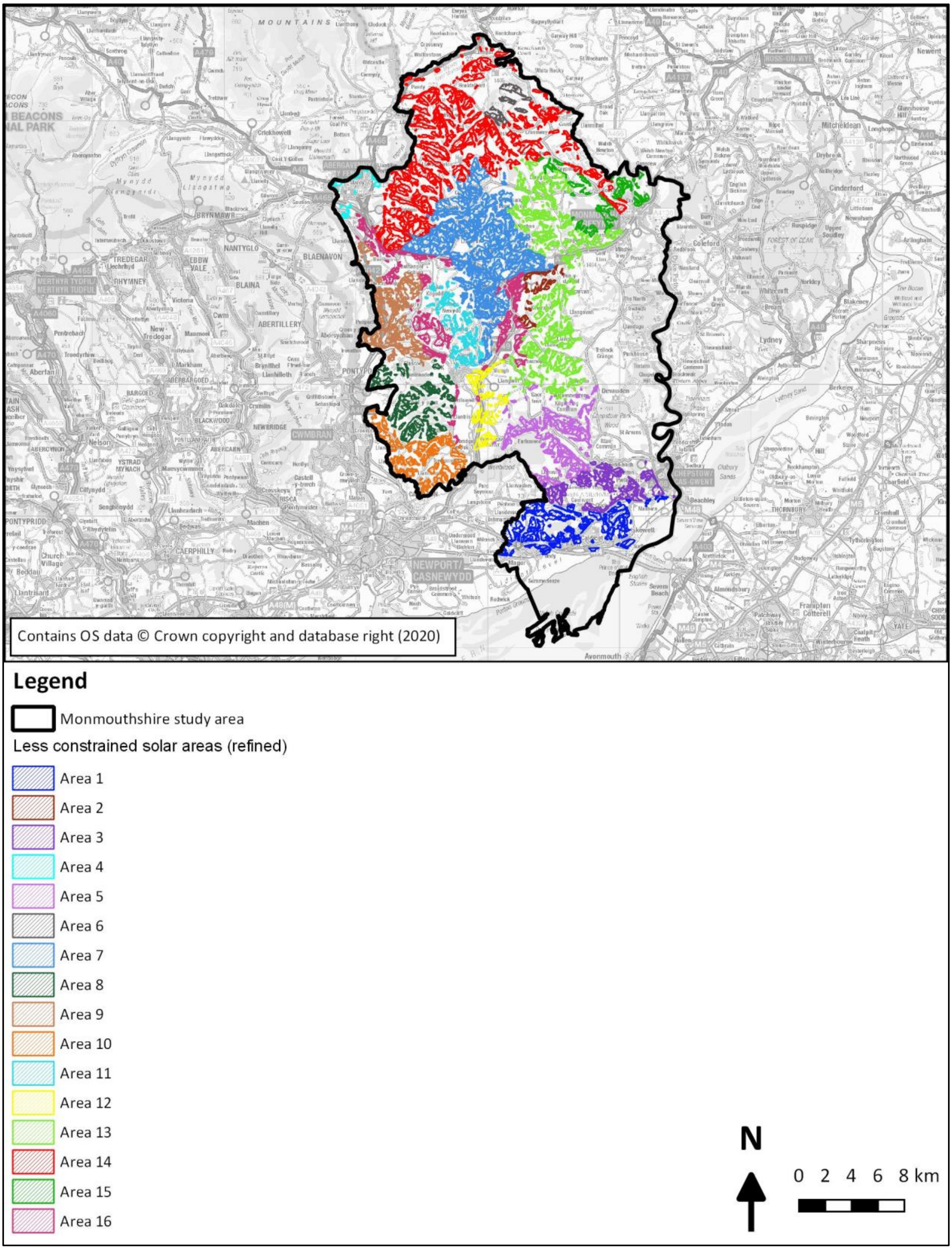


Figure 47: Less constrained land for solar (refined) and grouped by geographical area

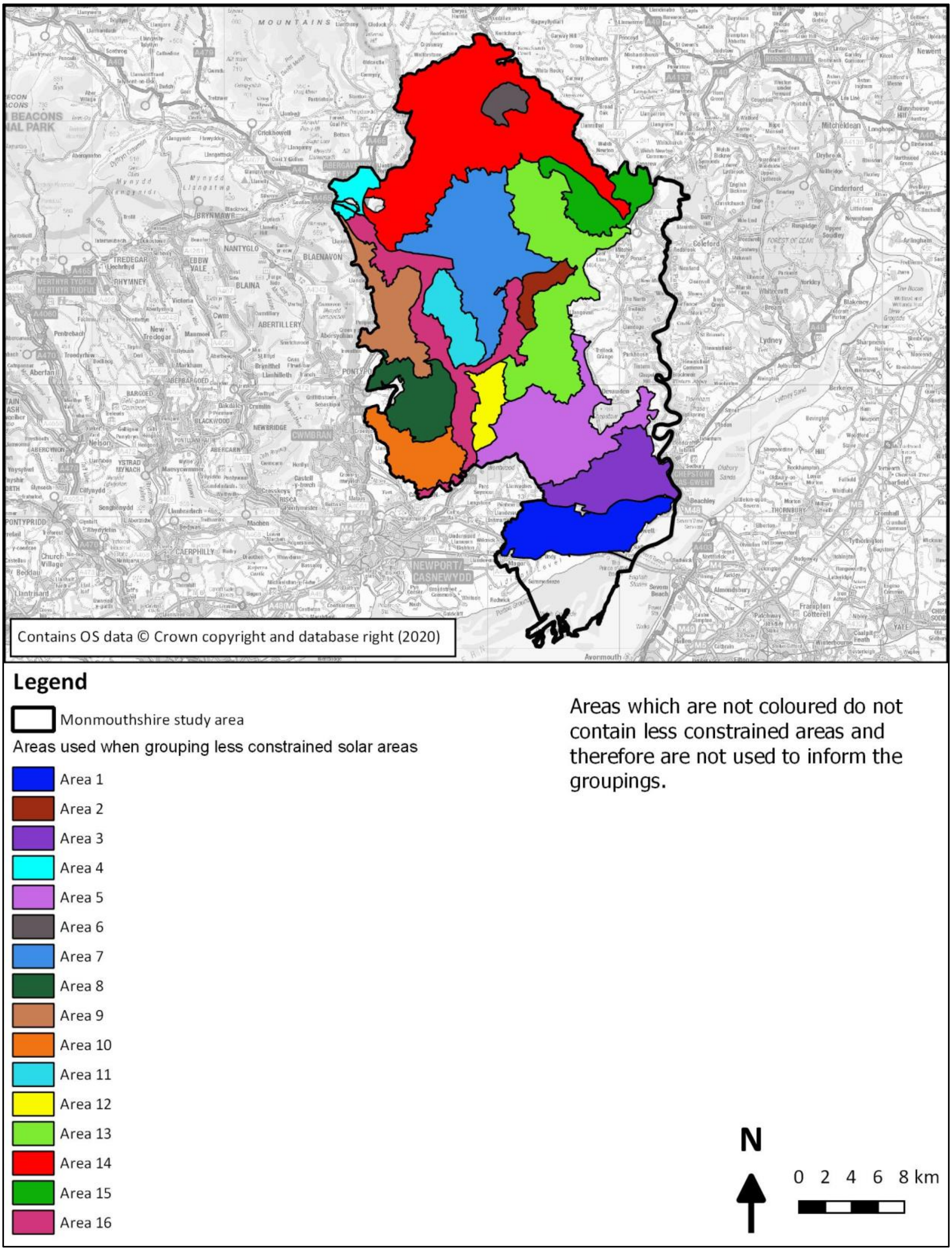


Figure 48: Groups of Landmap Visual Sensory Aspect areas which inform the less constrained land for solar groupings

9.2.6 Each group/cluster is scored out of 6 within each criterion relative to the other sites. The scoring is illustrated by colour in the results tables as shown in Table 40.

Table 40: Scoring criteria for prioritisation exercise

Score
6 – Least constrained
5
4
3
2
1 – Most constrained

Landscape value and cumulative impact

9.2.7 The landscape impact of a development is highly site specific, and therefore the discussion in this Section regarding landscape value is high-level in nature, and seeks to prioritise the areas identified with respect to their likely, local sensitivity, based on their designated landscape value. It is not intended to determine whether an individual site would be acceptable or not from a landscape perspective.

9.2.8 The individual wind clusters and groups of less constrained solar sites identified in Figures 45 and 46 are assessed with respect to their overall Landmap classifications, Landmap classifications for scenic quality and character, and proximity to other developments and designations. These categories are identified following a review of *Planning Guidance for Smaller Scale Wind Turbine Development Landscape and Visual Impact Assessment Requirement* (Gillespies 2015a), which provides detailed guidance on how individual sites should be assessed with respect to their landscape and visual impact. Landmap is an all-Wales landscape resource which records and evaluates landscape characteristics, qualities and influences on the landscape (NRW, 2020).

9.2.9 Within *Planning Guidance for Smaller Scale Wind Turbine Development Landscape and Visual Impact Assessment Requirements,* Gillespies LLP (2015a) suggest that impacts from a development are related to the size and scale of the proposal and the sensitivity of the location. Within a landscape sensitivity assessment for wind turbines in the Heads of the Valleys area, Gillespies LLP (2015b, p.13) also states that *"A landscape that is highly valued by society may still be able to accommodate some wind turbine development in the right location if it fits with the characteristics of the landscape. In designated landscapes wind turbine development is acceptable if it does not compromise the purpose of designation. In undesignated landscapes wind turbine development is acceptable if it does not compromise the qualities and values attached to the landscape. Conversely a landscape that isn't designated may be highly sensitive to wind turbine development if it has particular landscape or visual characteristics that are very susceptible to wind turbine development."*. This statement confirms that landscape impact is highly site specific, and should be reviewed on a case by case basis.

9.2.10 Within the landscape sensitivity assessment, Gillespies LLP (2015b) provide the following criteria for determining wind turbine size:

- **Micro:** Less than 25m tip height/roof mounted, only one turbine
- **Small:** Less than 50m tip height, three or fewer turbines
- **Medium:** Less than 80m tip height, four turbines or fewer
- **Large:** Less than 109m, five turbines or fewer
- **Very large:** 109m or greater, any number of turbines

9.2.11 As the wind energy industry has matured, wind turbines have grown in both power generating capacity and physical size. A more recent study by Arup (2019) which informed the draft National Development Framework (Welsh Government, 2019e, 2020e) provided the following definitions:

- **Small turbine:** 22.2m tip height
- **Small-medium turbine:** 123m tip height
- **Medium-large turbine (average of commercially available turbine):** 222m tip height
- **Largest commercially available turbine:** 330m tip height

9.2.12 The candidate turbine referred to in section 4.2 of this assessment is a 2 MW wind turbine with an 80m hub height and 80m rotor diameter; providing a 120m tip height, which is in line with the small-medium turbine identified by Arup (2019), but would be considered a very large turbine in the criteria provided by Gillespies LLP (2015b).

9.2.13 Gillespies LLP (2015a) suggest that developments greater than 5 MW are likely to only be appropriate within the Strategic Search Areas (SSAs) identified in TAN 8. Whilst TAN 8 states that "… t*he Assembly Government would support local planning authorities in introducing local policies in their development plans that restrict almost all wind energy developments, larger than 5MW, to within SSAs and urban/industrial brownfield sites…"* (Welsh Government, 2005, p.8), the SSAs were identified to accommodate large wind developments over 25 MW in capacity, and it is this size which is referenced in PPW 10:

"The Welsh Government has identified Strategic Search Areas (SSAs) which, on the basis of substantial empirical research, are considered the most appropriate locations for large scale on-shore wind farm development (over 25MW)."

(Welsh Government, 2018b, p.93)

9.2.14 The number and capacity of existing developments is also considered for both wind and solar in order to understand the potential for cumulative impact issues to arise.

9.2.15 As such, the view that wind developments greater than 5 MW are only acceptable within Strategic Search Areas is considered outdated, and wind developments, wherever they are sited, should be assessed on their site-specific impacts and benefits.

Grid constraints

9.2.16 Western Power Distribution (WPD) provide information on their website in the form of a "network capacity map", which provides high-level information regarding the capacity available at grid supply points, bulk supply points and primary substations. WPD caution that the "*map gives a general illustration of availability constraints* ***only*** *and cannot be relied upon to assess the terms of connection for specific premises*" (WPD, 2020). To understand the costs, complexity and infrastructure requirements for a specific connection, a developer would need to contact WPD who would undertake development specific studies to understand the network implications of a proposal. As such, the data contained in WPD's map is used to provide a high-level assessment only and is related to information available at the time of writing (May 2020).

9.2.17 WPD’s network capacity map provides indicative values for:

> *Relevant for demand connections:*
  - Substation firm demand capacity
  - Substation peak demand
  - Substation demand headroom
  - Upstream demand headroom

> *Relevant for generation connections:*
  - Connected generation
  - Accepted not yet connected generation capacity
  - Offered not yet accepted generation capacity
  - Substation reverse power headroom
  - Upstream generation headroom

> *Relevant for demand and generation connections:*
  - Substation fault level headroom

9.2.18 It also indicates the level of total site capacity that is still available for these factors using a colour-coding system:

> Green: at least 25% total site capacity is still available,
> Amber: 10-25% total site capacity still available
> Red: less than 10% site capacity is still available
> Blue: no information is provided regarding the blue rating, but it is assumed that no constraints are known or identified or known*.

(WPD, 2020)

*These entries have been maintained in order to reflect the published network capacity map.

9.2.19 Reverse power headroom refers to the *“capacity available for export at that site”* (WPD, 2020). Upstream generation headroom refers to the *“availability at sites upstream from the substation. Any upstream constraints affect downstream so that the status of these sites are pulled up to the lowest availability rating in the hierarchy”* (WPD, 2020). Fault level refers to the maximum **current** that would flow in case of a short circuit **fault** at that point. Fault level head room refers to the “*remaining fault level capacity at the site*” (WPD, 2020). Any additional generation connections to be accommodated on the network must not contribute fault current greater than the available headroom. The contribution a generation asset would make to the primary substation would vary dependent on the asset technology type, capacity and location, and would be determined by WPD when a developer applies for a connection.

9.2.20 The less constrained wind and solar areas are prioritised with respect to the status of the Reverse Power Headroom, Upstream Generation Headroom and Substation Fault Level Headroom of bulk supply point and primary substations that serve the area.

9.2.21 Monmouthshire county is served by electricity network from two grid supply points: Uskmouth and Rassau. Constraints are not identified at any of these grid supply points within the network capacity map (colour coded blue). The status of the bulk supply points (BSPs) and primary substations that supply the areas covering the less constrained areas are reviewed in order to identify any potential network constraints which may need to be addressed in order to allow the further renewable energy generation to be connected to the distribution network in these locations. As noted above this information is indicative in nature, and could only be confirmed with development-specific detailed studies undertaken by WPD.

9.2.22 Figure 49 provides an overview of the status of substations within Monmouthshire from the WPD (2020) map, with respect to generation capacity, and shows that at a high-level Monmouthshire is constrained from this perspective.

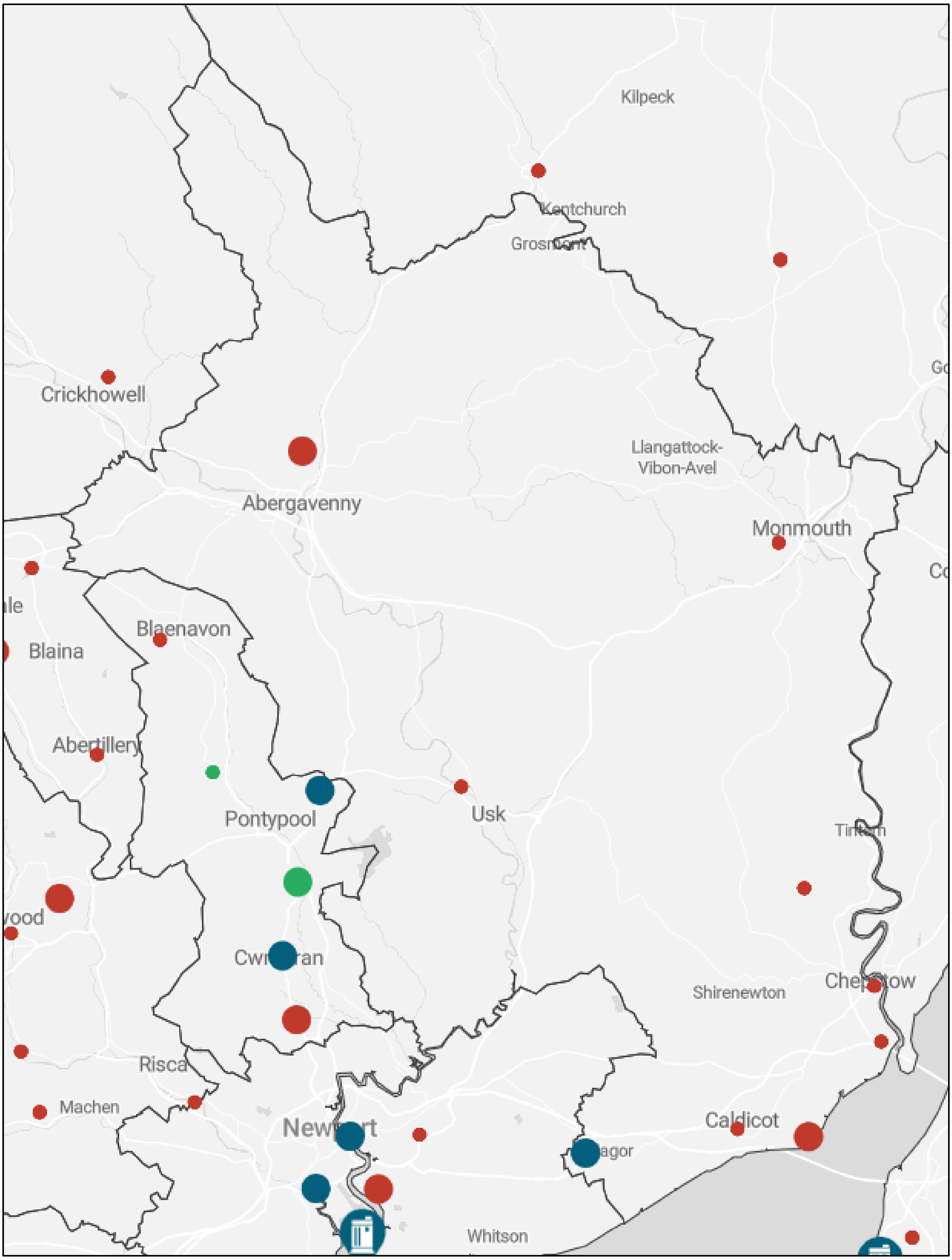


Figure 49: WPD network capacity map showing Generation Capacity status at substations

(WPD, 2020)

Box 14: Note relating to grid capacity

It may be possible to connect generation assets to substations that do not supply the area in which the site is located, especially if the site is located at the edge of a substation supply area.

Greater generation asset capacities may be able to be connected to the substations than indicated in the WPD maps if the infrastructure is upgraded/reinforced. The costs of any upgrades/reinforcement would only be known following detailed investigations on specific developments by WPD. The impact that this would have on a project's viability would need to be assessed by the developer and would be dependent on a variety of factors.

Network capacity constraints are wide-spread across the UK and it is anticipated that significant reinforcement/upgrade works will be required over the next decade in order to facilitate a decarbonised energy system and meet carbon reduction targets.

Resource and proximity to Strategic Search Areas

9.2.23 The Toolkit (Welsh Government, 2015) suggests prioritising the identified wind clusters by average wind speed. The wind speed range estimated by the Met Office (no date) for each cluster is provided. The presence of the clusters within the TAN 8 Strategic Search Areas are reviewed but none are present within the study area.

Aviation constraints

9.2.24 With respect to potential conflict between wind turbines and aviation, Table 41 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.

Table 41: Summary of CAA guidance regarding potential impact of wind developments on aerodrome 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

(CAA, 2016)

9.2.25 In addition to the CAA guidance, NATS (National Air Traffic Surveillance) provide self-assessment maps for the primary surveillance radar, air-ground-air (AGA) communication stations, navigation aids and secondary surveillance radar (NATS, no date).

9.2.26 The NATS (no date) self-assessment maps and geographical data on aerodromes provided by the CAA (2014) are consulted. Existing wind turbines are present within aviation radar zones, so whilst they present a risk to development, it is evident that there is still potential for development in these locations.

Agricultural land classification

9.2.27 It is considered best practice to site solar PV developments on non-agricultural land or lower quality agricultural land (Solar Trade Association, no date). The Welsh Government (2020b) provide a predictive Agricultural Land Classification map for the whole of Wales which is used to identify the agricultural land grades that are present within the less constrained solar areas identified.

9.3 Results

Less constrained areas prioritisation

9.3.1 Table 42 provides the scoring and prioritisation results. Figure 50 identifies the areas identified in the top three priorities. Tables summarising the information and details behind the prioritisation exercise are provided in Appendix 6.

9.3.2 Due to the size of the wind areas identified as less constrained, the scoring exercise is not as informative as it may be if the areas were larger. It is considered that Local Search Areas should cover broad geographical areas rather than individual sites, as such the eventual Local Search Areas should encompass the less constrained areas and not be restricted by them.

9.3.3 Appendix 4 contains the following Figures:

- Figure 58: Less constrained land for wind (refined) and landscape designations
- Figure 59: Less constrained land for wind (refined) and historic designations
- Figure 60: Less constrained land for wind (refined) and LANDMAP visual and sensory overall rating
- Figure 61: Less constrained land for wind (refined) and LANDMAP visual and sensory character rating
- Figure 62: Less constrained land for wind (refined) and LANDMAP visual and sensory scenic quality rating
- Figure 63: Less constrained land for wind (refined) and LANDMAP historic overall rating
- Figure 64: Less constrained land for wind (refined) and LANDMAP cultural overall rating
- Figure 65: Less constrained land for wind (refined) and LANDMAP landscape habitats overall rating
- Figure 66: Less constrained land for wind (refined) and LANDMAP geological overall rating
- Figure 67: Less constrained land for wind (refined) and existing wind developments
- Figure 68: Less constrained land for wind (refined) and wind speed
- Figure 69: Less constrained land for wind (refined) and aviation zones
- Figure 70: Less constrained land for solar (refined) and landscape designations
- Figure 71: Less constrained land for solar (refined) and historic designations
- Figure 72: Less constrained land for solar (refined) and LANDMAP visual and sensory overall rating
- Figure 73: Less constrained land for solar (refined) and LANDMAP visual and sensory character rating
- Figure 74: Less constrained land for solar (refined) and LANDMAP visual and sensory scenic quality rating
- Figure 75: Less constrained land for solar (refined) and LANDMAP historic overall rating
- Figure 76: Less constrained land for solar (refined) and LANDMAP cultural overall rating
- Figure 77: Less constrained land for solar (refined) and LANDMAP landscape habitats overall rating

- Figure 78: Less constrained land for solar (refined) and LANDMAP geological overall rating
- Figure 79: Less constrained land for solar (refined) and existing solar farm developments
- Figure 80: Less constrained land for solar (refined) and predicted agricultural land classification

Table 42: Prioritisation results

Priority	Wind clusters	Solar areas
1	12	10
2	14 and 15	7 and 13
3	13	1
4	4 and 11	6, 8 and 16
5	2, 3, 10	5 and 9
6	5 and 6	2 and 3
7	1 and 9	14
8	7, 8 and 16	4, 12 and 15
9		11

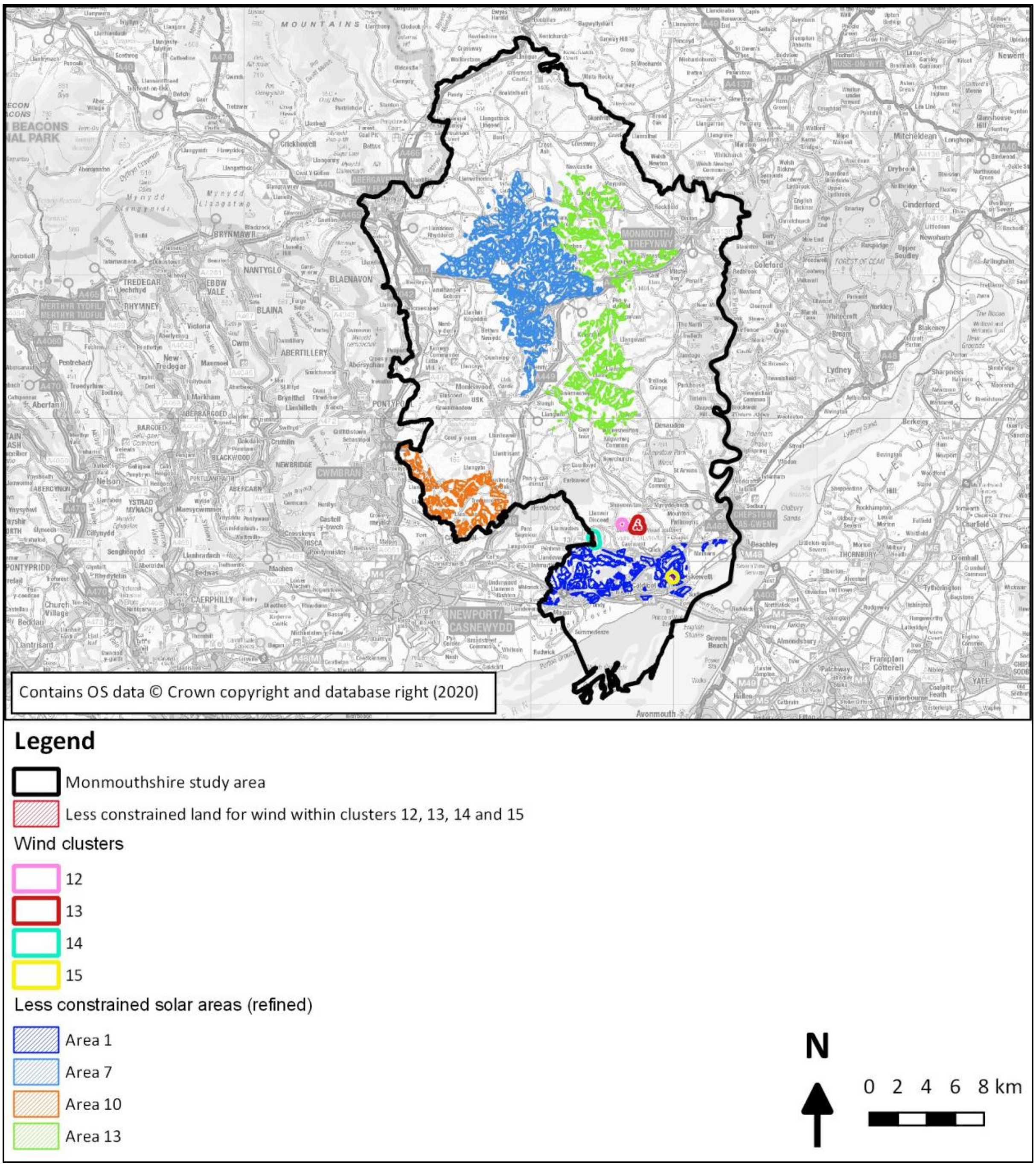


Figure 50: Top priority areas for wind and solar following scoring exercise

Candidate Renewable Energy Sites

9.3.4 MCC have provided details of candidate renewable energy sites, as follows:

- Penarth Farm (CS0064)
- Bridge View Farm, Portskewett (CS0066)
- Land adjacent to Raglan Enterprise Park (CS0069)

9.3.5 Figure 51 and Figure 52 show the location of these sites against the less constrained areas for wind and solar, respectively.

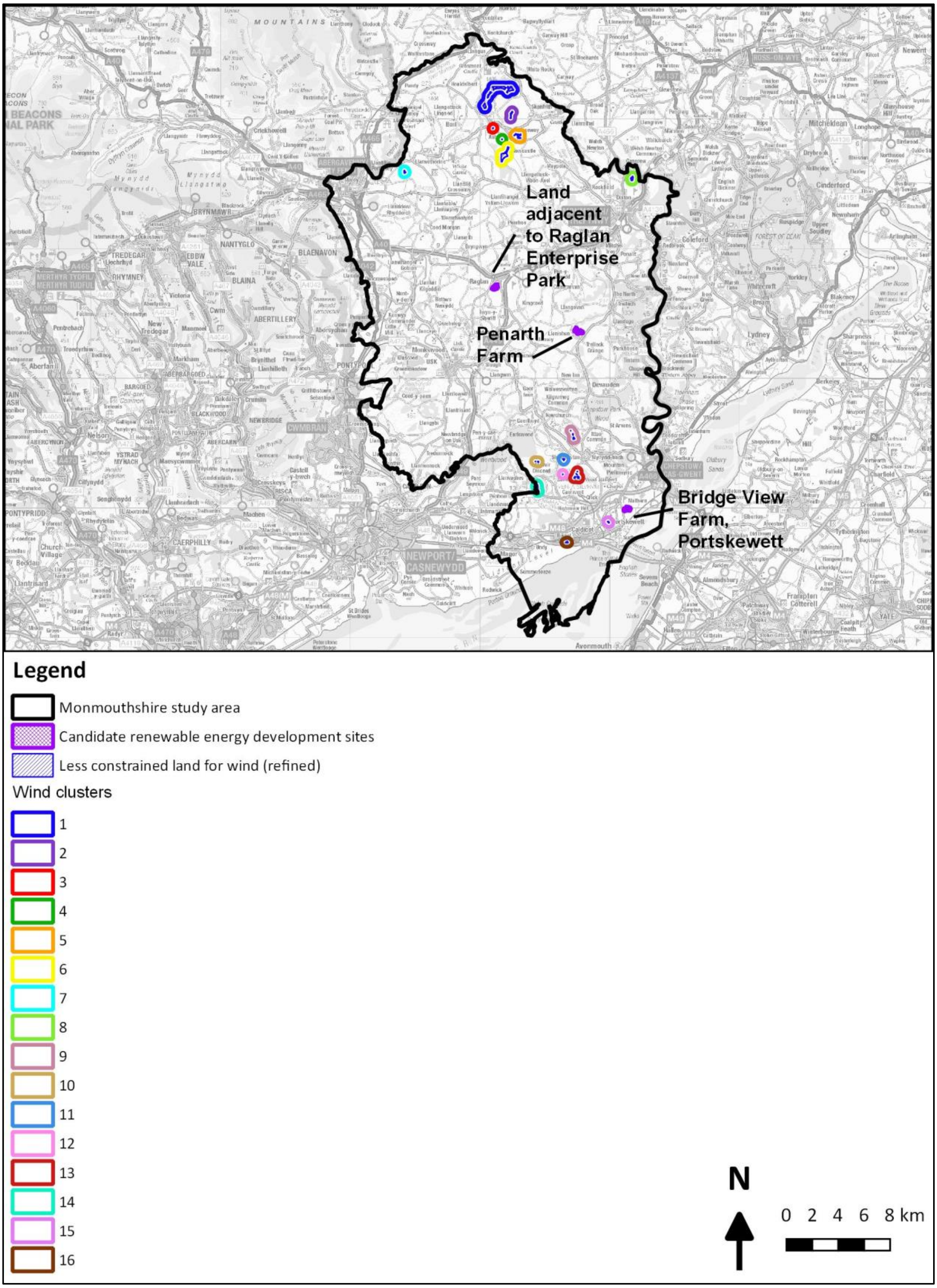


Figure 51: Candidate renewable energy sites and less constrained land for wind (refined)

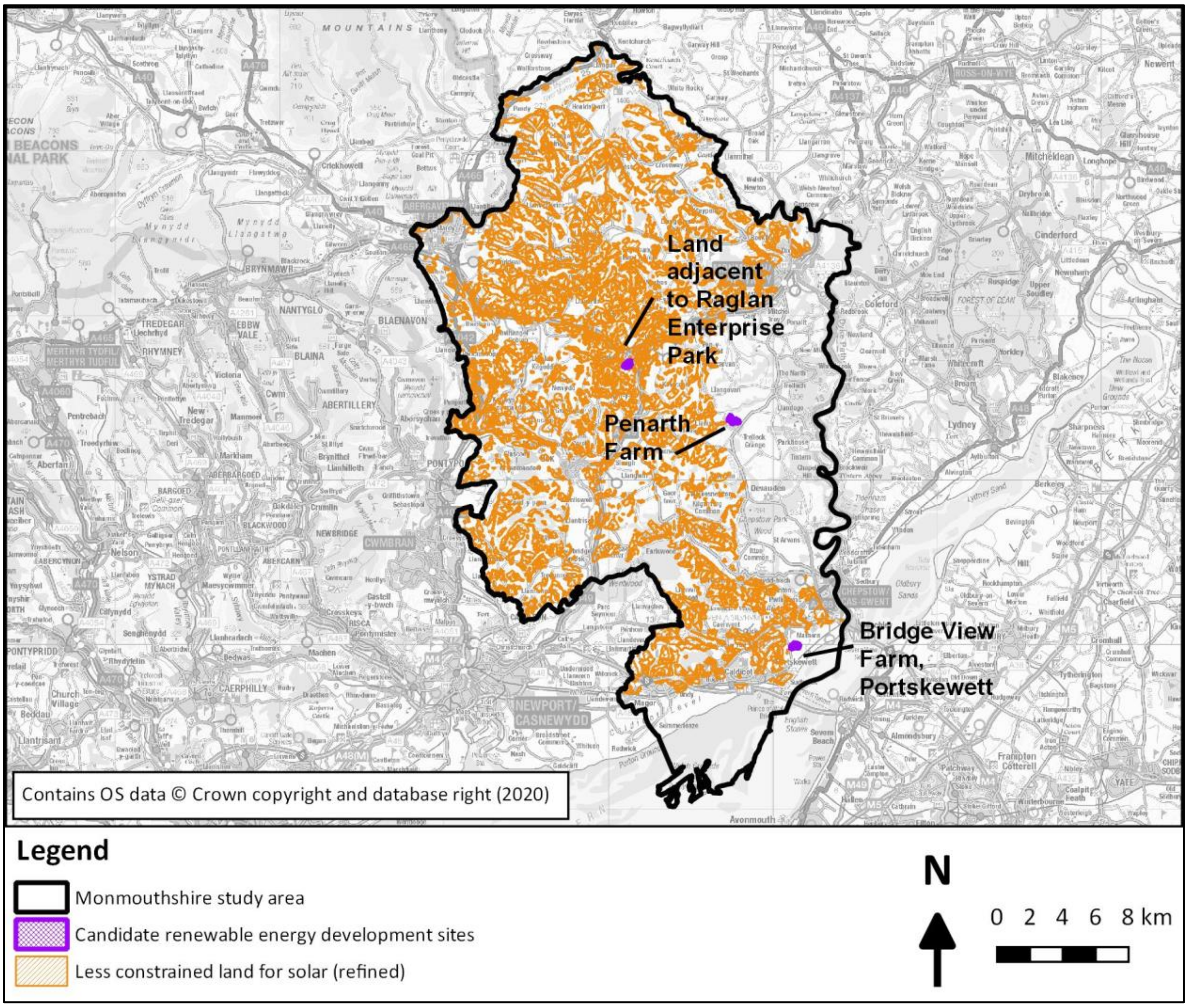


Figure 52: Candidate renewable energy sites and less constrained land for solar (refined)

9.3.6 The site on land adjacent to Raglan Enterprise Park partially coincides with the less constrained land for solar PV identified around Raglan. The other candidate sites lie outside of the less constrained land for either wind or solar PV developments. Whilst these sites lie outside the less constrained areas, this does not necessarily mean that the sites would be precluded from development for renewable energy generation. All sites regardless of their location should be determined based on the merits of the individual proposal.

9.3.7 By reviewing the wind constraints considered in Section 4 it is identified that all of the candidate sites are within 500 m of residential properties. It might be possible to site wind turbines within 500 m of residential properties however this would be subject to a project specific assessment of noise and visual impact.

9.3.8 Penarth Farm is located within the Wye Valley Area of Outstanding Natural Beauty, and is partially covered by the slope constraint, and Bridge View Farm is located within the Gwent Levels historic landscape area. The slope constraint used in the assessment is based on OS Terrain 50 data; topographical data with a resolution of 50m (Ordnance Survey, 2020b). Higher resolution topographical data may reduce the impact of this constraint and open up more sites as less constrained for development. It may be possible to site solar PV and wind turbines within designated areas such as Areas of Outstanding Natural Beauty and Historic Landscape Areas. This would be subject to acceptability from a landscape perspective and would require a site-specific landscape and visual impact assessment to determine this.

9.4 Conclusions

9.4.1 Whilst land identified as less constrained for wind and solar coincides with areas that are experiencing electricity network constraints, much of South Wales' electricity network is constrained with respect to new generation connections. As such it is anticipated that significant new infrastructure is likely to be required to enable national decarbonisation targets to be met. Planning policy should address the need for new grid infrastructure in addition to renewable energy generation assets.

9.4.2 Due to the low resource capacity associated with the less constrained wind areas identified, it is recommended that either:

- Supportive planning policy is adopted for wind developments proposed anywhere in the county, or
- Broad geographical areas covering all or the majority of less constrained areas identified are designated as Local Search Areas for wind.

These broad geographical areas could be identified from the geographical areas which are used to inform the grouping of less constrained solar areas.

9.4.3 With respect to Local Search Areas for ground mounted solar, due to the high resource identified across the county area it is difficult to identify specific geographical areas to designate. The prioritisation exercise identified areas 1, 7, 10 and 13, as the least constrained for ground mounted solar and it is recommended that consideration is given to designating Local Search Areas which cover these areas. It is, however, also acknowledged that MCC may wish to undertake further refinement of these areas before designating Local Search Areas within the RLDP. This further refinement would be undertaken outside of this assessment. MCC may wish to undertake a landscape sensitivity assessment of the whole county area to help inform this additional refinement exercise.

9.4.4 Of the candidate renewable energy sites identified, only the site on land adjacent to Raglan Enterprise Park coincides with the less constrained land for solar PV identified around Raglan. The other candidate sites lie outside of the less constrained land for either wind or solar PV developments. Whilst these sites lie outside the less constrained areas, this does not necessarily mean that the sites would be precluded from development for renewable energy generation. All sites regardless of their location should be determined based on the merits of the individual proposal.

10. Policy Options and Recommendations

10.1 Introduction

10.1.1 In 2019, following a wave of climate activism and recommendations from the Committee on Climate Change (CCC) that the UK should increase its carbon targets to net-zero by 2050 (CCC, 2019a), the Welsh Government and the UK Parliament declared a climate emergency and the UK committed to setting new net zero carbon targets for 2050. In June 2019, Welsh Government increased their carbon reduction target to a 95% reduction, in line with advice from the CCC, and has set the intention to increase this target beyond the CCC's current advice to net zero.

10.1.2 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. Further regulations are planned to bring these targets into line with the recommended 95% reduction.

10.1.3 Given Wales' ambition to become net zero carbon emissions 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. A similar viewpoint was presented by the Royal Town Planning Institute (RTPI) for the UK as a whole in their publication: *Planning for a Smart Energy Future* (RTPI, 2019).

10.1.4 "Smart energy" has been defined as: *"Keeping energy costs to the consumer low by keeping the cost of 'energy' infrastructure investment down by ensuring better use of existing assets through smarter management and integration, enabled by using innovative smart technology, putting the UK at the forefront of the global market whilst meeting our decarbonisation obligations"* (RTPI, 2019, p.12).

10.1.5 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 (RTPI, 2019).

10.2 Initial Feedback from LPA

10.2.1 Following development of the evidence bases presented in Sections 2-9 of this document, the Toolkit (Welsh Government, 2015) is used to assess different policy options to support MCC's intention to play their part in tackling the climate emergency.

10.2.2 Potential policy options based on the Toolkit (Welsh Government, 2015), were developed and shared with MCC for feedback. The policy options included example scenarios for area wide renewable energy targets, suggested areas for Local Search Areas for wind and solar, policy options for new developments and heat networks, and example policies from other local planning authorities. The feedback was discussed during a review meeting with representatives from MCC. Following receipt of this feedback the policy recommendations were revisited to ensure that they reflected any local context, which was raised.

10.2.3 A summary of the policy feedback provided and discussed during the meeting, and as additional feedback after the meeting, is detailed below:

Area wide renewable energy targets and monitoring progress

10.2.4 Potential target scenarios were discussed during the feedback meeting, as follows:

- 1: Welsh Government's target of 70% of electricity demand to be generated from renewable energy sources by 2030 applied at a local level (based on local demand)
- 2: Welsh Government's target of 1 GW of locally owned renewable energy by 2030 applied at a local level
- 3: Targeting a certain proportion of local demand to be met by renewables
- 4: Using the National Grid ESO (2019b) Community Renewables' renewable energy technology growth rates to provide a target based on the current installed local renewable energy mix
- 5: Targeting a certain proportion of the study area's land to dedicate for renewable energy generation
- 6: Targeting a certain proportion of the maximum theoretical capacity of different technologies.

10.2.5 A general preference was expressed to set the target based on a percentage of local demand, as it was considered that this approach offers opportunities to create tangible performance outcomes, e.g. Monmouthshire has generated as much energy/more energy/50% of the energy it uses. A local ownership target was also supported.

10.2.6 It was agreed that the targets provided in the assessment would be subject to further scrutiny and refinement following stakeholder engagement. MCC identified the following factors would need to be considered when confirming the final targets and determining the specific policy wording:

- Whether to adopt a target which just focuses on technologies that require planning consent or all renewable energy generation technologies. For example, a high amount of biomass potential has been identified within Monmouthshire but the sourcing of feedstock is not controlled through the LPA
- Acknowledging that permissions are not necessarily implemented
- Considering electricity network constraints and their impact on the relative attractiveness of renewable energy project development in the county. It was suggested that the target for the first five years of the Plan may be lower than the last two five year periods of the Plan, when current infrastructure limitations may have reduced.

10.2.7 MCC highlighted that the Toolkit (Welsh Government, 2015) suggests developing a renewable heat target, whereas PPW 10 (Welsh Government, 2018b) does not. It is suggested that if MCC are interested in incorporating a renewable energy heating target (this is not considered necessary following a review of PPW 10) this should only focus on new buildings, and the target should relate to the number of buildings/proportion of proposals with low carbon heating installed, rather than a specific heating capacity; as more energy efficient buildings will require heating systems with lower capacities.

10.2.8 A final consideration raised was that targets across the authority would need to be consistent albeit clearly defined e.g. MCC climate emergency declaration would need to be supported by individual departmental targets.

Identify suitable areas for renewable energy development

10.2.9 During the meeting a discussion was held regarding the very low wind resource identified within the county, and how this should be addressed with respect to Local Search Areas. The LPA felt that it would be helpful to have a Local Search Area for wind rather than a supportive policy covering the whole county.

10.2.10 With respect to the solar areas a discussion was held regarding the high resource, and how best to group the less constrained areas and identify potential Local Search Areas. It was suggested that agricultural land classification could be used to try and narrow down the areas identified. Following further analysis after the meeting, it was found that whilst removing the predicted higher grade agricultural land from the less constrained areas reduced the number of areas, the remaining areas were still evenly dispersed across the whole county (outside of the AONB) and therefore it did not help to identify more refined Local Search Areas. Following this analysis, in discussion with MCC it was decided that the refined solar areas would be largely grouped according to their landscape character type, defined in Landmap (NRW, 2020). Several Landmap aspect areas are grouped together to provide the groupings in order to reduce the number of areas to consider and ensure that larger areas are covered.

10.2.11 When confirming the final Local Search Areas for adoption MCC will also consider additional designations within the LDP, e.g. strategic growth areas, which would take priority over renewable energy developments in these specific locations. With respect to minerals safeguarding areas, PPW 10 (Welsh Government, 2018b) notes that policies should protect potential mineral resources from other types of permanent development which would either sterilise them or hinder extraction, or which may hinder extraction in the future as technology changes. MCC will ensure that the criteria policy will require renewable energy proposals to demonstrate that any impact on natural mineral reserves is minimised but due to the temporary nature of wind/solar farms, it is considered that the Local Search Areas do not necessarily need to be located outside of minerals safeguarding areas.

10.2.12 Where a solar farm is proposed in a minerals safeguarded area, the developer would need to satisfy the relevant minerals related policies which would include any potential for sterilisation. Green wedges were discussed as a potential additional constraint but as Planning Policy Wales identifies renewable and low carbon energy generation as a form of development that may be appropriate in a green wedge provided they preserve its openness and do not conflict with the purposes of including land within it, it was concluded that they did not need to be included in the scoring exercise within Section 9.

10.2.13 MCC raised concerns that some of the less constrained solar areas are located in open countryside divorced from settlements. Solar farms do not necessarily need to be located close to areas of high energy demand. Whist this can help to provide private wire opportunities where energy generated by the solar farm is directly used by a building, if suitable grid infrastructure is available or can be developed it is possible for solar farms to be located some distance from settlements. Grid constraints are identified on the electricity network within Monmouthshire, however it is anticipated that grid infrastructure investment will be required to facilitate decarbonisation, and therefore these may be relieved in the future.

Site allocations and development design and layout

10.2.14 A discussion was held around the interactions between building regulations and planning policy. It was noted that Building Regulations are a minimum requirement, and requirements to future proof developments could be considered in planning policy. It was acknowledged that it would be difficult to require standards which are higher than building regulations and difficult for Building Regulations and Planning policy to enforce post development requirements (e.g. post occupancy monitoring). In order to include this MCC will require a clear understanding of how such a policy would be implemented and what resources implications it would have on staff.

Develop policy mechanisms to support low carbon heating

10.2.15 Concerns were raised in relation to adopting low carbon heating requirements and standards which are higher than building regulations.

10.2.16 MCC were interested to understand what information would be required from developers in order to help evidence the appropriateness of decisions with respect to low carbon heating systems and compliance with planning policy. To support this Section 10.3 provides details of how other local authorities have implemented relevant planning policies.

10.3 Policy Options

10.3.1 The Toolkit (Welsh Government, 2015) provides guidance on how the evidence base established in Sections 2 to 9 of this document can be translated into energy policy within the RLDP, by exploring a range of policy themes, as outlined in the following Sub-sections. The initial feedback from the council stakeholders has been considered when providing the details below.

Area wide renewable energy targets and monitor progress

Policy objectives

10.3.2 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, 2018b, p.90)

10.3.3 Section 6 shows the Monmouthshire study area could theoretically generate approximately three times its current energy demand (excluding heat pump generation) and over 20 times its current electricity demand. The *practical* resource that will be exploited is likely to be less than the resource identified due to grid capacity, competition with other land use and issues such as landscape impact. This, in addition to the discrepancy between times of generation and demand, means that energy generated in other parts of the country and offshore, and local energy storage assets are also likely to be relied upon to ensure that energy demand patterns can be met from low carbon and renewable sources. In order to reduce reliance on external resources and play a full part in tackling the climate emergency MCC should consider setting ambitious targets for renewable energy deployment in the RLDP.

Existing policy

10.3.4 The previous renewable energy assessment provided suggested targets for renewable energy deployment by 2020 (Camco, 2012). It provided a low (147 GWh_e p.a. and 41 GWh_{th} p.a.) and high (279 GWh_e p.a. and 61 GWh_{th} p.a.) target scenario and recommended that these were tested with relevant stakeholder groups before a target was adopted (Camco, 2012). The existing adopted local development plan does not include any targets for renewable energy deployment (MCC, 2014). From Section 3 it is identified that the suggested low electricity and high thermal generation targets have been exceeded.

10.3.5 The existing adopted local development plan (LDP) provides the following conclusion regarding the studies (original REA and Addendum) (Camco and CDN, 2010 and Camco, 2012): *"The studies found that wind power, together with solar power and, to a lesser extent, energy crops had the greatest potential for contributing to renewable energy provision in the County."* (MCC, 2014, p. 126).

10.3.6 The existing adopted LDP includes an overall renewable energy policy as follows:

> *"**Policy SD1 - Renewable Energy***
>
> *Renewable energy schemes will be permitted where:*
>
> *(1) There are no unacceptable adverse impacts upon the landscape, townscape and historic features and there is compliance with Policy LC5, with regard to protection and enhancement of landscape character;*
>
> *(2) There are no unacceptable adverse impacts on biodiversity;*
>
> *(3) There are no unacceptable adverse impacts on the amenities of nearby residents by way of noise, dust, odour or increases in traffic;*
>
> *(4) The wider environmental, economic, social and community benefits directly related to the scheme outweigh any potentially adverse impacts; and*
>
> *(5) The distinct identity of Monmouthshire will not be compromised.*
>
> *For all types of renewable energy, cumulative impacts will be an important consideration where there are other renewable energy schemes currently operating in the area.*
>
> *When the technology is no longer operational there is a requirement to decommission, remove the facility and complete a restoration of the site to its original condition."*
>
> (MCC, 2014, p. 127)

Evidence base for future policy

10.3.7 A number of potential methods or scenarios could be used to inform the targets. The method chosen will be based on the ambitions and priorities of the council. Methods that could be used include:

- 1: Welsh Government's target of 70% of electricity demand to be generated from renewable energy sources by 2030 applied at a local level
- 2: Welsh Government's target of 1 GW of locally owned renewable energy by 2030 applied at a local level
- 3: Targeting a certain proportion of local demand to be met by renewables
- 4: Using the National Grid Community Renewables renewable energy technology growth rates to provide a target based on the current installed local renewable energy mix
- 5: Targeting a certain proportion of the study area's land to dedicate for renewable energy generation
- 6: Targeting a certain proportion of the maximum theoretical capacity of different technologies.

10.3.8 Example targets based on these scenarios are provided in Table 43, alongside details of the maximum resource identified and current installed generation. The example scenario details are as follows:

- **Scenario 1:** Welsh Government (WG) Target of 70% of Electricity from Renewables by 2030.
  - **1a:** based on 2033 Community Renewables local electricity demand estimation.
  - **1b:** based on Wales' current (2017) national demand and MCC's proportion based on the population of Monmouthshire in comparison to the whole of Wales
  - **1c:** based on Wales' current (2017) national demand and MCC's proportion based on the land area of the study area in comparison to the whole of Wales
  - **Additional variations that could be considered:** alter demand estimations or consider a different percentage to the Welsh Government target
- **Scenario 2:** WG Target of 1 GW of locally owned renewable energy by 2030.
  - **2a:** based on the proportion of Welsh population in Monmouthshire County
  - **2b:** based on the proportion of Wales' land area in the study area
- **Scenario 3:** Target a certain proportion (X%) of energy demand to be met by renewables.
  - **3a:** based on 80% of 2033 Community Renewables local electricity and heat demand estimation (energy for transport is not considered).
  - **Variations that could be considered:** alter the percentage to target, or energy demand estimation upon which the target is based
- **Scenario 4:** National Grid Community Renewables trends applied to current installation details.
  - **4a:** based on the individual technology trends
  - **Variations that could be considered:** base on total energy generation trends
- **Scenario 5:** Target a certain proportion (X%) of Study Area's land to dedicate for renewable energy generation.
  - **5a:** based on 10% of land area, technology breakdown: 48% solar, 4% wind, 48% woody energy crops (all of the woodland potential is included in the target).
  - **Variations that could be considered:** alter the percentage to target and the technology breakdown.
- **Scenario 6:** Target a certain proportion (X%) of maximum theoretical capacity targeted.

- **6a:** 50% of maximum theoretical capacity
- **Variations that could be considered:** alter the percentage to target.

10.3.9 Whilst PPW 10 notes that renewable energy targets "*should be calculated from the resource potential of the area and should not relate to a local need for energy*" (Welsh Government, 2018b, p. 90), it can still be useful to understand the level of local demand that can be met by renewable energy targets to aid understanding in the level of ambition provided by the target. The target established from local demand would need to be sufficiently high and relatable to the local resource identified, in order to be adopted, and should not be seen as an upper limit with respect to renewable energy deployment.

10.3.10 The examples provided in Table 43 include those discussed during the feedback meeting and some additional examples. For simplicity, and ease of understanding, the details provided in Table 43 are rounded, and therefore the values may differ to those stated elsewhere in the assessment. The household energy demand equivalent values provide an indication of the number of typical household's electricity/heating demands are equivalent to energy generation values provided. Typical values are obtained from details provided by Ofgem (2020c) and a typical 80% boiler efficiency.

10.3.11 The example target based on a proportion of maximum resource (scenario 6) is based on 50% maximum resource as per the low example provided in the Toolkit (Welsh Government, 2015). This results in a very high target due to the high solar resource identified. MCC could consider using a lower proportion of ground mounted solar resource than the other technologies when determining the targets based on this scenario.

10.3.12 To translate the targets into an estimate of the equivalent numbers of turbines or hectares of solar PV the following conversion factors could be used:

- 1 MW : 1.75 hectares of land for ground mounted solar
- 2 MW : 1 wind turbine (based on the candidate size in this assessment)

These conversion factors will just provide a rough estimate, with examples provided in Table 43. Note that some of the wind examples provided in Table 43 are greater than the maximum resource identified, and therefore represent unrealistic scenarios for Monmouthshire and are provided for illustration purposes only.

10.3.13 Ranges are provided for the biomass and anaerobic digestion details as the resource could be used for heat generation only or heat and power generation with the associated energy generation capacities and yields varying.

10.3.14 Further consideration by MCC and consultation with stakeholders is required before MCC are in a position to decide upon a final renewable energy target to adopt within the RLDP.

Table 43: Potential renewable energy targets for consideration

		Estimated maximum resource	Current installed capacity	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b	Scenario 3a	Scenario 4a	Scenario 5a	Scenario 6a
Wind	MW	32	0.3							0.6 (low due to low existing capacity)	28 (14 x 2 MW turbines)	16 (8 x 2 MW turbines)
	MWh p.a.	76,000	700							1,000	66,000	38,000
	Household (HH) electricity demand equivalent	25,000	200							500	22,000	13,000
Ground mounted solar	MW	8,279	35							96 (~168 hectares)	2,021 (~3537 hectares)	4,149 (~7261 hectares)
	MWh p.a.	7,252,095	31,000							84,000	1,770,000	3,626,000
	HH electricity demand equivalent	2,417,000	10,000							28,000	590,000	1,209,000
Roof mounted solar PV	MW	138	14							63 (~19,000 dwellings)		69
	MWh p.a.	121,000	12,000							55,000		60,000
	HH electricity demand equivalent	40,000	4,000							18,000		20,000
Hydro	MW	1	0.2							0.2		1
	MWh p.a.	4,000	500							600		2,000
	HH electricity demand equivalent	1,000	200							200		700
AD (power)	MW	0-3	0.4							1		2
	MWh p.a.	0-27,000	3,000							6,000		13,000
	HH electricity demand equivalent	0-9,000	1,000							2,000		4,000
Biomass (power)	MW	0-12	18							23 (greater than max potential)		6
	MWh p.a.	0-94,000	142,000							182,000		47,000
	HH electricity demand equivalent	0-31,000	47,000							61,000		16,000
Total power	**MW**	**8,469-8,484**	**68**	***Equivalent to ~112 MW wind or ~304 MW solar PV***	***Equivalent to ~132 MW wind or ~356 MW solar PV***	***Equivalent to ~156 MW wind or ~422 MW solar PV***			***Equivalent to ~128 MW wind or ~347 MW solar PV***	**183**	**2,049**	**4,242**
	MWh p.a.	**7,453,000-7,574,000**	**189,000**	**266,000**	**312,000**	**370,000**			**304,000**	**328,000**	**1,837,000**	**3,787,000**

	HH electricity demand equivalent	**2,484,000-2,525,000**	**63,000**	**89,000**	**104,000**	**123,000**			**101,000**	**109,000**	**612,000**	**1,262,000**
AD (heat)	MW	5-16	0.2							0.3		8
	MWh p.a.	22,000-71,000	800							1,000		36,000
	HH heat demand equivalent	2,000-7,000	80							100		4,000
Heat pumps	MW	503	4							97		252
	MWh p.a.	883,000	6,000							171,000		441,000
	HH heat demand equivalent	89,000	600							17,000		45,000
Biomass (heat)	MW	20-92	25							48	75	54
	MWh p.a.	89,000-243,000	79,000							125,000	196,000	142,000
	HH heat demand equivalent	9,000-25,000	8,000							13,000	20,000	14,000
Total heat	**MW**	**528-612**	**29**						***Depends on technology***	**145**	**75**	**314**
	MWh p.a.	**994,000-1,197,000**	**86,000**						**555,000**	**297,000**	**196,000**	**620,000**
	HH heat demand equivalent	**101,000-121,000**	**9,000**						**56,000**	**30,000**	**20,000**	**63,000**
Total power &	**MW**	**9,001-9,112**	**97**	**-**	**-**	**-**	**30**	**36**	***Depends on technology***	**328**	**2,123**	**4,556**
	MWh p.a.	**8,463,000-8,813,000**	**275,000**	**266,000**	**312,000**	**370,000**	***Depends on technology***	***Depends on technology***	**859,000**	**626,000**	**2,032,000**	**4,407,000**

Example policy wording

10.3.15 Merthyr Tydfil County Borough Council, (MTCBC) has included a local contribution target towards renewable energy production within their adopted LDP monitoring framework (MTCBC, 2020). They have divided up the target across three time periods in order to monitor progress to achieving targets, see Example Policy 1 below (the monitoring targets are cumulative in nature, i.e. the overall target is 37.4 MW_e by 2031).

10.3.16 Whilst resource availability and supportive planning policy are crucial to achieving high-levels of renewable energy deployment they are not the only relevant factors; as discussed in detail within National Grid ESO's (2019a) Future Energy Scenarios. RLDP targets, and their monitoring, are adopted to ensure that the RLDP planning policy is fit for purpose and to trigger policy review and revision during the RLDP plan period if required. Following discussions with the five local authorities who jointly commissioned this assessment (alongside assessments in neighbouring areas) it is considered reasonable that two targets may be adopted within the RLDP:

- A higher aspirational target that communicates the local authority's intention to play a full part in the decarbonisation of the national energy system and includes all renewable energy technology deployment (including those that are included in permitted development legislation)

> A lower target that acknowledges that planning policy is not the only determining factor of whether renewable energy installations are deployed in the local area.

Example policy 1: MTCBC (2020) 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.	*16.1*	*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 secure planning permissions for 7.17 MWe of electricity generation by 2021 by 10%. To secure planning permissions for 14.33 MWe of electricity generation by 2026 by 10%. To secure planning permissions for 21.5 MWe of electricity generation by 2031 by 10%.*	*MTCBC Development Management Monitoring*			
Renewable Energy Technology	*Available (undeveloped) resource*		*Current installed capacity (erected, installed or permitted)*		*Target scenarios for renewable energy generation by 2031*			
					Low		*High*	
	MW_e (Capacity)	*GWh/yr (Annual energy output)*	*MW_e*	*GWh/yr*	*MW_e*	*GWh/yr*	*MW_e*	*GWh/yr*
Onshore wind	*0*	*0*	*1.5*	*3.5*	*2*	*4.7*	*2.5*	*5.9*
EfW	*0*	*0*	*0*	*0*	*-*	*-*	*-*	*-*
Landfill gas	*n.a.*	*n.a.*	*6.2*	*23.4*	*3.5*	*13.2*	*3.5*	*13.2*
AD	*0.01*	*0.06*	*-*	*-*	*-*	*-*	*-*	*-*
Hydropower	*0.24*	*0.5*	*0.1*	*0.48*	*0.1*	*0.3*	*0.2*	*0.6*
Building integrated sector	*n.a.*	*n.a.*	*2.4*	*2.6*	*5.9*	*5.7*	*11.2*	*10.9*
Standalone solar PV	*158.3*	*138.7*	*-*	*-*	*10.0*	*9.7*	*20.0*	*19.4*
Total	*158.55*	*13.26*	*10.2*	*6.0*	*21.5*	*33.6*	*37.4*	*50*
Merthyr Tydfil projected electricity demand 2031						*208*		*228*
Percentage electricity demand in 2031 potentially met by renewable energy resources						*16%*		*22%*

(MTCBC, 2020 p.125)

Recommendations

10.3.17 The recommendations provided below are made in order to support decarbonisation of Monmouthshire and Wales. By effectively monitoring progress in meeting renewable energy deployment targets, policies in the RLDP can be effectively updated if required to provide the greatest likelihood of targets being met. The LPA will need to consider these recommendations alongside other objectives of the RLDP when finalising the RLDP's exact policy wording.

10.3.18 It is recommended that MCC adopt two overall capacity targets relating to renewable energy deployment:

- A higher ambitious, aspirational target which includes all renewable energy technologies and systems (including those included within permitted development rights)
- A lower target relating to the capacity of *planning permissions secured*. It is still recommended that this target is ambitious, but that it acknowledges that supportive planning policy is not the only factor that affects the level of renewable energy deployment in a local area.

10.3.19 A specific target relating to renewable heat is not required by PPW 10 (Welsh Government, 2018b), however if MCC are interested in incorporating a renewable energy heating target it is recommended that this focuses on new buildings, and relates to the number of buildings/proportion of proposals with low carbon heating installed, rather than a specific heating capacity; as more energy efficient buildings will require heating systems with lower capacities.

10.3.20 It is recommended that the LPA consider all of the example targets provided in this assessment and liaise with other internal local authority and external stakeholders when deciding on the final targets to adopt. Reference to the maximum resource identified and the current installed capacities will be relevant in this process, and the decision on final targets may also take into account the capacity of Local Search Areas, presence of NDF Pre-Assessed Areas for Wind, the current market conditions and wider local authority ambitions. Stakeholders to consider engaging with include:

- Local Authority elected members and officers from relevant departments, such as officers responsible for:
  - Planning policy and development management
  - Waste
  - Energy management
  - Landscape/conservation
  - Economic development/regeneration
  - Sustainable development
  - Property/estates
- External stakeholders:
  - Statutory agencies, such as Natural Resources Wales (NRW)
  - Renewable energy developers
  - Other local stakeholders, such as National Farmers' Union (NFU), local energy agencies, etc
  - Local Service Board representatives (e.g. NHS Trust, Police, Fire, NGOs, not for profit organisations, faith organisations) plus UK Government Departments (e.g. MoD)

- Utilities, ESCos and MUSCos.

10.3.21 The local planning authority can support achievement of the higher target by ensuring that renewable energy deployment is promoted locally and providing clear guidance to businesses and householders regarding their permitted development rights. The wider local authority (outside of the planning department) can support achievement of the higher target by providing a leadership role, through progressing their own renewable energy developments and encouraging others to do the same e.g. by sharing best practice in low carbon and renewable energy development.

10.3.22 It is recommended that the monitoring framework is used to monitor progress in meeting the lower target, as the local planning authority will have the relevant data to undertake this monitoring effectively. It is recommended that the target is broken down into individual technology types within the monitoring framework, and details regarding which technologies are being consented is monitored. This is because different technologies generate different amounts of energy (e.g. MWh) for the same power (e.g. MW) capacity (e.g. 1 MW of solar PV typically generates less energy than 1 MW of wind due to a lower capacity factor). If the overall target is met by a technology with a lower associated capacity factor, it might be appropriate to raise the overall target during the plan period. It is also recommended that the target is broken down within the monitoring framework across three time periods as per MTCBC's (2020) monitoring framework. If progress in meeting targets is slow, the reasons for this should be assessed, and if planning policy is found to be a causal factor, this should be addressed.

10.3.23 The evidence base in Sections 4 and 5 has identified particularly high levels of resource potential for solar PV, and therefore this technology should be prioritised, with respect to target setting and promotion within the area. Potential for smaller scale developments based on other resources is identified, including a relatively high biomass resource. Given the presence of biomass generators already operational within the study area, it is recommended that suitable policies are developed that look to encourage use of locally generated biomass fuel. Wind resource in the county is relatively limited and therefore it is considered unlikely that large-scale developments for wind will be progressed, however small areas of potential are identified, and supportive planning policy should be adopted to encourage exploitation of these areas and maximisation of this resource.

10.3.24 In order to support attainment of the targets set, supportive, clear criteria-based policies will be required for all renewable energy technologies. It is recommended that NRW's advice is incorporated into any planning policy or guidance related to hydropower developments.

10.3.25 In order to retain the existing renewable energy deployment within the study area, it is recommended that supportive policies are adopted in relation to repowering existing assets at the end of their current planning consent period. For this reason, it is recommended that the adopted target does not relate to *new* renewable energy deployment, but *total* renewable energy deployment (i.e. it includes existing generation). Repowering refers to the upgrading or continuation of operation of existing renewable energy assets beyond the time period of their initial planning consent.

Identify suitable areas for renewable energy development

Policy objectives

10.3.26 The National Development Framework (NDF) working draft identifies Pre-Assessed Areas where there is a presumption in favour of large-scale (greater than 10 MW) wind developments (Welsh Government, 2020e). The NDF is currently in draft form with the final document expected to be published in early 2021.

10.3.27 PPW 10 (Welsh Government, 2018b) requires LPAs to identify areas for renewable energy developments (termed "Local Search Areas" in this assessment) 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.

10.3.28 If the local authority's Local Search Areas coincide with the NDF pre-assessed areas for large-scale wind developments it is anticipated that Welsh Government would not want smaller developments to prevent larger developments progressing, and planning policy should be adopted which prevents this (refer to Box 13 for further details).

10.3.29 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 anticipated that Pre-Assessed Areas for Wind within the NDF will replace the SSAs. Welsh Government has advised that they will be updating PPW 10 in line with the NDF. There are no SSAs in Monmouthshire, however the local authority should review all adopted national policy when available to ensure the requirements are met.

10.3.30 The working draft NDF does not identify any Pre-Assessed Areas for Wind within Monmouthshire, however MCC should review the final adopted NDF.

Existing policy

10.3.31 The current LDP does not identify any preferred areas for wind or solar PV, but instead references the previous Renewable Energy and Energy Efficiency Study (REEES) (Camco and CDN 2010 and Camco 2012) as follows:

> *"The wind constraints map within the REEES identifies areas with potential for providing wind power, having calibrated wind speeds against various constraints, including heritage, landscape and ecology designations, unsuitable terrain, distances from dwellings and communications equipment, etc. This crude mapping exercise has identified possible areas of search, therefore, although much more detailed assessment on a site-by-site basis would be required before any decision could be taken on an area's suitability for a wind farm. In this respect, none of the areas with potential for wind power are located on urban/brownfield sites, which TAN8 recommends as being suitable for wind installations up to 25MW."*
>
> (MCC, 2014, p. 126)

and

> *"The REEES Addendum included a similar mapping exercise for solar power as for wind. Again, however, sites in areas indicated as having technical potential for ground mounted*

solar PV would need detailed assessment before any decision could be taken on a site's suitability for a solar farm."

(MCC, 2014, p.127)

Evidence base for future policy

10.3.32 Section 9 and Appendix 6 reviews 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.

10.3.33 The low wind resource identified and high ground mounted solar resource identified within the county means that it is difficult to identify specific geographical areas to designate as Local Search Areas. In general, the less constrained wind areas in the south of the county (north of the M4) scored highest in the scoring exercise. Solar areas in the centre of the county (between Abergavenny and Monmouth, surrounding the A40 and A449 roads), to the west of the county (east of Cwmbran), and just north of the M4 scored highest through the scoring exercise. These areas are identified to have 3,482 MW of potential capacity (see Table 55 in Appendix 6).

10.3.34 Section 9 identifies that Monmouthshire is currently affected by grid infrastructure capacity constraints. MCC has queried whether identifying Local Search Areas close to settlements may provide more potential for project development from a grid connection perspective. Due to the complexity of the electricity network WPD would need to be contacted to provide insights relating to this, as the answer will be location specific. There may be potential to provide electricity directly to buildings via a private wire from developments located close to settlements, however again this will be location-specific and will be dependent on the nature of the buildings and building owners in specific areas. Grid capacity constraints are present across much of the South Wales electricity network. In order to achieve national decarbonisation targets it is anticipated that investment in electricity infrastructure will be required over the coming decade and therefore the current grid status should not be considered static, and planning policy should include supportive policy relating to new grid infrastructure.

10.3.35 Of the candidate renewable energy sites identified, only the site on land adjacent to Raglan Enterprise Park coincides with the less constrained land for solar PV identified around Raglan. The other candidate sites lie outside of the less constrained land for either wind or solar PV developments. Whilst these sites lie outside the less constrained areas, this does not necessarily mean that the sites would be precluded from development for renewable energy generation. All sites regardless of their location should be determined based on the merits of the individual proposal.

Example policy wording

10.3.36 MTCBC has included reference to Local Search Areas for solar PV within their adopted Local Development Plan (MTCBC, 2020).

Example policy 2: *Policy EcW8* of MTCBC's (2020) 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, 2020, p.89)

Recommendations

10.3.37 The recommendations provided below are made in order to support decarbonisation of Monmouthshire and Wales, by recommending identification of Local Search Areas which are considered more appropriate due to a combination of technical and land use perspectives. The LPA will need to consider these recommendations alongside other objectives of the RLDP when finalising the RLDP's exact policy wording.

10.3.38 The wind resource within the county is relatively low and therefore it is unlikely that a large number of wind developments will be progressed in the area. It is recommended that either:

- Supportive planning policy is adopted for wind developments proposed anywhere in the county, or
- Broad geographical areas covering all or the majority of less constrained areas identified are designated as Local Search Areas for wind

MCC have acknowledged a preference to identify Local Search Areas for wind. These broad geographical areas could be identified from the geographical areas which are used to inform the grouping of less constrained solar areas.

10.3.39 With respect to Local Search Areas for ground mounted solar, due to the high resource identified across the county area it is difficult to identify specific geographical areas to designate. The prioritisation exercise identified areas 1, 7, 10 and 13 (areas in the centre of the county (between Abergavenny and Monmouth, surrounding the A40 and A449 roads), to the west of the county (east of Cwmbran), and an area in the south of the county north of the M4, as the least constrained for ground mounted solar and it is recommended that consideration is given to designating Local Search Areas which cover these areas. It is, however, also acknowledged that MCC may wish to undertake further refinement of these areas before designating Local Search Areas within the RLDP. This further refinement would be undertaken outside of this assessment. MCC may wish to undertake a landscape sensitivity assessment of the whole study area to help inform this additional refinement exercise.

10.3.40 With respect to identifying Local Search Areas for solar PV developments within Monmouthshire, it is advised that areas outside the flood plains are initially identified, and guidance provided within the new TAN 15 is adhered to, when it is published.

10.3.41 If any potential Local Search Areas coincide with the final NDF Pre-Assessed Areas for Wind (this is considered highly unlikely), a clause should be included in any policy wording that smaller developments should not impact the potential for larger-scale projects to be developed.

10.3.42 The designation of Local Search Areas should be supported with clear criteria-based, so that developers are clear regarding how potential developments will be assessed for planning consent.

10.3.43 As identified in Sections 8 and 9, grid infrastructure upgrades may be required during the plan period to facilitate connection of additional renewable energy developments. It is recommended that supportive policies for development of new grid connection infrastructure are adopted to account for this.

10.3.44 In addition to these Local Search Areas, it is recommended that positive policy regarding siting solar PV assets within built-up and urban areas is adopted, including a requirement for the integration of roof-top PV on all new buildings where technically possible (if not already provided for in Building Regulations).

10.3.45 To provide strength to the Local Search Area designation, MCC 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, 2020, p.89).

Site allocations and development design and layout

Policy objectives

10.3.46 Welsh Government planning policy recognises an energy hierarchy, as provided in Figure 53 (Welsh Government, 2018b). The Welsh Government expects all new development to mitigate the causes of climate change in accordance with the energy hierarchy and this should be achieved through suitable policies which support reducing energy demand, increasing energy efficiency, and meeting remaining energy demands in an appropriate manner.

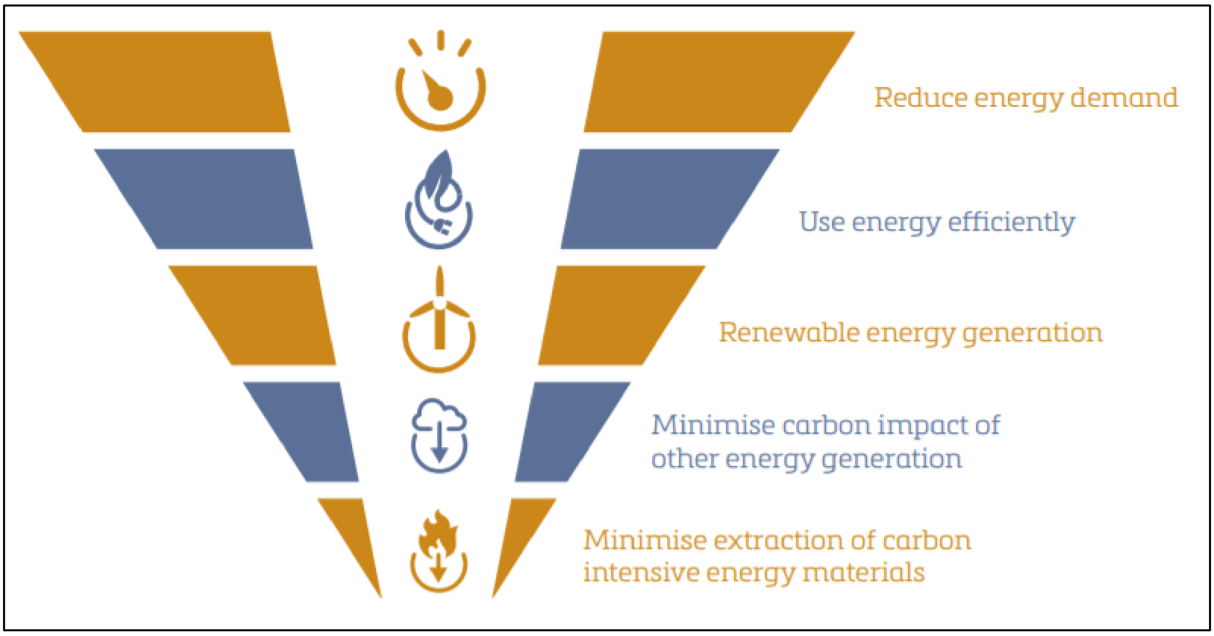


Figure 53: Energy hierarchy

(Welsh Government, 2018b, p. 90)

10.3.47 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 RLDP strategic development sites, the Toolkit (Welsh Government, 2015) suggest that local authorities could encourage this by setting a carbon reduction target for the RLDP strategic development sites 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 the local authority demonstrates that the level of carbon saving is achievable, without representing an undue burden to a developer.

Existing policy

10.3.48 The current MCC Local Development Plan policy encourages integration of renewable energy and energy efficiency measures into new development proposals:

"Policy S12 – Efficient Resource Use and Flood Risk

All new development must:

- *Demonstrate sustainable and efficient resource use – this will include energy efficiency/ increasing the supply of renewable energy, sustainable construction materials/ techniques, water conservation/ efficiency and waste reduction;*
- *Avoid the siting of inappropriate development in areas at risk of flooding."*

(MCC, 2014, p.77)

Evidence base for future policy

10.3.49 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. Suitability for a net-zero carbon energy system will also result from adhering to the Welsh Government's energy hierarchy (Figure 53). Integration of wind/ground mounted solar PV into new strategic development sites will need to be considered from a landscape perspective, especially outside of any Local Search Areas. 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.

10.3.50 In addition to the integration of low carbon heat and electricity generation, 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.

10.3.51 With respect to design and layout requirements associated with new developments, the Development Plans Manual (Welsh Government, 2020, p.18) states the following with respect to development management policies*; "Plans should not duplicate provisions in other legislative regimes, for example, in environmental health, building regulation and health and safety legislation".* As such the RLDP should not provide requirements that are already in the building regulations. Whilst MCC could require higher requirements they should not replicate the requirements of adopted building regulations.

Strategic site layout and design

10.3.52 Optimising the layout and design of strategic development sites is key to maximising renewable energy opportunities in new development and also ensuring broader sustainability principles are demonstrated. It is recommended that strategic development sites should be required to comply with a set of core sustainable design principles. These principles should be high level and ensure that developments are considering sustainability in a holistic manner.

Example policy 3: Hammersmith & Fulham Policy CC2: Ensuring Sustainable Design and Construction

"The council will require the implementation of sustainable design and construction measures in all major developments by:
a. implementing the London Plan sustainable design and construction policies to ensure developments incorporate sustainability measures, including:

- *minimising energy use;*
- *making the most effective use of resources such as water and aggregates;*
- *sourcing building materials sustainably;*
- *using prefabrication construction methods where appropriate;*
- *reducing pollution and waste;*
- *promoting recycling and conserving and promoting biodiversity and the natural environment;*
- *ensuring developments are comfortable and secure for users and avoiding impacts from natural hazards (including flooding); and*

b. Requiring Sustainability Statements (or equivalent assessments such as BREEAM) for all major developments to ensure the full range of sustainability issues has been taken into account during the design stage.

The integration of sustainable design and construction measures will be encouraged in all other (i.e. non-major) developments, where feasible."

(Hammersmith & Fulham, 2018, pp.195-196)

Reducing energy demand

10.3.53 Building Standards are critical for reducing the energy demand from new development and ensuring resilience against a changing climate, for example by combatting the risk of overheating in new dwellings.

10.3.54 PPW 10 states that planning authorities should assess strategic development sites to identify opportunities to require higher sustainable building standards, including zero carbon, in their development plan (Welsh Government, 2018b). In bringing forward standards higher than the national minimum, which is set out in Building Regulations, planning authorities should ensure the proposed approach is based on robust evidence, has taken into account the financial viability of the scheme and recognises the wider policy objectives of reducing carbon emissions.

10.3.55 Welsh Government proposals for all new homes in Wales to be heated and powered from clean energy sources from 2025 closed for consultation on 12 March 2020 (Welsh Government 2020a). It included guidance that all new homes will need to be future-proofed, to make it easier to retrofit low carbon heating systems (Welsh Government, 2019b).

10.3.56 It also recommended improving energy efficiency through introducing measures that limit heat loss and reduce the demand for heat, such as triple glazing and higher standard fabrics for walls, roofs, floors, and windows (Welsh Government, 2019b).

10.3.57 The approach being taken is a stepped one, with a 2020 standard (for either 37 or 56% CO_2 reduction from new dwellings depending on the consultation outcome), stepping up to a higher standard in 2025 (Welsh Government, 2019d). Strategic development sites should be mindful of this increasing ambition, particularly in relation to measures which could help future proof new dwellings in line with the higher standard – such as choosing to install low carbon heating systems.

10.3.58 The Welsh Government also plan to consult on making improvements to Building Regulations requirements for new and existing non-domestic buildings, including opportunities to promote low carbon and higher energy efficiency heating, ventilation and air conditioning systems in new buildings, and the performance gap (Welsh Government, 2019d). RLDP strategic development sites should ensure they are future proofed for the tightening of these requirements. 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.

10.3.59 As referenced above, the RLDP should not provide requirements that are already in the building regulations. Whilst MCC could require higher requirements they should not replicate the requirements of adopted building regulations.

Example policy 4: 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 4) 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, 2019a, pp.221-222)

Renewable energy generation

10.3.60 TAN 8: Planning for Renewable Energy states *that "Design, infrastructure and site layout are key to achieving energy efficient development by optimising passive solar gain in domestic and non-domestic buildings" (*Welsh Government, 2005, p. 12).

10.3.61 The location of uses across a site and the orientation and design of individual buildings have an important role in minimising energy demand and maximising the opportunities for roof-mounted solar. Although the approach to site development will be significantly driven by topography and the nature of the surrounding landscape, design should aim to optimise sunlight penetration and avoid overshadowing an exposed area.

Example policy 5: TAN 12: Design (Welsh Government, 2016b) sets criteria for development layout and approaches that can be included within a design.

These include:

> *"to avoid poor micro-climate (hill crests or frost pockets) and make the most of south facing slopes;*
>
> *passive measures that balance the benefits of minimising heat loss in winter with the risk of excessive solar gain during the summer (avoiding the need to install artificial cooling systems);*
>
> *shelter from the elements to minimise heat losses in winter and provide adequate shade in summer provided from land form, landscape and other buildings;*
>
> *orientation to enable the buildings to face within at least 45 degrees of south to maximise solar gain (dependent on type of use);*
>
> *provision of natural shade in outdoor spaces;*
>
> *sustainable drainage measures through layout and design features which enable the consequences of flooding to be acceptably managed;*
>
> *maximising of opportunities to maintain and/or enhance habitat connectivity and create space for future adaptation."*

(Welsh Government, 2016b, p.32)

Other considerations

10.3.62 In addition to planning policies relating to energy generation and energy use in buildings, there are a number of other elements of sustainability that should be incorporated into the design and layout of LDP strategic development sites. Table 44 summarises other aspects that the LPA should consider.

Table 44: Additional actions that MCC should consider in RLDP strategic development site design and layout to achieve renewable energy and carbon targets

Category	Actions
Sustainable transport	Ensure developments maximise the use of active, public and shared transport over private transport and expand the existing cycle network. Ensure integration with pedestrian transport routes, the public transport network and expanding the electric vehicle network.
Integration of electric vehicles	PPW 10 states the planning system should encourage and support the provision of Ultra Low Emission Vehicle (ULEV) charging points as part of new development. Where car parking is provided for new non-residential development, planning authorities should seek a minimum of 10% of car parking spaces to have ULEV charging points. Consider integration of solar canopies.
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.
Water conservation and management	Ensure that all new developments incorporate sustainable drainage systems and rainwater harvesting.
Smart development	Consider integration of heat mains and digital infrastructure in new roads.
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.
Waste management	Ensure that all waste management processes comply with the Waste Management hierarchy (Welsh Government, 2010)

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

Example policy 6: 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)

Implementation

10.3.64 Different Local Authorities have taken different approaches to the implementation of design and layout policies. The two main approaches are:

1. To produce a Supplementary Planning Document which sets out specific standards for design and layout. Applicants must then demonstrate these standards through a Design and Access Statement.

2. To require a Sustainability Statement to be submitted with a planning application.

10.3.65 Table 45 shows the implementation approach for the example design and layout policies set out above.

Table 45: Implementation of policy examples

Policy example	Implementation
Policy SC1: Sustainable Construction of Milton Keynes Council's *Plan: MK 2016-2031*	Milton Keynes Council refers to a Sustainable Construction and Design SPD which has not yet been developed. The previous SPD on **Sustainable Construction** contains a Sustainability Statement checklist for Housing and Non-Housing developments as well as explanatory notes. To demonstrate this policy, Milton Keynes Council require a Sustainability Statement as part of a Planning Application. ***Requirements for Planning Applications*** (Milton Keynes Council, 2019b, p.17) states: *"The Sustainability Statement should include information about how the design and construction of the development complies with sustainable design and construction policies and guidance and will be built to achieve the highest standards possible. It should include information about how the layout achieves the most sustainable development, how landscaping is likely to be utilised to improve sustainability, renewable energy utilisation, use of building materials and achieving carbon neutrality, where appropriate.* *Where an element of the scheme cannot meet any of the goals of sustainability in policy, it should be highlighted why this cannot be achieved. The statement should also outline how the development proposes to interact with providing positive environmental, social and economic implications, such as integration with sustainable transport networks and infrastructure and climate change mitigation."*
Proposed Policy CCS1: Climate change, sustainable design and construction from Bristol City Council's *Local Plan Review, Draft Policies and Development Allocations Consultation (March 2019)*	Bristol City Council requires a Sustainability Statement proportionate to the scale of development proposed to be submitted with planning applications**.** ***The Local Plan Review, Draft Policies and Development Allocations Consultation*** document states: *"The application drawings and supporting information should show how the measures proposed form an integral part of the proposed design and the approach to green infrastructure.* *The assessment of major development against national sustainability methodologies will ensure that development engages thoroughly with issues of sustainable design and construction. Assessments should be completed by a licensed assessor.* *The BREEAM methods should be used where relevant unless they are replaced by any such national measure of sustainability which is approved by the local planning authority.* *There are a number of assessment and ratings schemes available that can assist applicants and design teams in integrating sustainability into the design of residential buildings.* *These include:* > *PassivHaus* > *Home Quality Mark (HQM) Leadership in Energy and Environmental Design (LEED)* > *AECB Carbonlite Programme* *For the purposes of this policy, major development is defined as development of 10 or more dwellings or development exceeding 1,000m² of other floorspace."* (Bristol City Council, 2019, p.108-109)

Policy example	Implementation
Hammersmith & Fulham Policy CC2: Ensuring Sustainable Design and Construction	The London Borough of Hammersmith and Fulham provide further guidance to meeting Policy CC2 in their ***Supplementary Planning Document***. All major development applications require a Sustainability Statement to be submitted which demonstrates how the scheme has integrated the requirements of Policy CC2. Acceptable methods of assessing sustainability of developments are referenced within the guidance, including the Home Quality Mark.
Proposed Policy CCS2: Towards zero carbon development from Bristol City Council's *Local Plan Review, Draft Policies and Development Allocations Consultation (March 2019)* Relating to *Heating and Cooling Systems*	Bristol City Council's proposed Policy CCS2 requires proposals for development to be accompanied by an energy strategy as part of the Sustainability Statement submitted with the planning application. This should set out measures to reduce CO_2 emissions from energy use. *"The energy strategy should:* > *Set out the projected annual energy demands for heating, cooling, hot water, lighting and power from the proposed development against the appropriate baseline (current Building Regulations Part L standards), along with the associated CO_2 emissions.* > *Show how these demands have been reduced via energy efficiency measures, and set out the CO_2 emissions associated with the remaining energy demand and the % emissions saving that will be achieved.* > *Set out the choice of heating and cooling systems and how these have been selected, and the residual CO_2 emissions that the development will generate after energy efficiency and sustainable heating/cooling have been taken into account.* > *Demonstrate how the incorporation of on-site renewable energy has been maximised to offset residual CO_2 emissions.* > *Set out how carbon offsetting will be used to offset any remaining residual CO_2 emissions.* *Renewable sources of heating and power include ground, water and air source heat pumps, geothermal heat, and heat from former mine workings, photovoltaics, solar thermal, biomass and wind (large and small scale).* *Heat pumps can also be used to provide cooling from the ground and water. In some cases this can be combined with heating to provide seasonal storage of heat.* *Low carbon sources of heating include energy from waste processes and gas fired combined heat and power.* *The appropriate baseline at the time of writing is the 2013 Building Regulations Part L. In the event that the Building Regulations are updated, any change in the implementation of this policy will be set out in further guidance published separately by the council."* (Bristol City Council, 2019, p.111-112)

Recommendations

10.3.66 The recommendations provided below are made in order to support decarbonisation of Monmouthshire and Wales, by ensuring that new developments are built in a manner that consider the causes and effects of climate change and reduce the need for retrofit measures to be installed at a later date. The LPA will need to consider these recommendations alongside other objectives of the RLDP when finalising the RLDP's exact policy wording.

10.3.67 Welsh Government is in the process of reviewing building regulations, with the intention of adopting an initial 2020 standard which will be revised again in 2025 to achieve higher energy efficiency and low carbon standards within new buildings. MCC should not look to replicate the requirements of building standards and have acknowledged that there are challenges to implementing requirements above the proposed new building regulations. However, this should not exclude requiring standards above the current building regulations where this is consistent with meeting local and national carbon emission targets.

10.3.68 It is therefore recommended that MCC continue to engage with the Welsh Government's building regulations review and assess the requirements that are in force when the RLDP is due for adoption. The requirements should be assessed against all sustainable design principles, covering a broad range of aspects (transport, drainage, green infrastructure resilience) to understand whether there is any scope for MCC to stipulate further requirements within their local context. If the proposed new 2020 building standards are not adopted prior to adoption of the RLDP, and the current Part L: 2014 regulations are still in force, it is recommended that MCC **do** require higher building sustainability standards such as those laid out in the example policies provided. In doing so, MCC will be demonstrating compliance with the energy hierarchy laid out in PPW 10 (Welsh Government, 2018b).

10.3.69 To support compliance with building regulations it is recommended that a full and thorough assessment of the designed energy performance and potential to integrate renewable and low carbon energy provision is included in any new development proposals. The Committee on Climate Change (CCC, 2019b, 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"*. In addition to higher design standards, it is, therefore, recommended that MCC require developers to provide a monitoring system that demonstrates compliance with the approved designs, even if this is not required by Building Regulations. Policy SK1 of Milton Keynes Council's Plan MK 2016-2031, requires a 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 [ensuring] that the information recovered is provided to the applicable occupiers and the planning authority."* (Milton Keynes Council, 2019a, p.222). Systems proposed under this policy in Milton Keynes, could be referenced to provide examples to prospective developers within Monmouthshire.

Develop policy mechanisms to support District Heating Networks (DHN) for strategic sites

Policy objectives

10.3.70 The Toolkit (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.

10.3.71 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. As identified in Section 7, some areas are better suited to district heat networks than others. As such, whilst the Toolkit focuses on district heat networks, as acknowledged within the proposed building regulations, it is more appropriate for developers to focus on low carbon heating more broadly, and ensure that the most appropriate solution is deployed.

Existing policy

10.3.72 The current LDP does not provide any guidance or policies in relation to low carbon/renewable heat or district heat networks.

Evidence base for future policy

10.3.73 An example policy suggested in the Toolkit is to designate areas as strategic (or priority) district heat areas (Welsh Government, 2015). Section 7 identified limited opportunities for heat networks within the study area and therefore it is likely to be more appropriate to have an overarching low carbon heating policy in the new RLDP rather than a specific heat network policy.

10.3.74 It is more straight forward to design a district heat network (and other low carbon heating systems) into a new development than install it in an existing development, therefore RLDP strategic development sites may provide a good opportunity for heat network development and should be encouraged to consider all low carbon heating systems.

10.3.75 A financially viable project is one that provides a sufficient and acceptable return on investment for a developer to invest in it. The point of viability will vary dependent on an individual developer's (and investor's) requirements.

10.3.76 The predominant heating system used in the UK is individual gas boilers, which are currently relatively cheap to both install and run. Whilst heat pumps and district heat networks are generally more expensive than gas boilers this does not mean they will automatically make a development "unviable". Energy efficient developments, combined with low carbon heating designs, can provide a lower cost alternative than more traditional solutions. A study of the impact of heat pump technologies in new build developments in London states the following: "*Heat pump systems are already widely used in a variety of commercial buildings (e.g. offices, retail, hotels). Individual heat pump systems are also often used for individual houses. This can be considered as evidence that their cost does not have a significant impact on viability for these types of development."* (Etude, 2019, p.63).

10.3.77 The cost implications of integrating district heating and heat pump heating systems into new developments is site specific requiring assessment by individual developers, as it depends on building density, fabric efficiency, site location, the specific heating technology solution, etc., and should consider the whole-life cost (including replacement and running costs). The International Energy Agency (IEA, 2011) compared cost effectiveness of air source heat pumps with a coefficient of performance of 2.5 and a district heat network for three different areas of different housing densities in the UK (15, 30 and 60 dwellings per hectare). The results found that, over 25 years, air source heat pumps were more cost effective for the developments of 15 and 30 dwellings per hectare but less cost effective for 60 dwellings per hectare (IEA, 2011). The tipping point for a district heating network to be more cost effective is suggested to be a linear heat density of 1.5 MWh/m of trench length (IEA, 2011). The methodology used in the study (IEA, 2011) could be used by developers to assess the relative cost effectiveness of different heating solutions for their own proposals.

10.3.78 It is worthy of note, that technology costs can change over time as the market penetration of a product increases. DECC (2016) expect an overall cost reduction in air source heat pump costs of 20% under a mass market scenario in comparison to current market costs and a report by the Energy Technologies Institute (ETI, 2018) identifies the potential for a 30-40% reduction in the cost of heat networks. Deployment of heat pumps and heat networks are expected to increase, especially following the announcement in the 2019 Spring Budget that no gas boilers will be installed in new homes from 2025.

Example policy wording

10.3.79 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 7: 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

10.3.80 The recommendations provided below are made in order to support decarbonisation of Monmouthshire and Wales, by ensuring that new developments adequately consider low carbon heating systems during the design process. The LPA will need to consider these recommendations alongside other objectives of the RLDP when finalising the RLDP's exact policy wording.

10.3.81 It is acknowledged that heat is a challenging sector to decarbonise. Integrating low or zero carbon heating into existing properties is more challenging than into new properties. Following adoption of the new 2020 and 2025 building regulations, new developments may be required to install low carbon heating solutions. Due to the range and differing suitability of low carbon heating solutions, it is considered appropriate for developers to determine, decide and evidence the most suitable low carbon heating solution (e.g. individual heat pumps, hydrogen, district heat network) for their development, unless the LPA particularly want to encourage a specific low carbon heating solution, such as a heat network in a certain location, e.g. at the new strategic development sites. If this is a desire of the local authority, the areas around these sites could be designated as priority heat network areas and developers could be required to formally consider this heating solution when drafting their development plans. Policy wording relating to district heat networks should require developments to be designed so that they are suitable for integration with lower temperature heat generation systems (e.g. solar thermal and heat pumps).

10.3.82 Whilst it is acknowledged that some developers will resist providing lower carbon heating solutions than are required by building regulations, if the Part L: 2014 building regulations are still in place at the time of RLDP adoption, it is recommended that MCC consider requiring this in order to support decarbonisation of the energy system and reduce requirements for future retrofitting. If it is not considered possible to adopt low carbon heating requirements, and these aren't required by building regulations, it is recommended that new properties are built so they are at least *compatible* with low carbon heating solutions, so that these can be more easily retrofitted in the future.

10.3.83 From 2025 onwards, it is anticipated that gas boilers will not be permitted in new homes. Prior to this legislation coming into force, it is recommended that new connections to the gas network are discouraged and, where connections are proposed, a full and robust justification for the need for this is provided.

10.3.84 It is recommended that the low carbon heating solution installed by developers can be determined by the developer. However, if the local planning authority has a preference for particular technologies, a hierarchy of solutions could be provided for within the policy wording as per proposed policy CCS2 provided by Bristol City Council (2019).

10.4 Identify Further Actions for Local Authority, Public Sector and Wider Stakeholders

Community and local ownership

Targets

10.4.1 The Welsh Government has set the following targets for energy generation in Wales:

- *Wales to generate electricity equal to 70 per cent of its consumption from renewable sources by 2030*
- *1 gigawatt (GW) of renewable electricity and heat capacity in Wales to be **locally owned** by 2030*
- *New energy projects to have at least an element of **local ownership** from 2020*

(Welsh Government, 2020c, p. 3)

10.4.2 With respect to the terms often used when discussing local ownership of renewable energy projects, Welsh Government has provided the following definitions:

- ***Local ownership:*** *energy installations, located in Wales, which are owned by one or more individuals or organisations wholly owned and based in Wales, or organisations whose principal headquarters are located in Wales. This includes the following categories:*
  - *Businesses*
  - *Farms and estates*
  - *Households and other domestic scale generation*
  - *Local Authorities*

- *Other public sector organisations*
- *Registered Social Landlords*
- *Third sector organisations including social enterprises and charities, their subsidiaries, trading arms and special purpose vehicles*

> **Shared ownership:** projects, which are owned by more than one legal entity, e.g. project ownership is shared between a developer and a community group, individuals, landowners, or a public sector organisation.

> **Community ownership:** projects located in Wales, which are wholly owned by a social enterprise(s) whose assets and profits are committed to the delivery of social and/or environmental objectives.

(Welsh Government, 2020c, pp.2-3)

Benefits of local ownership

10.4.3 Welsh Government's emphasis on local ownership, within their energy targets, is based on the assertion that local ownership of renewable energy projects will give rise to wider benefits, in addition to the inherent environmental benefits associated with renewable energy generation (Welsh Government, 2020c). The Welsh Government held a call for evidence on locally owned renewable energy in 2018 (Welsh Government, 2018a). The results of this call for evidence identified a range of additional financial, and non-financial, benefits which arise from locally owned projects in comparison to projects owned by external bodies outside of the local area.

10.4.4 Whilst there are differing views on geographic capital allocation, benefits of local ownership include:

> It is estimated that Wales could be exporting 6-10% of Gross Value Added through energy bills alone, if local organisations owned the generation assets more of the money spent associated with energy bills would be retained in the local area (Welsh Government, 2020c, p. 4)

> DECC (2014a, p.2) stated that community energy projects offer *"between 12 and 13 times as much community value re-invested back into local areas as would be achieved through 100% commercial models."*

> It has been estimated that that small-scale hydropower schemes (<500 kW) could generate as much as £300,000 of GVA/MW and 10 full-time equivalent jobs per MW (approximately twice as much as the estimate for commercially owned schemes) (Bere et al., no date, p.14)

> Local ownership of projects can provide the potential for local people to feel more connected to the infrastructure projects which are developed in their local area

> Community energy initiatives, can help to increase social cohesion in local areas, increase volunteering possibilities, and provide the opportunity for individuals to build confidence in working together on local community projects, which could lead to the development of further initiatives developed for local social, environmental and economic benefit (Welsh Government, 2018a)

> Education and awareness raising has been cited as a wider benefit of community energy projects, helping to drive low carbon behaviour change and increase environmental understanding within communities (CEE, no date)

> Community share offers have enabled local people to directly invest and benefit from renewable energy assets developed in their local area (Welsh Government, 2018a).

10.4.5 As the energy system continues to develop, additional benefits from local ownership may arise. For example, the Energy Local project (piloted in Bethesda in North Wales) has enabled residents local to a hydropower generation plant to purchase electricity that is generated from the hydropower plant via an "Energy Local Club" (Energy Local, 2020). Local ownership of the hydropower plant involved in the project (owned by the National Trust), and heavy involvement from the Ynni Ogwen community group in the area, may have helped to engage local residents in the project and encourage them to sign up for the scheme.

Local ownership and planning policy

10.4.6 Planning Policy Wales Edition 10 (PPW 10) states the following:

> *"The Welsh Government supports renewable and low carbon energy projects which are developed by communities, or benefit the host community or Wales as a whole. The social, environmental and economic (including job creation) benefits associated with any development should be fully factored into, and given weight in the decision-making process. However, planning decisions must be based on an assessment of the impacts of the proposed development, irrespective of who the applicant is."*

(Welsh Government, 2018b, p.95)

10.4.7 Commercial-scale renewable energy projects have often involved a community benefit fund; a fund which the project developer pays into over the project lifetime for use in the host community. PPW 10 provides the following information on Welsh Government's view of community benefit funds and how they should be considered within the planning consenting process:

> *"We also support the principle of securing financial contributions for host communities through voluntary arrangements. Such arrangements must not impact on the decision-making process and should not be treated as a material consideration, unless it meets the tests set out in Circular 13/97: Planning Obligations"*

(Welsh Government, 2018b, p.96)

10.4.8 Circular 13/97 Planning Obligations states that:

> *"Amongst other factors, the Secretary of State's policy requires planning obligations to be sought only where they meet the following tests:*

- *Necessary*
- *Relevant to planning*
- *Directly related to the proposed development*
- *Fairly and reasonably related in scale and kind to the proposed development*
- *Reasonable in all other aspects."*

(Circular 13/97 Planning Obligations, 1997, p.2)

10.4.9 Planning obligations are private agreements between the local authority and developer, which can be attached to a planning permission to make acceptable development which would otherwise be unacceptable in planning terms (Planning Portal, 2020).

Recommendations

10.4.10 The recommendations provided below are made in order to support attainment of the Welsh Government's targets relating to local ownership of renewable and other energy assets. The LPA will need to consider these recommendations alongside other objectives of the RLDP when finalising the RLDP's exact policy wording, guidance and LPA support protocols.

10.4.11 From the guidance provided by Welsh Government, it is recommended that MCC planning authority ensure that:

- Voluntary community benefit funds associated with developments are not considered in the decision-making process
- The full benefits of a proposal are considered in the decision-making process. As described previously, benefits from renewable energy developments are not limited to the inherent environmental benefits associated with renewable energy generation. The additional economic, social, and environmental benefits should be fully considered, including those which may only arise or be present to a greater extent due to the nature of the project ownership. The project ownership, on its own, should not be factored into the weighting of the decision-making process, but the benefits that would arise from the project ownership should be
- Applicants for planning permission for renewable energy developments are required to identify the benefits that will arise from their application in order to allow the LPA to ensure that these are fully factored into and given weight in the planning consent decision making process
- Planning obligations are used to secure the wider benefits that may arise from the proposed project ownership structure, if it is considered that this is necessary, relevant to planning, directly related to the proposed development, fairly and reasonably related in scale and kind to the proposed development, and reasonable in all other aspects
- Community organisations, and those seeking to promote renewable energy projects, are given specific assistance when progressing through the planning process, and that the LPA is as accommodating as possible when dealing with their projects, as suggested by PPW 10 (Welsh Government, 2018b).

10.4.12 In order to support attainment of the local ownership targets LPAs, should look to support the development of wholly, locally owned developments and encourage commercial developers to consider integrating an element of local ownership into their projects.

10.4.13 At the time of writing the Welsh Government (2020) provide specific support through the Welsh Government Energy Service to community and public sector organisations looking to develop renewable energy projects. LPAs could sign post these organisations to this service or to other organisations providing other forms of support and advice, e.g. Community Energy Wales.

10.4.14 When engaging with commercial developers in the pre-planning process, local planning authorities could question the developer regarding the ownership nature of the development, and raise the topic of potential for shared ownership.

10.4.15 At a wider local authority-level (i.e. extending beyond the planning department), MCC should encourage integration of local ownership, by providing information to private developers of any known local community energy organisations, public sector bodies, or private sector organisations who may be interested in investing or being involved in the development and delivery of renewable energy projects in the local area. To do this the local authority could advertise for interest within the local area and keep a live list of organisations interested in collaborating on projects and provide this list to relevant commercial developers as they come forward. Additionally, the local authority could look to develop renewable energy projects on their own land either wholly owned by the local authority or in collaboration with other organisations.

Funding opportunities for renewable and low carbon energy schemes

Different funding sources

10.4.16 There are a range of funding sources available to finance renewable and low carbon energy schemes. The source will be dependent on the nature of the development (size, technology, location) and the developer themselves (public sector, large private sector, small private sector, community, etc.). Funding for individual projects can come from a single source, or multiple sources (including mezzanine finance; a mixture of loan and equity finance).

10.4.17 The funding types can largely be split into three categories, with sub-categories within them:

- Debt finance:
  - Commercial loans
  - Specific Energy Funds
  - Public sector loans (available to public and private sector projects)
  - Bonds
- Equity finance:
  - Organisation reserves
  - Private sector investments (e.g. pension fund investments, venture capitalists)
  - Crowd funding
- Grants:
  - Public sector grants
  - Private sector grants

10.4.18 The specific funding sources available to renewable and low carbon energy schemes will vary over the plan period, but they are likely to fit into the categories identified above.

10.4.19 The characteristics of each of the categories identified are summarised in Table 46.

Table 46: Summary of funding sources for renewable and low carbon energy projects

Source	Typical characteristics
Debt finance: commercial loans	Commercial loans are available to all types of developer for renewable energy projects, from many well-known banks. Award of funding will be subject to a high-level of due diligence on both the project and developer to ensure that repayment terms are likely to be met. Due diligence of projects can be both time-consuming and costly for the developer. Interest rates will be set dependent on the project type, and its associated risks, and loan terms tend to be between 8 and 18 years, dependent on the project type. Commercial loans are likely to be more applicable to larger projects, and may have a minimum investment amount. Set up fees may be charged, and a debt service reserve account is likely to be required (increasing the overall funding required). Removal of the feed-in tariff and renewables obligation (and the potential removal of the renewable heat incentive) has reduced the level of income certainty associated with energy projects, increasing the level of risk associated with them. This is likely to have reduced the number of projects that commercial loans will be awarded to and deteriorated the funding terms offered.
Debt finance: specific energy funds	Loan finance from specific energy funds are available for specific project or developer types, e.g. loans provided to the public sector/community sector, or loans provided for specific energy measures. Award of funding will still be subject to due diligence, but this is likely to be less onerous and costly than that required for commercial loans. The terms associated with specific energy funds are generally more attractive than those provided via commercial finance, e.g. longer-term loans, or lower interest rates. Where funding terms are not more attractive than a commercial loan, they may provide other advantages, e.g. more accessible to smaller or riskier project (e.g. innovation funds), more understanding of capacity issues within organisations where energy project development is not their primary focus. Specific funds are generally time limited, and can be subject to a competition process. The Wales Funding Programme currently provides zero interest loans for renewable energy projects developed by the public sector that meet certain eligibility criteria. The Robert Owen Community Bank's Community Energy Fund was developed with Big Lottery and Community Energy Wales to provide funding for community energy projects in Wales. The fund provides both development and capital loans, and sets its funding terms based on individual project assessments.
Debt finance: public sector finance	Public sector organisations may be able to fund energy projects through their main capital works budget, via Public Works Loan Board borrowing. Sign off for project borrowing tends to be undertaken internally within the public sector organisation, rather than the third-party funder. The terms associated with public sector borrowing tend to be more favourable than commercial borrowing, with lower interest rates and longer repayment periods generally provided.
Debt finance: bonds (including "Green Bonds")	Bonds are an important part of the financing process for renewable energy projects. Bond issuance can be at either the corporate level i.e. issued by companies operating in the renewable sector, or the project level i.e. by an SPV specifically incorporated to develop a particular project or group of projects. Institutional investors are the main subscribers for these bonds and maturities of 20 years or more are not unusual. Transaction amounts tend to be larger and issuers, companies or SPVs, generally require a rating from a recognised rating agency. Historically, bond investors have been reluctant to accept significant construction risk so this type of financing was more associated with operating or brownfield assets. A recent solar PV installation developed by Swindon County Borough Council was part-financed through municipal bonds (Abundance, 2019). There is a growing interest in the investment community for investment in certified "green bonds" i.e. an investment specifically linked to sustainable developments providing a fixed income. Funding of renewable energy projects using this route, potentially combined with municipal bonds e.g. Community Municipal Investment, has potential.
Equity finance: organisation reserves	If a developer has sufficient reserves they could choose to fund the capital cost of the project themselves without the need for third party finance. This greatly reduces the financing risk for the project and eliminates the costs associated with third-party finance. However, due to the generally high capital cost of renewable/low carbon energy projects, this is likely to be an option in a minority of cases.
Equity finance: private sector investments	A developer may choose to sell equity stakes in the project to investment partners (e.g. pension funds, venture capitalists). The investor will provide funding for a project in return for a proportion of the project ownership and corresponding proportion of the project returns over the project lifetime.
Equity finance: crowd funding	A developer may choose to sell equity stakes in the project via community shares. This funding option can secure greater buy in for a project in a local area, and help to spread the benefits of the project across more individuals. The terms of the share sales (and any associated buy back) can be set by the developer, but it needs to be demonstrable that the project could meet these terms at the project outset. This form of finance is likely to be associated with higher ongoing administration and operational costs. It is possible that it could fund up to 100% of the costs but this is dependent on the success of the crowd funding activities.
Grants: Public sector	Whilst public sector financed grants have been awarded to renewable energy projects, state aid rules tend to limit the grant amount that a project can receive, or very strict eligibility criteria will apply.
Grants: Private sector	Private sector grant sources for renewable energy projects exist, including community benefit funds, associated with other renewable energy projects. Private sector grants are not affected by state aid rules and therefore could fund up to 100% of the project costs.

Recommendations

10.4.20 The recommendations provided below are made in order to support local investment in renewable energy technologies. These recommendations are directed at the local authority as a whole rather than the Local Planning Authority specifically.

10.4.21 To encourage local investment in renewable energy technologies, the wider local authority should consider whether they are able and interested in investing in third party energy projects. If there is interest in doing this within the local authority, the conditions associated with any potential investment should be considered, e.g. investment hurdle rates, whether any decision-making powers or project ownership are desired, whether investment in projects in neighbouring authorities would be acceptable. The desire to invest in projects should be widely advertised so that potential developers are aware of the interest.

10.4.22 MCC should also help potential developers to advertise any opportunities for local businesses/residents to invest in local projects, by advertising any share offers on their websites and other public noticeboards.

10.4.23 MCC should identify potential opportunities for raising funding, e.g. through municipal green bonds, to contribute to low carbon and renewable energy project costs.

Corporate and leadership actions

10.4.24 In addition to developing and implementing supportive and ambitious planning policies, and encouraging local ownership and investment in projects, MCC and other stakeholders can undertake additional actions in a wider corporate and leadership role to assist in:

- the delivery of strategic opportunities for renewable and low carbon energy generation,
- transitioning to a “smarter” energy system,
- achieving wider decarbonisation, and
- building resilience and adapting to climate change.

10.4.25 Table 47 summarises some additional actions that could be undertaken by MCC in this capacity. Actions that relate to planning policy but have not been covered elsewhere are identified in italic.

10.4.26 In addition to the details in Table 47, within Monmouthshire Climate Emergency Strategy the following actions, relating to planning, are identified:

- Plant 10,000 new trees by 2022
- Promote Monmouthshire as a test-bed for companies to trial low carbon technologies in a rural setting
- Build and operate two new solar farms – subject to national grid capacity
- Develop proposals for a district heating scheme
- Install photovoltaic canopies at Council owned car parks to park electric vehicle charging points with renewable energy
- Use low carbon building technologies like green walls or roofs
- Increase ‘reduce, re-use & recycling’ across the county
- Build a new high quality recycling facility in central Monmouthshire
- Develop proposals for electric charging in streets and new housing developments.

(MCC, 2019)

Table 47: Additional actions that MCC could undertake in a corporate and leadership capacity

Category	**Actions**
Delivery of strategic opportunities for renewable and low carbon energy generation	Develop additional renewable energy generation projects on MCC'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.
Smart energy system transition	Share learning from any MCC decarbonisation projects with others (private and public sector). *Act as an enabler for energy systems innovation, allowing new innovations to be trialled within Monmouthshire.* *Consider supportive policies for new additional energy system infrastructure including electric vehicle charging infrastructure and battery storage.*
Wider decarbonisation	Commit to building any new council developments to the highest energy efficiency and environmental standards consistent with MCC's climate action commitments and policy. Implement energy efficiency measures on MCC'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. *Ensure developments maximise the use of active, public and shared transport over private transport and expand the existing cycle network*
Resilience and adaptation	*Ensure resilience to climate change is considered in all new development (council and third party)*

11. Conclusions

11.1 For national energy and decarbonisation targets to be met, the national decarbonisation rate will need to be faster than the current reference projection set out by UK Government (BEIS, 2019g). This will likely require increased electrification of heat and transport and large increases in energy efficiency (both with respect to electrical appliances and building fabric efficiency) to ensure that the overall increase in electricity demand is minimised.

11.2 The Toolkit states the *"future energy demand should be established in order to: Provide indicative figures to inform area wide renewable energy installed capacity targets."* (Welsh Government, 2015, p. 43), however PPW 10 notes that: renewable energy targets *"should be calculated from the resource potential of the area and should not relate to a local need for energy"* (Welsh Government, 2018b, p. 90). This requirement acknowledges that some areas may be characterised with higher energy demands and lower renewable energy generation potential.

11.3 Notwithstanding the information above, in order to meet/offset the *estimated lower future* total energy demand (electricity, non-electric heat and non-electric transport) of the Monmouthshire study area, the level of renewable/low carbon energy generation needs to increase approximately six-fold from existing levels. To achieve 70% of *current* local electricity demand from renewable sources, the renewable electricity generation needs to increase by approximately 40% from existing levels.

11.4 With respect to resource potential within the study area, solar resource is identified as the predominant energy resource available. At a high-level, relatively large amounts of land in the study area are considered less constrained for ground mounted solar PV development.

11.5 The total estimated potential solar capacity is 8,297 MW, including existing developments (Table 19), this is reduced to 8,279 MW if the areas identified as also less constrained for wind developments are excluded. This equates to 7,252 GWh p.a. (Table 21) or almost three times the estimated current energy needs of the study area and over four times the lower estimated energy needs for 2033 (comparing results to those in Table 7). This is equivalent to the amount of electricity used to power over 2,417,000 typical homes for a year (it should be noted there are other users of electricity apart from residential properties such as industry, commercial, transport etc.).

11.6 It is considered impractical for all of the solar resource in the study area to be exploited due to additional considerations including cumulative impact, landscape impact, grid capacity and competition with other land uses, including agricultural land, recreational land and further land developments. As such, any targets associated with ground mounted solar PV developments are expected to be much lower than the total potential resource identified in the assessment.

11.7 Solar developments could be encouraged within the study area by adopting policies which:

> set an overall target for renewable energy deployment within the RLDP, broken down within the monitoring framework into individual technology deployment targets to identify how much of the target is likely to arise from solar developments,

- identify preferred areas for developments (termed Local Search Areas in this assessment), which are considered preferable from a resource, land use and landscape sensitivity perspective
- require new developments to directly integrate renewable energy technologies, if this is not a requirement of building regulations.

11.8 The wind resource within the study area is relatively low and therefore it is unlikely that a large number of wind developments will be progressed in the area. Supportive policies and associated targets should be put in place in order to maximise the potential deployment.

11.9 The estimated maximum theoretical energy generation from building integrated solar PV in the study area is relatively high; comparable to approximately 33% of the current (2017) electricity demand of the study area. However, as the uptake of roof-top solar PV is at the discretion of the building owner, it is considered unlikely the maximum resource potential will be achieved within the RLDP period. Based on a review of the growth trends included within the National Grid ESO (2019a) Future Energy Scenarios, it is considered that deployment of 45% of the theoretical maximum resource in the study area would be a more achievable target.

11.10 The assessment has identified a relatively high biomass heat resource in the area, and a relatively high capacity of existing energy generation from biomass sources. This provides a good opportunity to stimulate a biomass fuel generation industry within the local area. In addition to the existing plants, the resource could be utilised within new smaller commercial and domestic biomass boilers, especially in homes and buildings, and for industrial uses where heat generated from heat pumps may not be considered suitable. Planning policy should be supportive of infrastructure required to process biomass for wood fuel as well as the energy generators themselves to ensure that the resource present within Monmouthshire can be exploited and that the generators are not just reliant on fuel imports from outside the local area.

11.11 Energy generation potential from waste and hydro are relatively low, although their use should still be encouraged and maximised by adopting favourable policies. Additional hydropower resource may become available if the viability of small-scale pumped hydropower improves. The amount of residual waste, food waste and sewage waste generated within the study area and the existing processes in place means it is unlikely that any developments which generate energy from these sources will be developed in the study area within the RLDP period.

11.12 Monmouthshire County Council has not yet identified candidate strategic development sites for the RLDP. When these are identified, the overall energy demands of all planned new developments will be estimated, and the potential for integration of low carbon heat and electricity generation will be appraised. To minimise reliance on energy generation in new developments, it is recommended that MCC 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.

11.13 It is anticipated that new building regulations will be adopted in 2020 and 2025 to ensure new developments are designed with decarbonisation in focus. Whilst MCC should not replicate the requirements of adopted building regulations, if Part L:2014 building regulations are still in place at the time of RLDP adoption, it is recommended that MCC consider using their development controls to ensure that the energy hierarchy outlined in PPW 10 is followed, and energy demand from new sites is minimised by adopting higher energy efficiency standards and renewable energy requirements than Part L: 2014 building regulations.

11.14 The heat sector is considered to be a challenging sector to decarbonise. Energy efficiency measures, such as enhanced building regulations for new developments and retrofitted improvements to existing stock, may help to reduce emissions from heat. Despite this, it is anticipated that low levels of heat decarbonisation will take place during the RLDP period, with a greater transition taking place in the 2030s and 2040s.

11.15 Whilst it is acknowledged that some developers will resist providing lower carbon heating solutions than are required by building regulations, if the Part L: 2014 building regulations are still in place at the time of RLDP adoption, it is recommended that MCC consider requiring this in order to support decarbonisation of the energy system and reduce requirements for future retrofitting. If it is not considered possible to adopt low carbon heating requirements, and these aren't required by building regulations, it is recommended that new properties are built so they are at least *compatible* with low carbon heating solutions, so that these can be more easily retrofitted in the future.

11.16 With respect to district heat network opportunities; whilst the heat mapping exercise identified groups of anchor heat loads within eight settlements within the study area, the heat density maps generated indicate very limited potential for a new financially viable heat network to be developed. To investigate the heat network opportunity further, more detailed assessments of the areas around the anchor heat loads identified could be undertaken, mapping out potential pipe routes, and undertaking site specific financial assessments. Additionally, the areas around the existing heat generation plants identified within the county could be investigated to understand if there are suitable heat loads located nearby which could utilise any waste heat available.

11.17 To maximise the potential of meeting decarbonisation targets, positive development policies and targets should be adopted to maximise the resource available alongside other land uses and considerations.

11.18 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.

11.19 The evidence base helps to inform policy development for the Replacement Local Development Plan. With respect to the policy options outlined in Section 10, Table 48 summarises the recommendations made.

Table 48: Summary of policy recommendations

Policy Option	Recommendation
Area wide renewable energy targets	> Adopt two overall capacity targets relating to renewable energy deployment: - A higher, ambitious, aspirational target which includes all renewable energy technologies and systems (including those included within permitted development rights) - A lower target relating to the capacity of planning permissions secured. > Breakdown the target within the monitoring framework into individual technology types across three time periods. > Prioritise solar PV due to the relatively high resource potential identified (i.e. anticipate that the majority of the target being met from ground mounted solar PV). > Develop policies to encourage use of locally generated biomass fuel. > Incorporate NRW's advice into any hydropower policies. > Adopt supportive policies relating to repowering existing assets at the end of their current planning consent period.
Identify suitable areas for renewable energy development	> It is recommended that either: - Supportive planning policy is adopted for wind developments proposed anywhere in the county, or - Broad geographical areas covering all or the majority of less constrained areas identified are designated as Local Search Areas for wind. > Identify local search areas for solar outside flood zones, and adhere to new TAN 15 guidance when published. > If Local Search Areas (LSAs) coincide with the final NDF pre-assessed areas for wind, a clause should be included in any policy wording that smaller developments should not impact the potential for larger-scale projects to be developed. > Support the designation of LSAs with clear, criteria-based planning policy. > Adopt supportive policies for development of new grid connection infrastructure. > Positive policy regarding siting solar PV assets within built-up and urban areas should be adopted, including integration of roof-top PV on all new buildings where technically possible. > To provide strength to the LSA designation, MCC 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, 2020, p.89).
Site allocations and development design and layout	> Fully engage with Welsh Government's review of building regulations and assess the requirements against all sustainable design principles to understand whether there is any scope for

	MCC to stipulate further requirements within their local context. If the proposed new 2020 building standards are not adopted prior to adoption of the RLDP, and the current Part L: 2014 regulations are still in force, it is recommended that MCC require higher building sustainability standards than provided in Part L: 2014 building regulations in order to comply with the energy hierarchy. > Ensure a full and thorough assessment of the designed energy performance and potential to integrate renewable and low carbon energy provision is included in any new development proposals. > Require developers to provide a monitoring system that demonstrates compliance with approved designs, if this is not required by building regulations.
Develop policy mechanisms to support District Heating Networks (DHN)	> If the Part L: 2014 building regulations are still in place at the time of RLDP adoption it is recommended that MCC require the installation of low carbon heating systems. If it is not considered possible to adopt low carbon heating requirements, and these are not required by building regulations, it is recommended that new properties are built so that they are at least compatible with low carbon heating systems. > Prior to national legislation preventing the installation of gas boilers in new homes it is recommended that new connections to the gas network are discouraged. > If the local planning authority prefer particular low carbon heating technologies, a hierarchy of solutions should be provided for within the policy wording and particular areas (e.g. the RLDP strategic development sites) could be designated as priority heat network areas. > Any new district heat networks should be designed so that they are suitable for integration with lower temperature heat generation systems (e.g. solar thermal and heat pumps).

11.20 In addition to setting a positive planning policy environment for decarbonisation, MCC can demonstrate leadership with respect to the decarbonisation challenge by:

- Developing additional renewable energy generation projects on MCC's (or other stakeholders') own estate
- Investing in renewable energy generation technologies (joint venture or sole investor)
- Ensuring that renewable energy generation from waste is secured through any new waste management contracts
- Sharing learning from any MCC decarbonisation projects with others (private and public sector)
- Acting as an enabler for energy systems innovation, allowing new innovations to be trialled within Monmouthshire
- Committing to building any new council developments to the highest energy efficiency and environmental standards
- Implementing energy efficiency measures on MCC's (and other stakeholders') own estate

- Managing organisation operations in the most energy efficient manner (through staff training)
- Ensuring that climate change impact and sustainable development is considered throughout all procurement activities.

Next steps

11.21 The policy recommendations made in Section 10 are informed by the evidence base generated by the assessment and look to maximise planning policy support for attaining decarbonisation targets.

11.22 Following the completion of this assessment, MCC should consider the recommendations made alongside the other Replacement Local Development Plan (RLDP) objectives (for example economic requirements, housing requirements etc.) and the LPA's resource capacity to determine how to implement the recommendations within their RLDP policy proposals. It is recommended that additional stakeholders are consulted to support this process. Stakeholders to engage with include:

- Local Authority elected members and officers from relevant departments, such as officers responsible for:
  - Planning policy and development management
  - Waste
  - Energy management
  - Landscape/conservation
  - Economic development/regeneration
  - Sustainable development
  - Property/estates
- External stakeholders:
  - Statutory agencies, such as Natural Resources Wales (NRW)
  - Renewable energy developers
  - Housing developers
  - Other local stakeholders, such as National Farmers' Union (NFU), local energy agencies, etc
  - Local Service Board representatives (e.g. NHS Trust, Police, Fire, NGOs, not for profit organisations, faith organisations plus UK Government Departments (e.g. MoD)
  - Utilities, Energy Service Companies (ESCOs) and multi utility services companies (MUSCOs).

Appendices

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