FINAL REPORT

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Renewable Energy Resource Assessment Report

Bath and North East Somerset Council

February 2022

Quality information

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Acronyms and Abbreviations

Acronym/ Abbreviation	
AC	Alternating Current
AD	Anaerobic Digestion
AGL	Above Ground Level
AHL	Anchor Heat Load
ALC	Agricultural Land Classification
AONB	Areas of Outstanding Natural Beauty
B&NES	Bath and North East Somerset
BD	Biodegradable
BEIS	Business, Energy and Industrial Strategy Department
BIR	Building Integrated Renewables
C&D	Construction and Demolition
C&I	Commercial and Industrial
CAA	Civil Aviation Authority
CCC	Climate Change Committee
CCHP	Combined Cooling Heating and Power
CCS	Carbon Capture and Storage
CES	Climate Energy Strategy
CF	Capacity Factor
CGS	Clean Grown Strategy
CHP	Combined Heat and Power
CMZ	Constraint Management Zones
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CS	Core Strategy
DC	Direct Current
DECC	Display Energy Certificates
DECC	Department for Energy and Climate Change
DEFRA	Department for Energy, Food and Rural Affairs
DFES	Distribution Future Energy Scenarios

DHN	District Heating Network
DHW	Domestic Hot Water
DNO	Distribution Network Operator
DNS	Development of National Significance
DPD	Development Planning Document
ECO	Energy Company Obligation
EfW	Energy from Waste
EPC	Energy Performance Certificate
ERF	Energy Recovery Facility
ESO	Electricity System Operator
ESCO	Energy Service Company
EU	European Union
FES	Future Energy Scenarios
FiT	Feed-in-Tarif
GI	Green Infrastructure
GIS	Geographic Information System
GW	Gigawatts
HNDU	Heat Network Development Unit
HNIP	Heat Network Investment Project
HWRC	Household Waste Recycling Centres
IRZ	Impact Risk Zones
JWCS	Joint Waste Core Strategy
kW	Kilowatts
LA	Local Authority
LDP	Local Development Plan
LAEP	Local Area Energy Plan
LP	Local Plan
LSOA	Lower Super Output Area
LZC	Low & Zero Carbon
MHCLG	Ministry of Housing, Communities and Local Government
MoD	Ministry of Defence
MSOA	Middle Super Output Area

MSW	Municipal Solid Waste
MW	Megawatts
MWe	Megawatts electrical
MWhe	Megawatt hours electrical
MWht	Megawatt Hours thermal
MWt	Megawatts thermal
NATS	National Air Traffic Service
NDF	National Development Framework
NECP	National Energy and Climate Plan
NIRAB	Nuclear Innovation and Research Advisory Board
NIRO	Nuclear Innovation and Research Office
NNR	National Nature Reserves
NO_x	Nitrogen Oxide
NP	Neighbourhood Plan
NPPF	National Planning Policy Framework
NPPW	National Planning Policy for Waste
odt	Oven-Dry Tonnes
PD	Permitted Development
PM	Particulate Matter
PPS	Planning Policy Statement
PSP	Policies, Sites and Places
PV	Photovoltaic
REGO	Renewables Energy Guarantees Origin
REPD	Renewable Energy Planning Database
RERAS	Renewable Energy Resource Assessment Study
RES	Renewable Energy Strategy
RHI	Renewable Heat Incentive
RIGS	Regionally Important Geological Sites
RO	Renewables Obligation
RSS	Regional Spatial Strategy
SA	Search Area
SAC	Special Areas of Conservation

SAM	Scheduled Ancient Monument
SDS	Spatial Development Strategy
SEG	Smart Export Guarantee
SH	Space Heating
SMR	Steam Methane Reforming
SPA	Special Protection Areas
SPD	Supplementary Planning Document
SPG	Supplementary Planning Guide
SSSI	Sites of Special Scientific Interest
UK	United Kingdom
UKAEA	UK Atomic Energy Authority
WDI	Waste Data Interrogator
WECA	West of England Combined Authority
WPD	Western Power Distribution

Report – Summary

Introduction

Bath and North East Somerset (B&NES) Council, working with its partners (South Gloucestershire Council, North Somerset Council and the West of England Combined Authority), has commissioned AECOM to undertake a Renewable Energy Resource Assessment Study (RERAS) to be used as an evidence base to inform their new Local Plans and a variety of future workstreams requiring the consideration of different renewable energy resources. The study informs decisions on policies that support and facilitate the deployment of renewable and low and zero-carbon energy systems. The RERAS consists of a bottom -up assessment of the potential for the deployment of various renewable and low and zero carbon energy technologies at different scales and in different locations across Bath and North East Somerset (B&NES).

Why is this Renewable Energy Resource Assessment Study Important?

Climate Change[1]

Climate change is the variation of the temperature and weather patterns over time. A significant change in temperature and weather patterns can lead to environmental changes that substantially impact the way we live. The current Global climate emergency relates to a sustained increase in average temperature, known as 'global warming'.

The Earth's average temperature has increased by approximately 1°C (1.8°F) in the last century. Although this seems like a small increase, this has had a significant impact on the warming of oceans, melting of polar ice and glaciers, rising sea levels and extreme weather events. Changes such as these could lead to shortages in access to fresh water, significant implications for the food chain, deaths from extreme weather conditions and extinction for many species (as their habitats will be changing faster than they can adapt to).

Figure 1: Image of Sea Ice

How is the Earth's Temperature Rising? [2]

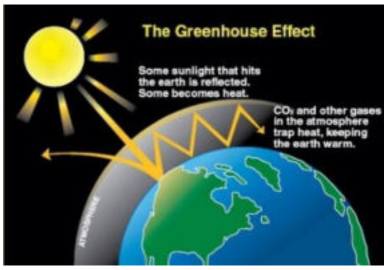


Figure 2: The Greenhouse Effect

The Earth is warmed by a natural process called the 'greenhouse effect'. Radiation from the sun (known as solar radiation), reaches the Earth's atmosphere and is absorbed by the oceans and land, warming the Earth. The Earth then radiates heat back towards space. Greenhouse gases in the atmosphere (such as carbon dioxide and methane) prevent some of this heat from escaping into space, keeping the Earth warm. However, as we produce more greenhouse gases, more heat is being trapped, increasing the Earth's temperature, leading to global warming.

What are we Doing to Prevent This?

Addressing climate change is an issue that is now at the forefront of public and government consciousness and there are new, fast-changing policies emerging.

Climate change is not a new issue and has been a concern for many years. In 1998 the Kyoto Protocol was adopted, committing over 190 countries to limit and reduce their greenhouse gas emissions to prevent dangerous anthropogenic interference with the climate system. The Paris Agreement was adopted in 2016 with the global action plan to limit the effects of climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. In 2008, the UK Climate Change Act set a legally binding target to reduce the UK carbon emissions by 80% compared to the 1990 baseline by 2050. Following recommendations from the Climate Change Committee (CCC), this target was updated to a reduction in carbon emissions by 100% compared to the 1990

[1] Image from https://aecom.assetbank-server.com/assetbank-aecom/action/viewHome
[2] Image from https://www.eden.gov.uk/your-environment/zero-carbon-eden/climate-change/

baseline by 2050, or in other words, 'net zero'. Since then, other policies and strategies have been published to help achieve this net zero target. The UK Renewable Energy Roadmap sets the path for the delivery of these targets. The first six-carbon budgets, leading to 2037, have been set in law. The first two budgets have been met (2008-12, 25% and 2013-2017, 31%) and the third is very likely to be met (2018-22, 37%). The remaining budget targets are as follows:

- Meeting the fourth carbon budget (2023-2027) will require that emissions be reduced by 50% on 1990 levels in 2025;
- Meeting the fifth carbon budget (2028-2032) will require that emissions be reduced by 57% on 1990 levels in 2030; and
- Meeting the sixth carbon budget (2033-2037) will require that emissions reduce by 78% on 1990 levels in 2035[3].

Bath and North East Somerset's Input into Reducing Carbon Emissions

In March 2019, B&NES Council declared a climate emergency. Subsequently, a Climate and Ecology Emergency Action Plan was developed, establishing that in order to meet their carbon neutral aim by 2030, B&NES requires:

Energy efficiency improvement of the majority of existing buildings (domestic and non-domestic) and zero carbon new build

A major shift to mass transport, walking and cycling to reduce transport emissions.

A rapid and large-scale increase in local renewable energy generation

This RERAS includes an assessment of the potential for renewable energy generation across B&NES, highlighting the extent of the change required and informing considerations for future policies to ensure that the 2030 aims are achievable.

[3] The Sixth Carbon Budget limits the volume of greenhouse gases emitted over the 5 year period from 2033 to 2037, this includes a target for 2035.

Technologies

Defining the Units Used in this RERAS

ELECTRICITY/ HEAT OUTPUT

Kilowatts (kW);

Megawatts (MW), which is one thousand kW; or

Gigawatts (GW), which is a thousand MW.

These are a measure of the electricity or heat output being generated (or used) at any given moment in time. When it is running at full load, the maximum output of a generator is referred to as its installed capacity or rated power/heat output.

Energy, on the other hand, is the product of power and time. It has kWh units (the h stands for “hour”) or MWh, or GWh.

ELECTRICITY/ HEAT OUTPUT

Kilowatt hour (kWh);

Megawatt hour (MWh), which is one thousand kWh; or

Gigawatt hour (GWh), which is a thousand MW.

As an example, if a 2MW wind turbine ran at full power for 1 hour, it would have generated 2 x 1 = 2MWh of energy. If it ran at full power for one day (24 hours), it would have generated 2 x 24 = 48MWh.

This distinction is essential because in carrying out the RERAS, certain assumptions have been made to calculate both the potential installed capacity (or maximum power output) of different technologies and the potential annual energy output.

Electricity vs Heat Output

It is essential to distinguish whether a generator produces electricity or heat to avoid confusion in terms of the units used. This is because some renewable energy fuels (i.e. biomass) can be used to produce either heat only or electricity and heat simultaneously when used in a CHP plant.

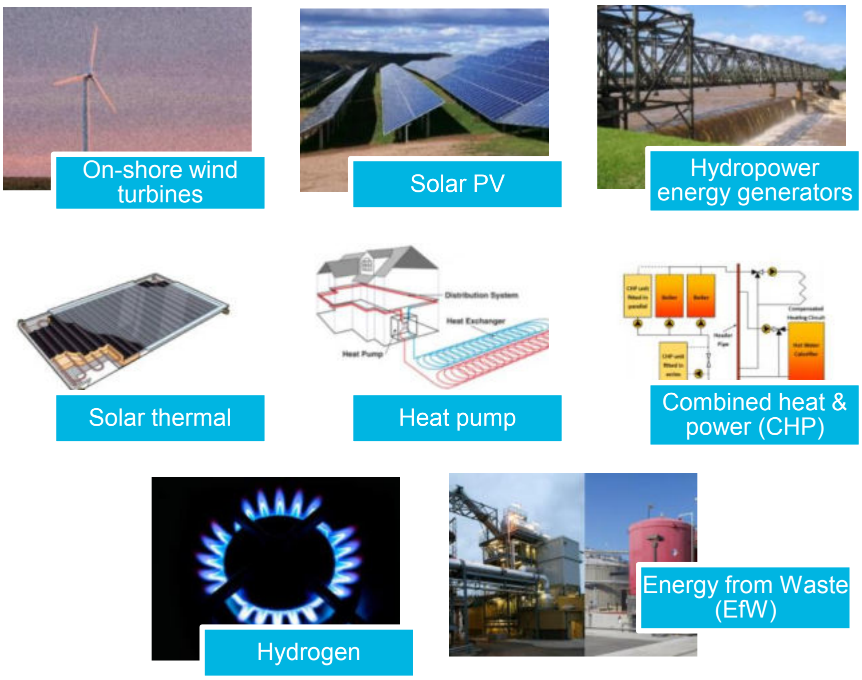
It is also important to be able to distinguish between renewable electricity targets and renewable heat targets.

The suffix “e” is added to denote electricity power or energy output, e.g. MWe, or MWhe

The suffix “t” is used (for “thermal”), to denote heat output, e.g. MWt, or MWht.

Technologies Addressed in this Study[4]

The following technologies are covered in this RERAS:



On-Shore Wind Turbines

Figure 3: Wind

On-shore wind power is a 'mature technology' that is being used for electricity generation worldwide. Most turbines are currently designed using a horizontal axis three-blade rotor system mounted on a steel mast. The blades drive a generator either directly or via a gearbox (generally for larger machines) to produce electricity. Turbines can produce electricity without operational carbon dioxide emissions.

Solar Photovoltaic

Solar Photovoltaic (PV) systems use solar cells to generate electricity directly from sunlight. The solar cells are normally packaged together into panels or other modular forms. The technology is technically well-proven, with numerous systems installed around the world, ranging from small domestic systems (circa 3.5 kW) to large PV farms (several MWs). PV technology is common in the UK, and new technologies such as solar tiles, which can be integrated into new buildings or refurbishments alongside conventional roofing tiles, are becoming more widely available.

Figure 4: Ground Mounted Solar PV Array

[4] Wind Turbine, Solar PV, Hydropower Images from: https://aecom.assetbank-server.com/assetbank-aecom/action/viewHome
Solar thermal Image:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879765/Solar_Thermal_TIL_-_April_2020.pdf
Heat pump Image: https://www.newcastle.gov.uk/services/environment-and-waste/energy-services/electrification-heat/electrification-heat-heat-pump
Combined heat & power Image:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/961492/Part_2_CHP_Technologies_BEIS_v03.pdf
Hydrogen Image:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845658/energy-innovation-needs-assessment-hydrogen-fuel-cells.pdf

Hydropower Energy Generators

Figure 5: Hydropower Energy Generator

Hydropower is the energy derived from flowing water. This can be from rivers or man-made installations, where water flows from a high-level reservoir down through a tunnel and away from a dam. The water drives a turbine connected to an electrical generator, with the energy generated proportional to the volume of water and vertical drop or head.

Solar Thermal

Solar thermal systems use solar collectors, usually placed on the roof of a building, to preheat water for use in hot water applications in buildings. A conventional boiler or immersion heater can be used to increase the temperature of the water, or to provide hot water when solar energy is unavailable.

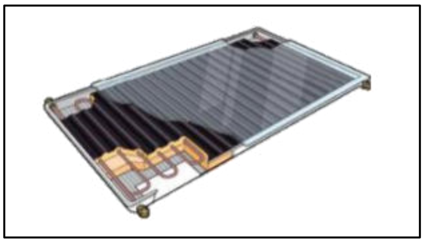


Figure 6: Diagram of a Solar Thermal Collector

Heat Pumps

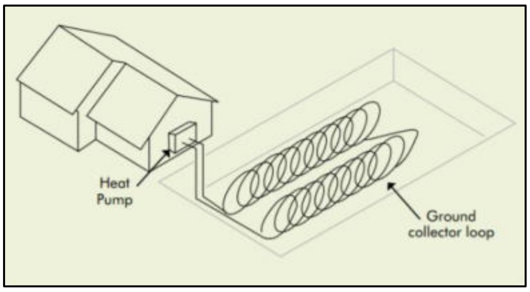


Figure 7: Diagram of a Ground Source Heat Pump System

Heat pump systems absorb the solar heat energy stored in the ground, water bodies, or air into a fluid at low temperature. The fluid is then passed through a compressor to increase its temperature to be used for heating purposes. Although the heat pumps extract renewable heat from the environment, they use electricity as fuel, which may or may not come from renewable sources. However, one of the significant advantages of heat pumps compared to other heat delivery systems is that the heat output is greater (typically 2 to 3 times) than the electricity input, making them an energy-efficient heating technology.

Combined Heat and Power

A Combined Heat and Power (CHP) plant is an installation where there is the simultaneous generation of usable heat and power. This improves the overall energy utilisation of a given fuel compared with the traditional stand-alone boilers. Fuel for the CHPs can come from various sources including biomass[5], energy from waste (incineration), anaerobic digestion[6] and landfill gas[7].

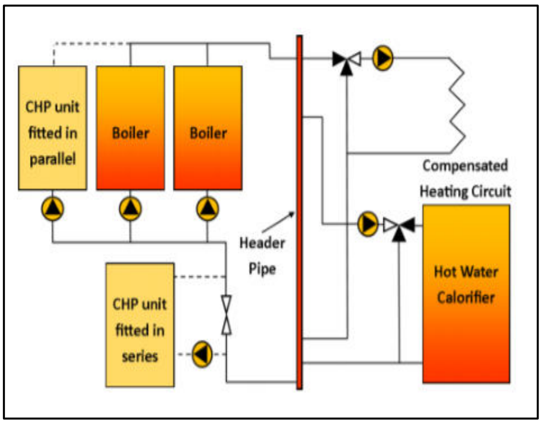


Figure 8: Diagram of a Combined Heat and Power System

[5] A broad term covering all organic material and can be generally defined as material of recent biological origin, derived from plant or animal matter.
[6] A process which produces a biogas with a high methane content which can be captured and burned to produce heat and/or electricity and utilisation as a transport fuel.
[7] Landfill gas is a natural byproduct of the decomposition of organic material in landfills. This gas can be collected and used as an energy source, usually for electricity generation.

Energy Storage - Hydrogen

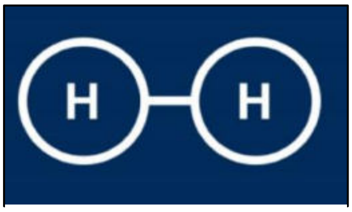


Figure 9: Diagram of a H_2 Molecule

Hydrogen is not a renewable energy source but rather an energy carrier for which renewable energy sources can be used to produce Hydrogen can be used as a heating fuel in homes or industry, in large scale power generation or as a fuel for hydrogen fuel cell vehicles especially for heavy-duty vehicles. There are three ways of producing hydrogen which are listed below; each production method has a descriptive colour.

Grey Hydrogen

Grey hydrogen is made using fossil fuels. This process emmits CO_2 into the atmosphere.

Blue Hydrogen

Blue hydrogen is made using fossil fuels, but carbon capture technology is used to prevent the emission of the CO_2 produced.

Green Hydrogen

Green hydrogen is the cleanest, producing zero carbon emissions. Green hydrogen is produced via electrolysis powered by renewable energy.

Only the use of green hydrogen is considered in this RERAS.

Methodology

This RERAS is compiled in alignment with government policy as set out in the Energy Renewable and Low-Carbon Energy Capacity Methodology for the English Regions [8] in alignment with the National Planning Policy Framework. This RERAS is a 'bottom up' study, of the available resource for renewable energy generation within the B&NES area, considering practical constraints. Using informed assumptions about the technologies likely to be employed for converting resources, energy generation figures have been produced for use in considering planning policies with a view to meeting Bath and North East Somerset's carbon neutral aims by 2030.
Assumptions and data used in producing this RERAS have been sought from established sources, and these are either referenced as footnotes to the text or appropriately appended. Where there are no established sources, assumptions have been made based on AECOM's best estimate and through discussion with Bath and North East Somerset Council and its partners.

Potential Installed Capacity

Maps have been produced to enable spatial identification and provide a visual representation of the potential renewable energy opportunities. These maps were produced using Geographic Information Systems (GIS), whereby overlaying multiple datasets enabled a reveal of opportunities through the removal of developmental primary constraint layers. The 'primary' constraints data were overlaid in stages and are related to resource, technological characteristics, safety, protection of heritage and the environment and other categories. The areas covered by these 'primary' constraints were then removed from further consideration.

On completion of the constraining exercise, the maximum theoretical installed capacity is established along with maximum renewable energy generation potential.

The decision was taken to consider 'other' constraints, and the impact they might have on the maximum potential generation, through the Local Plan process alongside issues relating to landscape sensitivity and grid capacity and other objectives. However, additional maps are presented in the RERAS to provide information about the locations of these 'other' constraints.

Projections about future energy generation potential to 2030 are also included in the report for technologies that do not lend themselves to spatial analysis but are more dependent upon statistics (e.g. municipal solid waste and food waste).

Maps showing the Search Areas (SAs) established for potential wind and solar PV farms after this constraining exercise are shown in and below. Higher resolution versions of these maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

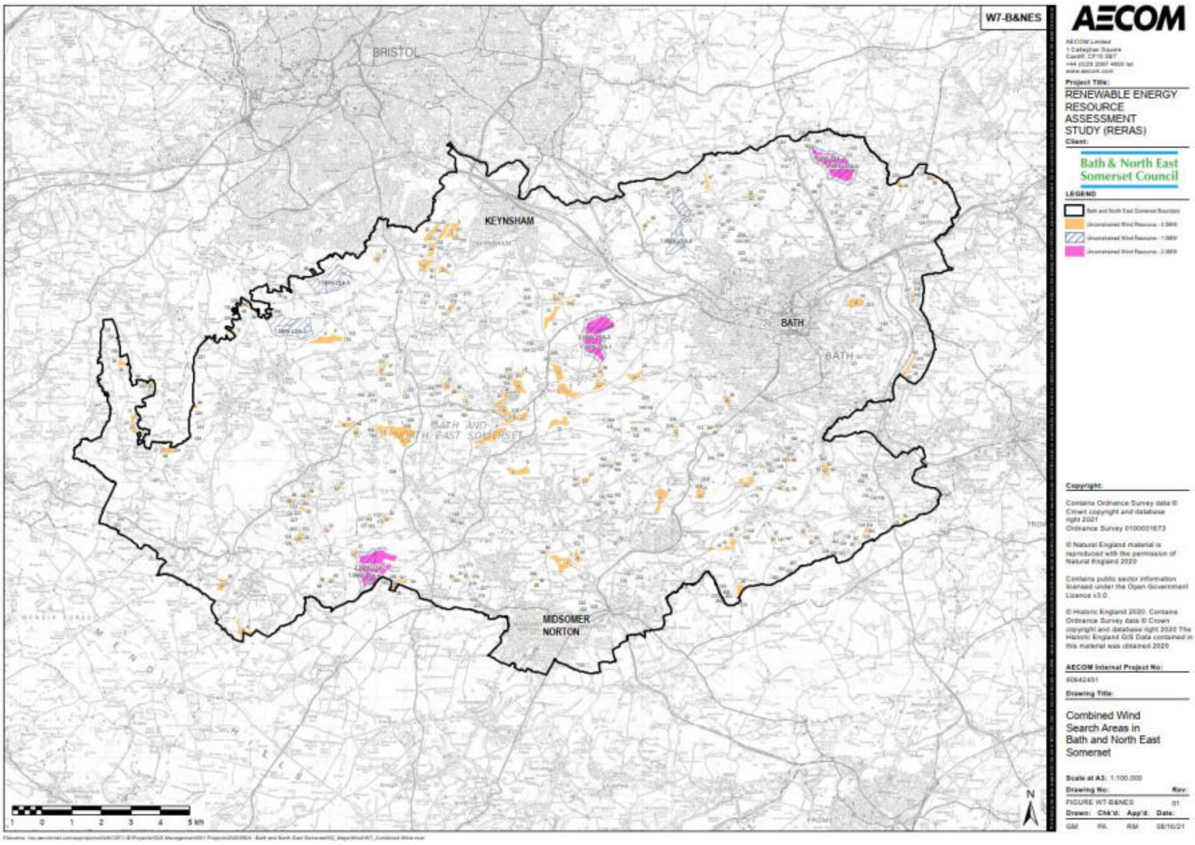


Figure 10: W7-B&NES: Combined Wind Search Areas in Bath and North East Somerset Map

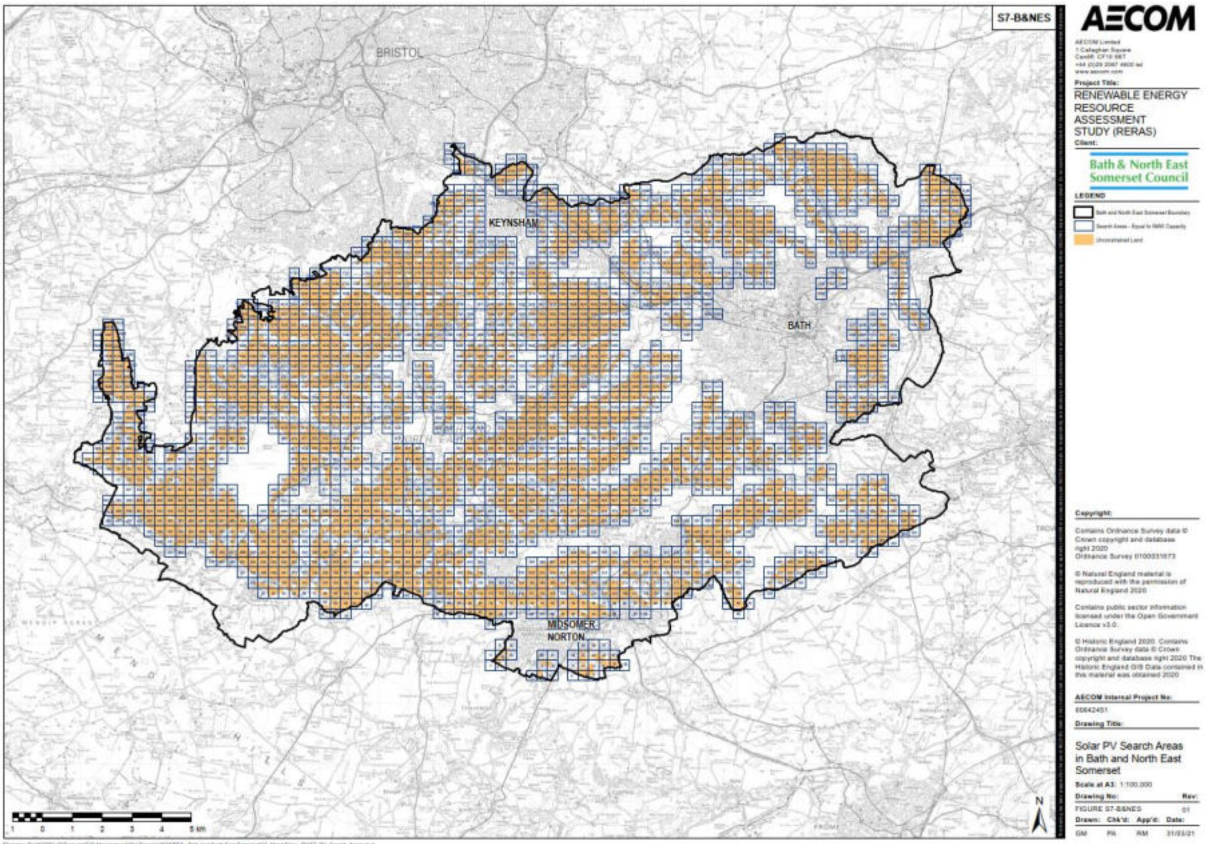


Figure 11: S7- B&NES: Solar PV Search Areas in Bath and North East Somerset Map

Future Energy Consumption

In order to understand different scenarios for renewable energy generation going forward, it has been necessary to understand the level of likely energy consumption in the future. It is projected that electricity will play a more significant role in heating our homes and other buildings as well as fuelling our transport.

Every year the National Grid Electricity Systems Operator (ESO) produce their Future Energy Scenarios (FES). These are in-depth analyses of four future scenarios for the energy system. Each scenario considers the amount of energy that may be needed and where it could come from. The 2020 FES have been updated to reflect the UK Government 2050 net zero targets. The four scenarios are described below:

1. Steady Progression

- Low levels of decarbonisation and societal change.
- Not compliant with the 2050 net zero emissions target.

2. System Transformation

- High level of decarbonisation with lower societal change. Larger, more centralised solutions are developed. This scenario has the highest levels of hydrogen deployment.

3. Consumer Transformation

- High levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and more decentralised solutions are developed. This scenario has significant electrification of domestic heat.

4. Leading the Way

- Very high levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and a mix of solutions are developed. This scenario aims for the “fastest credible” decarbonisation pathway

Western Power Distribution (WPD) has used the National Grid ESO FES as a framework to make projections concerning changes in consumption, storage and distributed generation, including electrified transport and heat across the South West of England; these are the Distribution Future Energy Scenarios (DFES).

Throughout this RERAS, the Consumer Transformation scenario is utilised. The Consumer Transformation scenario assumes that the net zero target is met with measures that have a greater impact on consumers and is driven through consumer engagement. This includes extensive changes to improve the energy efficiencies of homes as well as a higher level of renewable energy generation technology integrated into these homes (referred to in this report as ‘Building Integrated Renewables’).

As B&NES aims to be net zero by 2030, 20 years earlier than the UK target, the decarbonisation projections of DFES have been updated to reflect this. An adjustment was made to bring forward the projected energy consumption and installed capacity of renewables technologies to 2030, as well as increase the projected use of electric vehicles, but not energy consumption of new development between 2030 and 2050. This is because FES housing and population projections are consistent across their scenarios up to 2050, and therefore, the population growth has not been accelerated from 2050 to 2030 in this RERAS.[9]

Baseline Consumption and Future Consumption

The current energy consumption within B&NES is 3,097GWh and the projected future consumption in 2030 is 1,259GWh, The 2030 projected consumption is much lower than the current consumption

[9] FES assumes that the population of Great Britain reaches 68.6 million and that the number of homes grows to 31.9 million by 2050 in all of our scenarios. These compare to a population of 64.9 million and 28.3 million homes in 2019. https://www.nationalgrideso.com/document/173796/download

mainly due to efficiency improvements of electric systems and energy efficiency improvements to homes. A breakdown of the data is shown in Figure 12 below.

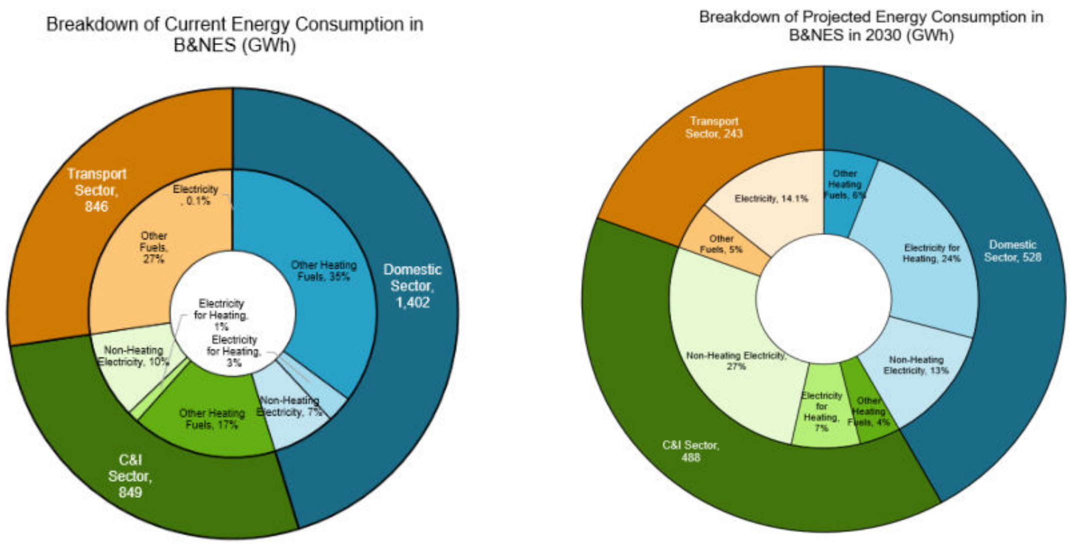


Figure 12: Breakdown of Current and Projected 2030 Energy Consumption in B&NES

A more detailed breakdown of the current and future energy consumption can be seen in Table 1.

Table 1: Current and Projected Energy Consumption (GWh) in B&NES

Fuel Type	Use	Details	Current Energy Consumption (GWh)	2030 Energy Consumption (GWh)
Fossil Fuels and Renewables Other Than Electricity	Heating	Domestic Buildings Fossil Fuels and Renewables Energy Consumption for Heating	1,089.0	72.8
Electricity	Heating	Domestic Buildings Electricity Consumption for Heating	91.7	295.2
Electricity	Non-Heating Electricity in Buildings	Domestic Buildings Non-Heating Electricity Consumption	221.1	159.6
Fossil Fuels and Renewables Other Than Electricity	Heating	Commercial and Industrial Buildings Fossil Fuels and Renewables Energy Consumption for Heating	505.4	54.1
Electricity	Heating	Commercial and Industrial Buildings Electricity Consumption for Heating	40.1	90.6
Electricity	Non-Heating Electricity in Buildings	Commercial and Industrial Buildings Non-Heating Electricity Consumption	303.8	343.4
Fossil Fuels and Renewables Other Than Electricity	Transport Sector	Transport Sector Other Fuels Consumption	843.5	66.1
Electricity	Transport Sector	Transport Sector Electricity Consumption	2.9	177.3
Total Heat Demand (Including Electrical Heating Consumption)			1,726.3	512.8
Total Electricity Consumption (Including Electrical Heating Consumption and Transport Sector Electricity Consumption)			659.5	1,066.2
Total Transport Sector Energy Consumption			846.4	243.4
Total Energy Consumption			**3,097.5**	**1,259.2**

The installed capacity of existing renewable energy technologies has been broken down into solar PV, onshore wind, hydropower, waste incineration, landfill gas and large-scale biomass for the electricity generators and waste incineration, domestic heat pumps, domestic biomass, domestic solar thermal and non-domestic renewable technologies for heat generators. The split can be seen below in Figure 13 and Figure 14.

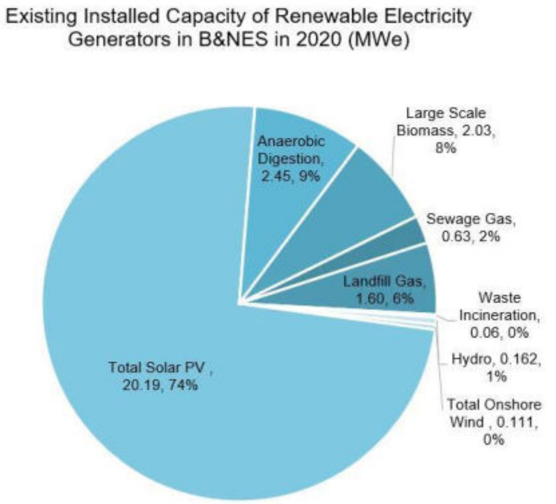


Figure 13: Existing Installed Capacity of Renewable Electricity Generators in B&NES in 2020

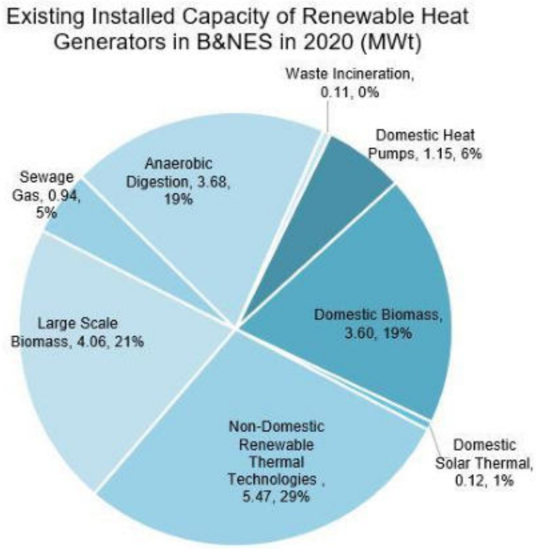


Figure 14: Existing Installed Capacity of Renewable Heat Generators in B&NES in 2020

There is currently enough installed capacity for electricity generation to meet the equivalent of 7.7% of local demand. A low proportion of the existing requirement for heat is currently met from renewables, being the equivalent of 3.3% of local demand.

The equivalent carbon savings from the current installed renewable generation, is shown in Table 2[10]. Natural gas was used as counterfactual for heating technologies, and it was assumed that a gas boiler has an efficiency of 85%.

Table 2: Total $CO2_e$ Savings from Current Installed Renewable Energy Generators[10]

Renewable Electricity Generation (GWhe)	Total Carbon Savings ($tonnesCO_2e$)	Renewable Heat Generation (GWht)	Total Carbon Savings ($tonnesCO_2e$)
63,010	14,690.1	74,083	17,757.2

[10] 2020 conversion factors have been used calculate the savings https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

Results[11] - Theoretical Maximum Available Resource

The figures and table below provide an overview of the potential additional capacity identified in B&NES.

STAND-ALONE WIND FARMS

For 1MW wind turbines, there is a total theoretical potential installed capacity of 40.88MW equating to 88.98GWh of electricity generation.

For 2.5MW wind turbines there is a total theoretical potential installed capacity of 21.42MW equating to 46.62GWh of electricity generation (the suitable areas for 2.5MW Turbines overlap with the 1.0MW areas and cannot be added together.).

272 additional small land parcels for 500kW turbines installations have been identified with a theoretical potential installed capacity of 136MW equating to 296GWh of electricity generation.

STAND-AONE SOLAR PV

There is a total theoretical potential installed capacity of 5,279.6MW equating to 5,121GWh of electricity generation.

BIOMASS: ENERGY CROP

Based on our assumptions, the total usable area of land for energy crops across B&NES is 2.98 km².

Based on combusting energy crops in combined heat and power engines and utilising the heat, there is a total theoretical potential installed capacity across B&NES of 0.55MWe and 1.09MWt, which, for comparison, is equal to supplying energy to 4 typical primary schools annually.

[11] Wind Turbine, Solar PV, Biomass Energy Crops, Municipal Solid Waste, Animal Slurry, Hydropower Images from: https://aecom.assetbank-server.com/assetbank-aecom/action/viewHome
Wood Fuel: https://www.forestresearch.gov.uk/documents/2046/Woodfuel_meets_the_challenge.pdf
C&I Waste: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf
Food Waste: https://www.northlincs.gov.uk/news/fight-climate-change-with-food-waste-action-week/
Poultry Litter: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732227/code-of-practice-welfare-of-laying-hens-pullets.pdf

BIOMASS: WOOD FUEL

The total area of woodland within the National Forestry Inventory in B&NES i.e. all woodland 0.5 hectares and over across B&NES is 35.28km^2 which could result in a total wood fuel yield from management activities of 7,056odt per annum across B&NES.

Utilising this wood fuel in biomass boilers would result in a maximum theoretical potential installed capacity from across B&NES of 10.7MWt, equivalent to supplying energy to 153 typical primary schools annually.

HYDROPOWER

The potential for hydropower generation across B&NES has been assessed. The total theoretical additional installed capacity from hydropower is 0.403MWe.

Energy from Waste

See Table 3 below for a summary of EfW potential. It should be noted that, although there is potential generation from energy from waste, a majority of this resource is currently either transported outside of B&NES or indications are that many of the economic opportunities are assumed to have already been exploited. Therefore, the potential resource from the energy from waste resource streams was not considered further in this study.

Table 3: Energy from Waste Summary

	Prior to Consideration of Likelihood of Utilisation for RE Generation				Reason for Adjustment / Change of Technology	Post Consideration of Likelihood of Utilisation for RE Generation 2030		
Photo	Resource	Technology	2030 MWe	2030 MWt		Technology	MWe	MWt
	C&I Waste	EfW with CHP	0.52	1.05	Currently the residual waste that is sent for landfill or incineration is exported to facilities outside B&NES. Therefore, counted as existing generation elsewhere.	None	-	-
	MSW	EfW with CHP	1.26	2.53	Currently, the waste is exported to EfW and landfill sites outside the B&NES. It has been assumed that the existing arrangement are likely to be in place until the end of 2030 therefore the resource is counted as generation elsewhere.	None	-	-
	Food Waste	AD with CHP	0.41	0.62	Food waste from B&NES is currently exported out of the Council area. Assuming the arrangement stays in place until 2030, the resource is counted as existing generation elsewhere	None	-	-
	Animal Slurry	AD with CHP	0.47	0.698	RHI database confirms 2.45MW of installed capacity. It is assumed that all economic opportunities have already been exploited	None		
	Poultry Litter	Bespoke plant with CHP	0.95	1.90	Not likely to be enough resource for bespoke plant.	None	-	-
	Sewage Sludge	AD with CHP	0.38	0.57	A bespoke CHP plant would need to be used to facilitate the poultry litter resource. However, in practice, as the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant.	None		
	Landfill Gas	Landfill gas recovery engine			There is a 0.63MWe installed capacity, it is assumed that all economic opportunities have already been exploited	None		
	Potential installed capacity		**3.99**	**8.69**			0	0

The following tables outline the current and maximum theoretical potential generation in B&NES

Table 4: Current and Maximum Theoretical Stand-Alone Renewable Electric Generation in B&NES

Resource	Existing Installed Capacity (MWe)	Maximum Installed Capacity from New Installations (MWe)	Potential Maximum Delivered Energy (GWhe)
Large Scale Wind[12]	0.105	180.01	392.03
Solar PV Farms	5.87	5,279.60	5,126.56
Hydropower	0.162	0.403	1.41
TOTAL	**6.14**	**5460.01**	**5520.0**

Table 5: Current and Maximum Theoretical Potential Large Scale Renewable Heat Generation in B&NES

Resource	Existing Installed Capacity		Maximum Installed Capacity from New Installations		Potential Maximum Delivered Energy	
	Electricity (MWe)	Thermal (MWt)	Electricity (MWe)	Thermal (MWt)	Electricity (GWhe)	Thermal (GWht)
Energy from Waste	0.06	0.11	-	-	0.45	0.25
Landfill Gas	1.60	-	-	-	6.48	-
Other (including food waste, animal slurry, poultry litter and sewage sludge. AD with CHP and biomass)	5.11	8.68	0.00	0.00	25.15	34.44
TOTAL	**6.77**	**8.79**			**32.08**	**34.69**

Table 6: Current Projected Maximum Theoretical Potential from Building Integrated and Non-Domestic Renewable Technologies in B&NES

Resource	Existing Installed Capacity		Maximum Installed Capacity from New Installations		Potential Maximum Delivered Energy	
	Electricity (MWe)	Thermal (MWt)	Electricity (MWe)	Thermal (MWt)	Electricity (GWhe)	Thermal (GWht)
Projected Building Integrated Wind (<6kW) Turbines	0.001	-	0.08	-	0.08	-
Projected PV-Commercial Rooftop (10kW - 1MW)	7.00	-	39.71	-	45.31	-
Projected PV-Domestic Rooftop (<10kW)	7.30	-	66.22	-	71.33	-
Projected biomass consumption by building integrated biomass boilers in 2030 (domestic)	-	-	-	-	-	5.95
Projected biofuel consumption by building integrated biofuel boiler in 2030 (domestic)	-	-	-	-	-	32.90
Projected heat delivered by solar thermal in 2030 (domestic)	-	-	-	0.09	-	0.16
Non-domestic renewable thermal technologies other than heat pumps[13]	-	4.8	-	-	-	8.33
TOTAL	**14.3**	**4.8**	**106.01**	**0.09**	**116.72**	**47.34**

[12] The potential from 1.0MW and 2.5MW Search Areas cannot be added together as some of the areas overlap. The maximum capacity in this Figure is taken from 1.0MW Search Areas plus and additional non-overlapping 2.5MW Search Areas.
[13] It has been assumed the majority of new renewable heat installations in non-domestic buildings will be of electric heating. High-grade heat requirements will be met by hydrogen in the C&I setting and therefore hydrogen electrolysis's portion of electricity demand is also calculated and included.

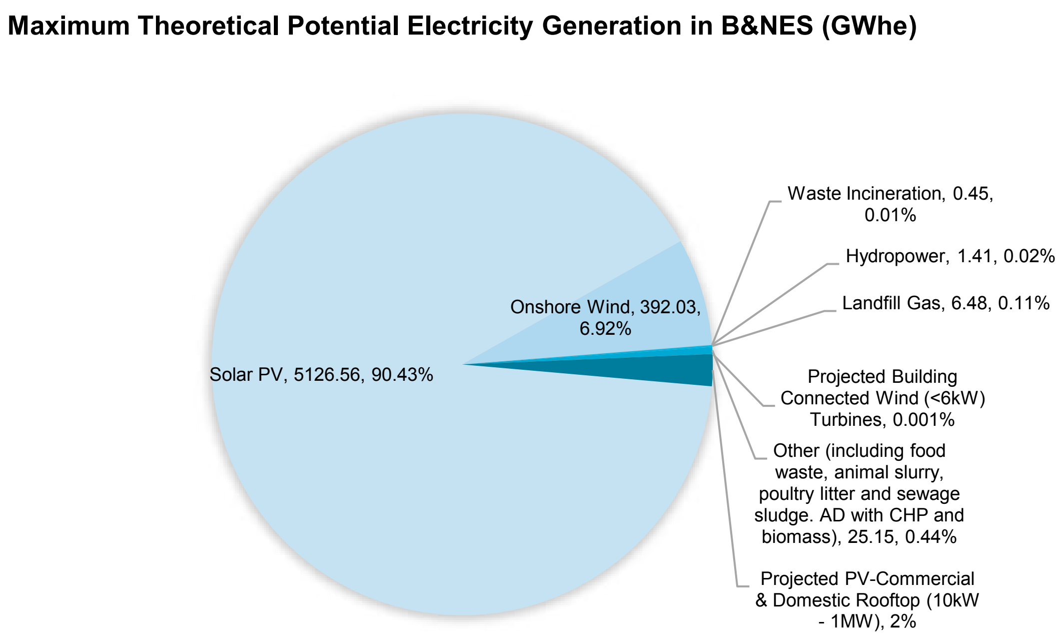


Figure 15: Maximum Theoretical Potential Electricity Generation in B&NES in 2030

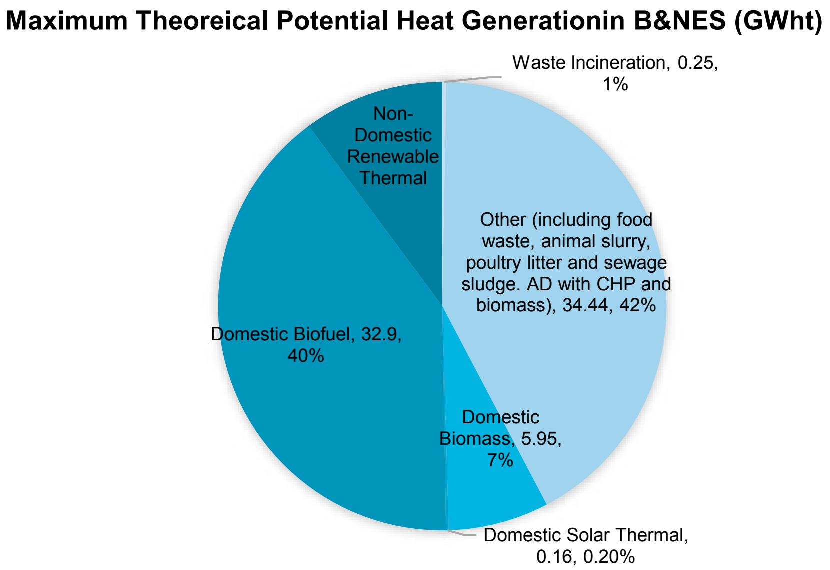


Figure 16: Maximum Theoretical Potential Heat Generation in B&NES in 2030, Excluding Electric Heating

> The maximum theoretical potential renewable electricity generation in B&NES in 2030 is circa 5,668.8GWh, meaning there will be enough potential resource to meet the equivalent of the 1,066GWh projected electricity demand in 2030.

> The maximum theoretical potential from renewable heating technologies is projected to be 82.03GWh in 2030. Therefore, it is concluded that there will not be enough potential resource to meet the equivalent of the projected 127GWh heat consumption by fuels other than electricity.

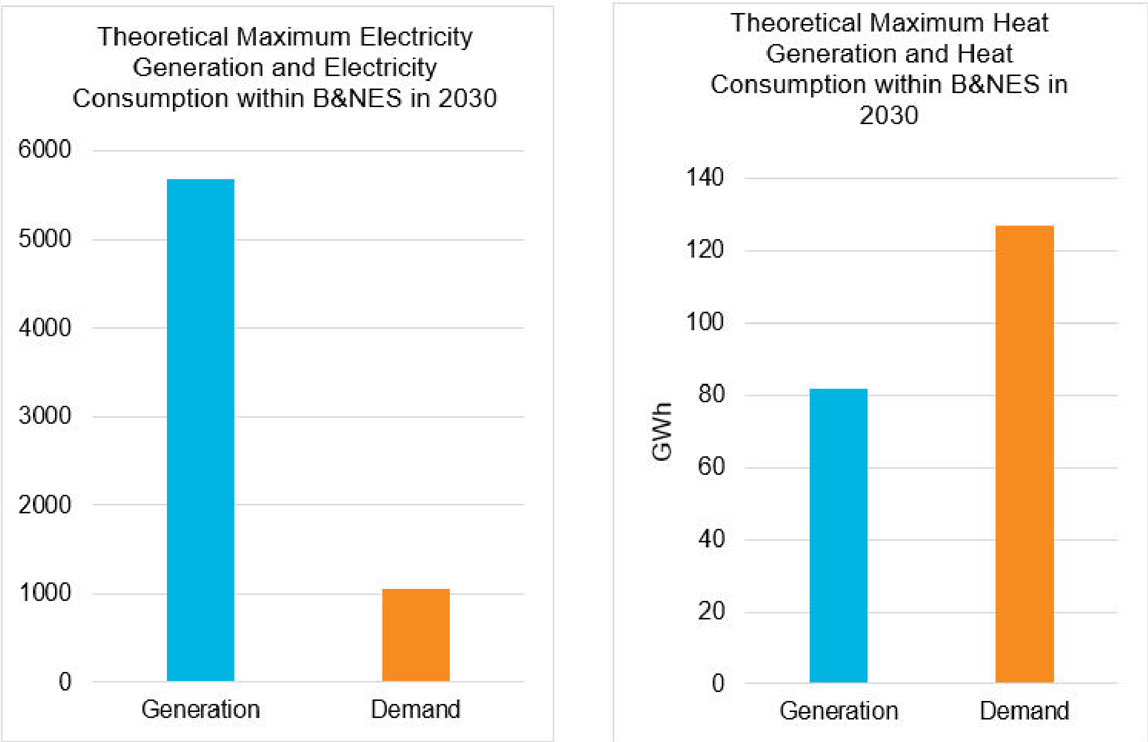


Figure 17: Theoretical Maximum Electricity and Heat Generation and Consumption within Bath and North East Somerset[14]

Scenarios for a Carbon Neutral B&NES in 2030

When considering a carbon neutral B&NES, it should be noted that all carbon neutral scenarios set out in this RERAS assume that buildings in B&NES are predominantly heated using heat pumps and that most of the vehicles on the road are electrically driven. That said, there remain different scenarios for renewable energy generation that can be considered. To provide an illustration of the challenge we have produced the following three scenarios, but it is recommended that B&NES Council aims to maximise the potential for the generation and supply of renewable and low and zero carbo electricity and heat in line with the NPPF.

[14] Electric heating demand and consumption data is included in the electricity figure only.

1. **Meet the DFES defined efficiency and renewable energy contribution only**

   In this scenario, it is assumed that the Consumer Transformation 2050 projections (see Appendix P) set out in the DFES for B&NES are met in 2030. The energy generation produced by renewables is equivalent to B&NES' share of grid renewable electricity in 2050 to meet zero carbon. This scenario results in B&NES greening its share of the grid electricity by 2030. Once other areas 'catch-up' in 2050 as per DFES, B&NES electricity consumption will become net zero. This scenario includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated and standalone renewables (e.g. solar PV and wind farms) and the transformation of the transport systems (e.g. electric vehicles uptake). This scenario and the following two scenarios are likely to require policy interventions at the local and national levels.

   This scenario means that B&NES would only 'green' the proportion of the grid identified by the DFES.

3. **Meet the equivalent of 33% of the demand in B&NES by 2030 and set out a pathway and targets to ensure the equivalent of 100% of the demand is met by 2050**

   This scenario acts as a steppingstone between scenarios 1 and 3 and assumes that 33% of the electricity demand in B&NES in 2030 will be met by installing additional wind and solar developments in some of the Search Areas identified in this study. As there are certain assumptions outlined in the DFES (such as uptake of heat pumps and electric vehicles) that have been condensed to 2030 in this study, this option provides insurance if these are not met as a higher proportion of the demand will be met by local renewables in comparison to the scenario one projection. Therefore, this scenario also includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated renewables and the transformation of the transport systems (e.g. electric vehicles uptake).

   The renewable energy generation can then be assessed every 10 years, and the aim increased to ensure the equivalent of 66% of B&NES' demand can be met by 2040 and 100% by 2050. By 2030, this approach also meets the equivalent of the proportion of the grid identified in the DFES as B&NES contribution to UK zero carbon in 2050.

2. **Meet the 2030 consumption in B&NES from generation located within B&NES the**

   This scenario assumes that the 2030 electricity demand in B&NES will be met by installing additional wind and solar developments in some of the Search Areas identified in this study. The demand could be met through a varying combination of wind development and solar development, promoted through Local Plan policies and strategy. This scenario also includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated renewables and the transformation of the transport systems (e.g. electric vehicles uptake).

Heat Opportunity and Strategic Site Assessment

A District Heating Network (DHN) is the term given to a distribution system providing multiple individual buildings with heat generated from a single source. The plantroom is generally housed in a building known as an energy centre, from which heat can be generated using a renewable or low carbon source such as recovered heat utilising heat pumps.

Traditionally, heat is typically generated at a building level, which means that only small-scale technologies can be used (most commonly gas boilers), limiting the use of other forms of low and zero-carbon heat generation technologies. Unlike the power sector, decarbonising heat at scale will require physical changes to the majority of the heating systems currently installed in buildings and industrial sites[15]. Additionally, sufficient heat demand should exist in close proximity to a heat source to make development viable, making the decarbonisation heating more challenging. A ‘Heat Opportunities Map’ has been produced, providing the locations of heat demand clusters and potential heat sources in the Bath and North East Somerset area.

The National Planning Policy Framework (NPPF) requires planning authorities to allocate a range of suitable housing and employment sites within their area to meet the scale and type of development likely to be needed. The heat opportunities mapping prepared in this study can assist the B&NES Council in sieving potential development sites, as well as developing policies to facilitate increased use of renewable and low carbon energy sources.

Figure 18 shows the results of heat mapping assessment in Bath and North East Somerset. The size of the circles on the maps indicate the relative size of the heat demand of a building and allows for easily identifiable comparisons to be made between different heat demands. This methodology can also provide a high-level indication of the viability of connecting a heat load. If there are large gaps between circles, it suggests that connecting loads may not be viable. Conversely, if circles overlap, connecting them may be more viable. As shown in Figure 18, there are clusters formed in the more residential areas, which could be further investigated. In addition to this, three of these larger clusters have been circled in Figure 18.

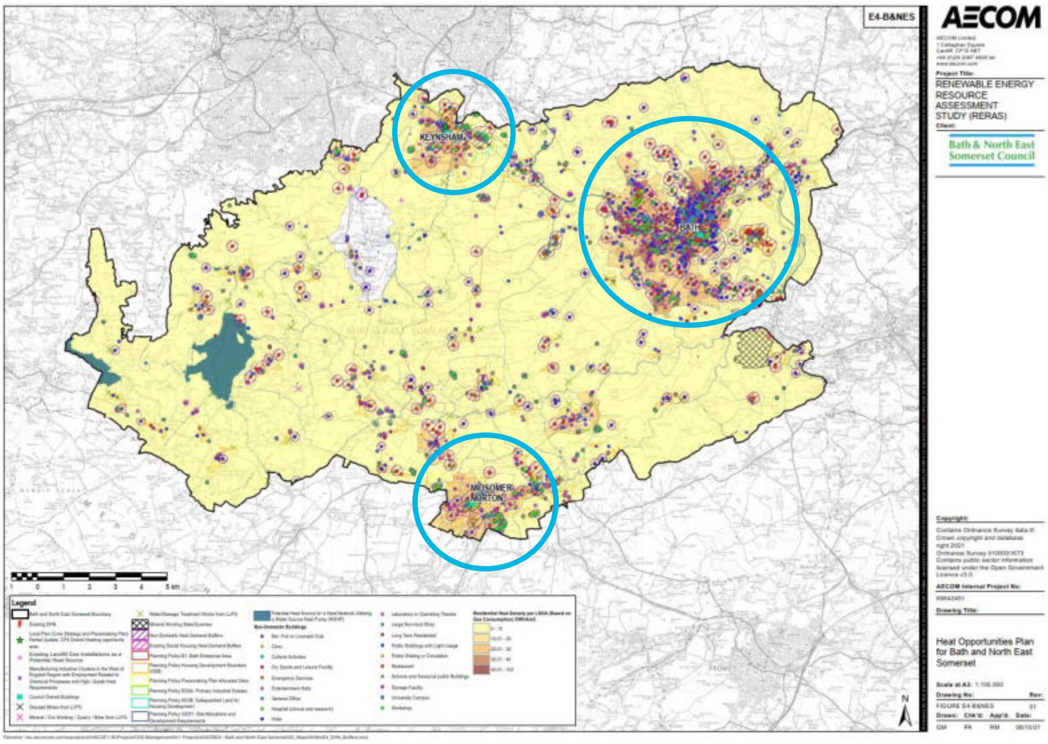


Figure 18: E4-B&NES: Heat Opportunities Map for Bath and North East Somerset

[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf

Planning Policy Approaches

This RERAS provides the evidence to inform Bath and North East Somerset Council's new Local Plan policies for renewable energy and associated infrastructure and contains recommendations regarding policy approaches with regard to:

- Net zero carbon scenarios;
- Search Areas for wind farms and solar PV farms;
- Increased energy storage;
- Encouraging the development of and connection to heat networks;
- Development of other renewable energy resources e.g. biomass, etc.

Based on the evidence gathered as part of the RERAS study, the key policy recommendations are as follows:

For net zero carbon scenarios:

- **SC-PR-1:** It is recommended the three NZC calculations are presented as scenarios, for information only.
- **SC-PR-2:** It is recommended that the Council aims to maximise the potential for the generation and supply of renewable and low and zero carbon electricity and heat.

For wind farms:

- **WF-PR-1:** It is recommended that the Search Areas (SAs) identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints.
- **WF-PR-2:** It is recommended that proposals for wind turbines of the appropriate number and size (to make the most efficient use of the resource/ land) benefit from a presumption in favour of wind development when located within the areas identified for that use through the Local Plan.
- **WF-PR-3:** It is recommended that proposals for wind turbines >2.5MW within the areas identified through the Local Plan will benefit from a presumption in favour of wind development, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple distances) and consideration of other site specific issues and constraints.
- **WF-PR-4:** It is recommended that proposals for wind turbines outside of areas identified as suitable for wind development through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.
- **WF-PR-5:** It is recommended that the SAs identified through the RERAS for 1MW and 2.5MW turbines are further refined and safeguarded through the Local Plan process.
- **WF-PR-6:** It is recommended that policy measures (e.g. safeguarding) are put in place to ensure that the areas identified for wind development through the Local Plan are not sterilised by non-wind development.
- **WF-PR-7:** It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity, subject to compliance with noise, topple-distance, site specific constraints, and other policy considerations should be looked upon favourably.
- **WF-PR-8**: It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity will, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple-distances), site specific constraints, and other policy considerations should be looked upon favourably.

For solar PV farms:

- **SF-PR-1:** It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints. As part of this a strategy approach which takes account of clustering and the potential need to manage cumulative impact should be considered.

- **SF-PR-2:** It is recommended that proposals for solar PV farms within the areas identified for that use through the Local Plan benefit from a presumption in favour of solar development.
- **SF-PR-3:** It is recommended that proposals for solar development outside of areas identified as suitable for that use through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.
- **SF-PR-4:** It is recommended that proposals for re-powering of solar PV farms at end-of-life to an equal or increased capacity, subject to compliance with primary constraints, site specific constraints, and other policy considerations should be looked upon favourably.

For energy storage:

- **ES-PR-1:** It is recommended that policy encourages applicants promoting schemes for renewable electricity generation of >1MW, regardless of technology, to consider including storage as part of their proposal. This could include some form of energy storage (green hydrogen production, seasonal or battery storage), private wire supply or evidence as to why this is not feasible or viable.
- **ES-PR-2:** It is recommended that applications for renewable electricity generation of >1MW located within 1km of an industrial cluster identified as having potential for hydrogen production consider utilising outputs (via private wire) for such purposes.
- **ES-PR-3:** Building on ES-PR-2, it is recommended that applications for new industrial development that may have a use for green hydrogen should be guided towards locations near/in 'hydrogen clusters' wherever practical.
- **ES-PR-4:** It is recommended that applications for renewable electricity generation, or development that is energy intensive and likely to have a surplus of heat, within 1km of a site with potential for seasonal energy storage (e.g. abandoned mine workings) should consider utilising such a facility.

For district heating networks:

- **DH-PR-1**: It is recommended that development proposals for dwellings, employment or depots for hosting transport fleets located within 0.5km of an existing renewable heat resources or renewable electricity generating installations should consider utilising such resources for heating, hot water and/or process use transport fuel.
- **DH-PR-2**: It is recommended that proposals for development that will host heat intensive activities and are likely to generate excess heat (or power) should consider:
    a. Potential to be located within 0.5km of a heat demand cluster identified in the Heat Opportunities Map or other identified heat use;
    b. Enabling heat (power) off-take for supply for other / nearby uses and provide evidence of discussions with potential off-takers for the heat (or power).
- **DH-PR-3:** Development proposals within 0.5km of an existing district heat network fed from a renewable (non-fossil fuel) source will be expected to connect where feasible and viable;
- **DH-PR-4:** It is recommended that areas identified through the Local Plan for wind farms and solar PV farms are within 0.5km of an identified heat cluster, consideration is given to safeguarding these sites in order to provide electricity for powering heat pumps as part of a private wire / district heat network.

For biomass:

- **BM-PR-1**: It is recommended that proposals utilising biomass are looked upon favourably where:
    a. a whole life carbon benefit can be evidenced; and
    b. the development should be located away from urban areas (and preferably in areas off the gas grid).

- **BM-PR-2:** It is recommended that there be a presumption in favour of proposals for stand-alone electricity generation plant utilising biomass if the proposal utilises a BECCS system and proposals are incompliance with BM-PR-1a and 1b.

These policy recommendations are explained in more detail in Section 17 of the main RERAS report.

Renewable Energy Resource Assessment Study (RERAS) Main Report

1. Introduction

The UK Government is required to contribute to achieving international targets for greenhouse gas emission reductions. The Climate Change Act 2008 provides the statutory framework for reducing greenhouse gas emissions in the UK[16]. At the core of the Act is a requirement for the UK to reduce net UK greenhouse gas emissions by 100% (net zero emissions) by 2050. The Act established a system of five-yearly carbon budgets to serve as stepping-stones on the way.

England originally had a carbon budget of 80% by 2050 against a 1990 baseline in legislation. However, to reach the net zero emissions target, in 2019 this figure was replaced with a target of 100% against a 1990 baseline.

As part of UN negotiations more than 190 countries, including the UK committed to the Paris Agreement to tackle climate change. The Agreement entered into force on 4th November 2016 and set out a global framework to limit the global average temperature increase due to global warming to well below 2°C and pursue efforts for 1.5°C.

The UK Renewable Energy Roadmap sets the path for the delivery of these targets. The first six carbon budgets, leading to 2037, have been set in law. The first two budgets have been met (2008-12, 25% and 2013-2017, 31%) and the third is very likely to be met (2018-22, 37%). The remaining budget targets are as follows:

- Meeting the fourth carbon budget (2023-2027) will require that emissions be reduced by 50% on 1990 levels in 2025;
- Meeting the fifth carbon budget (2028-2032) will require that emissions be reduced by 57% on 1990 levels in 2030; and
- Meeting the sixth carbon budget (2033-2037) will require that emissions reduce by 78% on 1990 levels in 2035.

The UK Government is committed to playing its part by delivering an energy programme that contributes to reducing carbon emissions as part of its approach to mitigating anthropogenic climate change whilst enhancing the economic, social and environmental wellbeing of our own and future generations. This is outlined in the Ten Point Plan for a Green Industrial Revolution[17] and the Energy White Paper[18].

1.1 Bath and North East Somerset

Bath and North East Somerset (B&NES) is a richly varied district in the South West of England. B&NES covers an area of 536.4km², of which approximately two thirds is green belt and has a population of approximately 193,282 people, based on 2019 figures[19].

In March 2019, B&NES Council declared a climate emergency. A Climate and Ecological Emergency Action Plan[20] was developed in which the council pledges to provide the leadership to enable carbon neutrality in the district by 2030. The plan outlines three priority areas for action:

[16] *Climate Change Act 2008, c.27*. Available at: https://www.legislation.gov.uk/ukpga/2008/27/introduction (Accessed: 24 September 2020).
[17] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf
[18] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf
[19] Office for National Statistics – Population Projections for Local Authorities: Table 2 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2
[20] Bath & North East Somerset and Ecological Emergency Action Plan, B&NES Council, January 2021; https://www.bathnes.gov.uk/sites/default/files/siteimages/Environment/Sustainability/climate_and_nature_emergency_action_plan_for_website_v1.3_jan_2021.pdf

- Energy efficiency improvement of the majority of existing buildings (domestic and non-domestic) and zero carbon new build;
- A major shift to mass transport, walking and cycling to reduce transport emissions;
- A rapid and large-scale increase in local renewable energy generation.

1.2 Purpose of this Assessment

B&NES has several key roles to play that can facilitate the use and generation of renewable and low and zero-carbon energy. These include:

- Preparing planning policies and allocating land or identifying areas of search to inform preparation of Local Plans (LPs);
- Development management – taking decisions on planning applications submitted to the Council for development;
- Corporate – taking action at a council wide level to achieve a low carbon economy; and
- Leadership – taking forward wider community action and communicating the need to increase the uptake of renewable energy.

This Renewable Energy Resource Assessment Study (RERAS) constitutes an evidence base informing the LP. This enables decisions to be taken based on policies that support and facilitate the deployment of renewable and low and zero carbon energy systems. The RERAS consists of a bottom-up assessment of the potential for different renewable and low and zero carbon energy generation scales in different locations.

In terms of development management, the RERAS will be useful in three ways.

- **Firstly**, when assessing applications for new development sites, it can aid officers in discussions with developers around opportunities for district heating and making use of waste heat.
- **Secondly**, when assessing applications for larger-scale new generation schemes, it can enable officers to identify whether there is the potential for those schemes to supply heat to new or existing development.
- **Thirdly**, in the case of wind and solar PV farm developments and other technologies, it can assist officers in understanding why a developer has chosen a particular location to develop a scheme.

1.3 Method Employed in this Renewable Energy Resource Assessment

This RERAS is compiled in alignment with government policy as set out in the method set out in the Renewable Energy and Low-Carbon Energy Capacity Methodology for the English Regions[21] in alignment with the NPPF. Using educated assumptions about the technologies likely to be employed for converting resource, energy generation figures have been produced for use in considering planning policy with a view to meeting the council's 2030 aims. Also, where appropriate, methods have been used to meet the National Planning Policy Framework requirements and to better reflect local data/circumstances.

Maps have been produced to enable spatial identification and provide a visual representation of the potential renewable energy opportunities. These maps were produced using Geographic Information Systems (GIS), where overlaying multiple datasets has enabled a reveal of opportunity by removing layers of primary constraints. The primary constraints data was overlaid in stages and relate to resource, technology, safety, protection of heritage and the environment, as well as other categories. The maps referred to in this RERAS can be located in the document 'Bath and North East Somerset RERAS – Maps'.

[21] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

1.4 Why this Renewable Energy Resource Assessment Study is Important

This RERAS will inform action to support the deployment and delivery of renewable and low and zero-carbon energy installations on the ground. This is expected to assist in meeting the two key challenges for UK energy policy, namely:

- Mitigating anthropogenic climate change by reducing carbon dioxide emissions, and;
- Improving energy security.

At a council strategic level, this RERAS provides an evidence base for the following policy[22] objectives:

- Identification and promotion of potential sites for renewable energy generation (not necessarily linked to new buildings);
- Development of area-wide renewable energy contributions (e.g. installed megawatt of heat and electricity generation) as a stimulus for concerted local action;
- Informing the selection of land for development (allocation of sites), by identifying those sites with the greatest potential for sustainable energy and carbon reduction or sites that potentially could preclude renewable energy developments (e.g. by sterilising good wind power sites);
- Identification of opportunities for delivering strategic energy options that could link to an offset fund (i.e. some Councils, where land values may be less, view this as an opportunity to make sites more attractive to developers by making them "low and/or zero carbon-enabled", rather than seeking to increase development burden by setting sustainability standards above future Building Regulations.);
- To enable B&NES Council's exploration of requiring developers to connect to an existing or proposed district heating network (e.g. how much could they charge, how close would a development need to be and so on).

This assessment is not an exhaustive guide to the different renewable and low and zero-carbon energy technologies available. The National Policy Statements[23] provide generic and technology-specific advice relevant to siting particular renewable and low and zero-carbon technologies that should be the first point of reference. Other technologies are listed by the Department for Business Energy and Industrial Strategy (BEIS - formerly the Department for Energy and Climate Change[24]) and the Energy Saving Trust[25].

1.4.1 Energy Hierarchy

The RERAS focuses on renewable and low and zero-carbon energy generation and the opportunities for promoting this through the LP, rather than on improving energy efficiency in new or existing buildings.

Where energy efficiency assumptions were required within the study, for instance in the calculation of the future renewable energy generation needed to meet future carbon reduction projections, these have been made in line with the Western Power Distribution's (WPD) Distribution Future Energy Scenarios (DFES)[26] Consumer Transformation scenario. These assumptions include for the continual improvement of domestic energy efficiency. Readers are referred to other sources of information on energy efficiency in buildings[27].

1.4.2 Transport

The RERAS does not include an assessment of the potential for renewable or low carbon fuels for transport, except for a calculation of the current and future demand from electric vehicles, which is kept in alignment with the WPD DFES.

[22] Meant in the broad sense, i.e. not just planning policy
[23] https://www.gov.uk/guidance/consents-and-planning-applications-for-national-energy-infrastructure-projects
[24] DECC http://www.planningrenewables.org.uk/page/index.cfm
[25] Energy Saving Trust a: https://energysavingtrust.org.uk/home-energy-efficiency
[26] WPD DFES 2020: https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf
[27] E.g. from the Energy Saving Trust, as per the web-link given above.

1.4.3 Stand-Alone Electricity Generating Assets

The RERAS is concerned with identifying the potential for additional renewable electricity generation opportunities. Search Areas (SAs) are identified for larger wind and solar photovoltaic (PV) farms that should be investigated further and refined through the Local Plan process. This approach does not necessarily preclude proposals for smaller-scale wind and solar farms from coming forward outside of the areas identified through the Local Plan.

1.4.4 Soundness

While this RERAS is prepared in line with government policy as set out in the NPPF and supporting Planning Practice Guidance, there is no definitive advice for undertaking such studies. It is the responsibility of the Council to prepare 'sound' evidence to support the policies and approaches it takes through its Local Plan. The Council has appointed AECOM to assist in this evidence gathering, and the methodology employed in this study is based on the methodology published by DECC[28] and AECOM's experience of preparing similar studies for other authorities. Assumptions and data used in carrying out this RERAS have been sought from established sources, and these are either referenced as footnotes to the text or appropriately appended. Where there were no established sources, they have been derived based on available evidence and through dialogue with the Council.

In the future, guidance, assumptions and data sources may change, particularly as technology and the policy and regulatory framework evolves.

1.5 Defining Renewable Energy and Low and Zero Carbon Energy

1.5.1 Renewable Energy

Renewable energy can be described as;

> *"That which makes use of energy flows which are replenished at the same rate as they are used[24]"*

The National Planning Policy Framework (NPPF)[30] defines renewable energy as follows:

> *"Renewable energy covers those energy flows that occur naturally and repeatedly in the environment – from the wind, the fall of water, the movement of the oceans, from the sun and also from biomass and deep geothermal heat. Low carbon technologies are those that can help reduce emissions (compared to conventional use of fossil fuels)"*

Most forms of renewable energy stem directly or indirectly from the sun. The direct ones include solar water heating and PV panels (electricity), and ground source heat pumps [31] that make use of solar energy stored in the ground. The primary indirect forms are: [32]

- Wind power, as wind is caused by differential warming of the Earth's surface by the sun;

[28] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf
[29] Sorensen, B. (1999) Renewable Energy (2nd Edition), Academic Press, ISBN 0126561524
[30] National Planning Policy Framework, Ministry of Housing, Communities & Local Government, July 2021; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf
[31] Strictly speaking, these technologies are only partially renewable, as they also make use of, most commonly, grid electricity to power a compressor. However, if they have a good efficiency, they can provide a form of heating, in the UK, that produces less carbon per unit of output than using a gas condensing boiler.
[32] If replanting occurs, the combustion of biomass fuel is acknowledged as carbon neutral, because although the combustion process releases CO_2, equal amounts of CO_2 were taken out of the atmosphere when the biomass was growing

- Hydropower, as rainfall is driven by the sun causing evaporation from the oceans;

- Biomass energy (from burning organic matter), as all plants photosynthesise sunlight in order to fix carbon and grow.[32]

The other two forms of renewable energy are:

- Tidal power, which relies on the gravitational pull of both the sun and the moon;

- Geothermal energy, which taps into the heat generated in the Earth's core.

Of all these resources, perhaps the most complex and versatile is biomass energy because it can take many forms. Biomass energy[33] can include:

- combustion of forestry residues;
- anaerobic digestion (AD) of higher moisture content wastes such as from animal manures and food wastes;
- combustion of straw and other agricultural residues and products;
- methane produced from the AD of biodegradable matter in landfill sites (i.e. landfill gas), and;
- energy generated from the biodegradable fraction of waste going into an Energy from Waste (EfW) plant.

Moreover, hydrogen is also considered in this RERAS but included under a separate subheading. This is because hydrogen is an energy carrier, and it can be produced using renewable electricity, which is called green hydrogen.

In addition to the above, nuclear fusion as well as marine renewables can also be considered as clean energy. Nuclear fusion reactors produce no high activity, long-lived nuclear waste. However, this technology is not yet commercially available and is not considered in this assessment; further details regarding nuclear fusion are provided in Appendix A. Further details regarding marine renewables are provided in Appendix B; however, they are excluded from this assessment as decisions about such development are outside the jurisdiction of the Council's planning department[34].

Another important characteristic of renewable energy is that, unlike fossil fuels, it produces little or no net carbon dioxide[35] (CO_2), which is one of the main greenhouse gas emissions. It is important to note that lifecycle CO_2 emissions vary between renewable energy technologies since some may require more energy or resources, for example during manufacture, operation or disposal. Figure 19 shows a comparison of lifecycle emissions of different renewable electricity technologies.

[33] Biomass is generally regarded as non-fossil fuel when at least 98% of the energy content is derived from plant or animal matter, or substances derived thereof.
[34] Decisions on marine or offshore energy is for the UK Government or Secretary of State
[35] Burning biomass releases carbon dioxide (CO_2), a greenhouse gas. However, the plants that are the source of biomass for energy capture almost the same amount of CO_2 through photosynthesis while growing as is released when biomass is burned, which can make biomass a carbon-neutral energy source. 'Net' CO_2 is the difference between the amount of greenhouse gasses produced and the amount removed from the atmosphere during the process

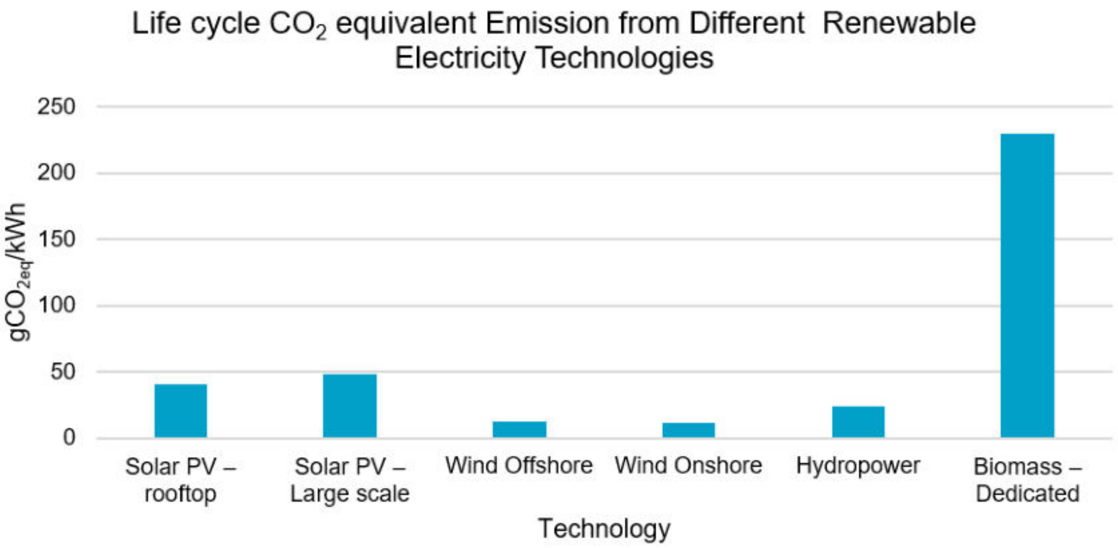


Figure 19: Lifecycle Emissions of Renewable Electricity Technologies (gCO2eq/kWh)[36]

Further information on these technologies is included in the relevant Sections 4 to 12.

1.5.1 Power vs. Energy Output

In the context of this Renewable Energy Resource Assessment Study, power and heat are measured in either:

Kilowatts (kW);

Megawatts (MW), which is one thousand kW; or

Gigawatts (GW), which is a thousand MW.

These are a measure of the electricity or heat output being generated (or used) at any given moment in time. When it is running at full load, the maximum output of a generator is referred to as its installed capacity or rated power/heat output.

Energy, on the other hand, is the product of power and time. It has kWh units (the h stands for "hour") or MWh, or GWh. As an example, if a 2MW wind turbine ran at full power for 1 hour, it would have generated 2 x 1 = 2MWh of energy. If it ran at full power for one day (24 hours), it would have generated 2 x 24 = 48MWh.

This distinction is essential because in carrying out the RERAS, certain assumptions have been made to calculate both the potential installed capacity (or maximum power output) of different technologies and the potential annual energy output.

[36] IPCC Technology-specific Cost and Performance Parameters 2014 https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf#page=7

1.5.2 Electricity vs. Heat Output

In terms of the units used, it is important to distinguish whether a generator is producing electricity or heat to avoid confusion. This is because some renewable energy fuels (i.e. biomass) can be used to produce either heat only or electricity and heat simultaneously when used in a CHP plant.

It is also important to be able to distinguish between renewable electricity targets and renewable heat targets

The suffix "e" is added to denote electricity power or energy output, e.g. MWe, or MWhe,

The suffix "t" is used (for "thermal"), to denote heat output, e.g. MWt, or MWht

1.6 Renewable Technologies Addressed in this RERAS

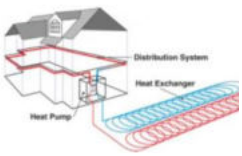
This RERAS covers the following renewable energy technologies (considering both electricity and heat) [37]:

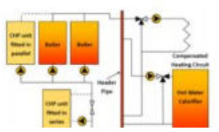

On-shore wind turbines

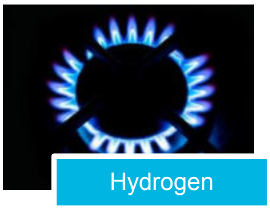

Solar PV


Hydropower energy generators


Solar thermal


Heat pump


Combined heat & power (CHP)


Hydrogen


Energy from Waste (EfW)

Greater detail on these technologies are covered in the relevant Sections 4 to 12 of the report.

1.6.1 Low Carbon Energy Options

Low carbon energy options cover a range of energy sources that are not renewable but can still produce less carbon than using conventional electricity grid or gas networks. Therefore, they are considered an important part of decarbonising the energy supply. Information on the following is included within the relevant sections:

[37] On-shore wind turbines, Solar PV, Hydropower energy generation and Energy from waste photos from: https://aecom.assetbank-server.com/assetbank-aecom/action/viewHome
Solar thermal photo: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879765/Solar_Thermal_TIL_-_April_2020.pdf
Heat pump photo: https://www.newcastle.gov.uk/services/environment-and-waste/energy-services/electrification-heat/electrification-heat-heat-pump
Combined heat & power photo: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/961492/Part_2_CHP_Technologies_BEIS_v03.pdf

- Waste heat, e.g. from power stations, or industrial processes; Waste heat generally refers to the heat generated by an industrial process that would have otherwise been wasted if it was not recovered and reused. The heat can be reused in different ways, including usage on-site or by another end-user (e.g. through a heat network) or converting the waste heat to power38. Such heat can be considered a low carbon option as it offsets the need for additional heating fuel by the new end-user.
- The non-biodegradable fraction of the output from EfW plants.

  Section 9 includes details of the EfW as a renewable technology. However, in the case where the waste is used as fuel includes materials that are not capable of being degraded by plants and animals, the fraction of heat output generated due to the incineration of these wastes is considered low carbon.

2. Policy Context and Drivers for Renewable Energy

Table 7 contains a summary of the key regulations, policies and strategies that drive and support the development of renewable energy and low carbon technologies internationally, nationally and at a local level. Greater detail on each of the policies is included in Appendix C.

Table 7: Policy and Drivers Summary

International & National Policy, Strategy and Guidance

The Kyoto Protocol (1998)	An international treaty with the collective goal of preventing dangerous anthropogenic interference with the climate system.
The Paris Agreement (2016)	Over 190 countries adopted the global action plan to limit the effects of climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C.
The UK Climate Change Act (2008)	A national legally binding target for the UK to reduce its emissions by 100%, compared with the 1990 baseline, by 2050. (increased from 80%).
National Planning Policy Framework (2021) (NPPF)	Overarching planning guidance in England, setting out the Government’s planning policies and guidance on how these policies should be applied. The NPPF states that “*the planning system should support the transition to a low carbon future in a changing climate , taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure”.*
UK National Energy and Climate Plan (2019) (NECP)	The NECP is the framework by which European Union Member States* are required to set out their integrated climate and energy objectives, targets, policies and measures, covering the 5 dimensions of the Energy Union for the period 2021 to 2030. *Following the exit of the UK from the EU, the UK was subject to EU legislation during the Brexit transition and so the UK NECP was submitted shortly before the end of 2020.
UK Industrial Strategy (2017)	Strategy providing emphasis on the need for clean growth in order to boost economic prosperity within the UK. Some of the stated aims of the Industrial Strategy

[38] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651125/IHRS_Consultation_Document-October_2017.pdf

	relevant to energy use in the built environment include increasing the delivery of new homes, decarbonising the heat supply, and lowering emissions from the transport sector. The strategy is now archived, and it is currently being replaced by Build Back Better: our plan for growth[39] policy.
England Resource and Waste Strategy (2018)	Strategy setting out how England will preserve material resources by minimising waste, promoting resource efficiency and moving towards a circular economy. Plans to encourage the reduction and increased management of waste through policies to support reuse, repair and remanufacture activities and by tackling waste crime.
Waste Management Plan for England (2021)	Strategy setting out the Government's ambition to work towards a more sustainable and efficient approach to resource use and management.
National Planning Policy for Waste (2014)	Details the implementation of waste policies across England's local authorities through the demand, suitability and ability to monitor waste management facilities.
Clean Growth Strategy (2017)	A strategy that sets out the UK Government's ambitious policies and proposals, through to 2032 and beyond for decarbonising all sectors of the UK economy.
25 Year Environmental Plan (2018)	A plan building on the proposals and policies outlined in the Clean Growth Strategy and aims to improve the environment within a generation and leaving it in a better state than we found it. It details how the government will work with communities and businesses to do this.
The UK Heat Strategy (2013)	Establishes a strategic framework for the transition to a low carbon heat supply.
Building Regulations in England (Part L and Part F) (2021 *under consultation*)	Regulations setting the minimum standards for building performance that must be met for a building to be approved for construction. Part L of the Building Regulations focuses on the conservation of heat and power and sets specific requirements for the fabric performance, building services efficiency, overheating and CO_2 emissions and Part F contains guidance on the building ventilation.
Ten Point Plan for a Green Industrial Revolution (2020)	Plan detailing how the UK intends to kick-start a green industrial revolution. Following the economic collapse induced by the coronavirus pandemic.
Offshore Wind Sector Deal (2020)	A deal that accentuates the partnership between the Government and the offshore wind sector, including the details of the investments into the sector, including the plans to provide funding to allow for 40GW (increased from the 30GW set out in the original deal).

Emerging National Policy	
Environmental Bill (2020)	The Environment Bill aims to manage the impact of human activity by creating a more sustainable and resilient economy, following on from the 25 Year Environment Plan.
Energy White Paper 'Powering our Net Zero Future' (2020)	Provides further clarity on the Ten Point Plan and highlights the long-term strategy for the wider energy

[39] https://www.gov.uk/government/publications/build-back-better-our-plan-for-growth

	system that transforms energy, supports green recovery and creates a fair deal for consumers, consistent with the target for net zero emissions by 2050.
Planning White Paper: ‘Planning for the Future’ (2021 *under consultation*)	A proposal aiming to reform the planning system in England, creating an efficient and modernised planning process that focuses on design and sustainability, improves developer contributions to infrastructure and ensures land is available for development.

Financial Incentive Schemes	
Renewable Heat Incentive (RHI)	A Government environmental programme to support renewable heat delivered to homes or non-domestic buildings. RHI provides incentives for consumers to install renewable heating in place of fossil fuels, open to homeowners and landlords, commercial, industrial, public, not-for-profit and community generators of renewable heat.
Energy Company Obligation (ECO)	Under this scheme, energy companies are obligated to promote and support carbon emissions reductions to customers.
Smart Export Guarantee (SEG)	The scheme requires licensed electricity suppliers to offer at least one export tariff, which must always be above zero and makes payment to small-scale low-carbon generators for electricity exported to the National Grid.
Heat Networks Delivery Unit	Provides grant funding and guidance to local authorities in England and Wales for heat network feasibility studies.
Green Heat Network Fund (GHNF)	A Government funding programme which is intended to help new and existing heat networks to move to low and zero carbon technologies.

West of England Policy	
The West of England Joint Waste Core Strategy (2011)	Strategic spatial planning policy to provide waste management infrastructure across the plan area. The joint strategy covers four councils of Bath and North East Somerset, Bristol, North Somerset and South Gloucestershire, and it applies to all waste, except for most radioactive waste the policy for which is dealt with at a national level.
The West of England Local Industrial Strategy (2019)	Strategy conveying the importance of minimising the impact on the environment when implementing the region’s four main priorities: cross-sectoral innovation; inclusive growth; addressing the productivity challenge; and delivering innovation in infrastructure delivery.

Bath and North East Somerset Local Policy	
Bath and North East Somerset Climate and Ecological Emergency Action Plan (2021)	Plan confirming Bath and North East Somerset’s commitment to achieving carbon neutrality by 2030.
Core Strategy and Placemaking Plan (2014)	Puts in place a strategic planning framework, guiding development within B&NES until 2029. There are many policies with the document, with existing policies aiming to encourage renewable energy development, where appropriate.

Neighbourhood Plans	Plans prepared by local communities and not B&NES Council. These are not listed as part of the Local Development Scheme, however, the policies contained in any Neighbourhood Plan will form part of the Local Plan once it has been formally adopted by Bath and North East Somerset Council. Current made (or adopted) plans are from: • Chew Valley Area • Claverton • Clutton • Englishcombe • Freshford and Limpley Stoke • Publow with Pensford • Stowey Sutton • Westfield • Whitchurch village

3. Baseline Energy Consumption and Low and Zero Carbon Energy Technologies in the B&NES

3.1 Introduction

This section of the RERAS outlines the baseline energy consumption and existing Low and Zero Carbon (LZC) energy technologies in B&NES, using the latest available data (2018 - published on September 2020). Establishing the baseline consumption and the existing LZC energy technologies provides an understanding of the progress being made in B&NES and enables a calculation of what remains to be done in order to meet aims.

The indicative heat demand and electricity consumption maps have been created based on the published data from the Office for National Statistics using Middle Layer Super Output Areas (MSOA). MSOA is a geographic hierarchy designed to improve the report of statistics in small areas in England and Wales. The Organisation Data Service publishes files created by the Office for National Statistics linking the postcodes to the MSOA. These maps provide a visual representation of the varying heat and electricity consumption across B&NES.

The existing LZC energy technologies map includes technologies generating electricity, heat and both electricity and heat simultaneously. The assessment includes 'stand-alone' generators (such as wind farms) as well as those installed in buildings (e.g. biomass boilers). Energy from Waste (EfW) schemes and biomass schemes have also been marked for their potential contribution to supply heat to strategic new development sites. The existing LZC energy technology maps show existing, consented and sites under construction. The information regarding these existing technologies has been provided by:

- Regen[40];
- Renewable Heat Incentive (RHI) data;
- Feed-in Tariffs (FIT) data;
- Renewables Obligation database (RO);
- Renewable Energy Guarantees of Origin database (REGO);
- Additional data provided by Regen on large renewable generators in B&NES;
- B&NES renewable energy progress report;
- Renewable Energy Planning Database (REPD); and,
- Any additional wind turbines that are identified from the planning data.

3.2 Baseline Energy Consumption in B&NES in the Baseline Year

Map References and Titles:

1. E1-B&NES: Indicative Heat Demand Based on Gas Consumption – Total Gas Consumption by MSOA in 2019 (MWh per Year)
2. E2-B&NES: Total Electricity Consumption by MSOA in 2019 (MWh per Year)

The Department for Business, Energy and Industrial Strategy (BEIS) of the UK Government (formerly the Department for Energy & Climate Change (DECC)) publishes annual energy consumption (GWh) at a sub-national level. Regen has analysed the latest available data (2018)[41] and provided a breakdown of the current energy consumption in B&NES, illustrated in Table 8.

[40] A non-profit organisation which promotes renewable energy and energy efficiency within the UK.
[41] Sub-national total final energy consumption statistics - 2018 (published on September 2020); https://www.gov.uk/government/statistics/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2018

Table 8: Existing Energy Consumption (GWh) in B&NES[42]

	Current Energy Consumption (GWh)
Domestic Buildings Fossil Fuels and Renewables Energy Consumption for Heating	1,089.0
Domestic Buildings Electricity Consumption for Heating	91.7
Domestic Buildings Non-Heating Electricity Consumption	221.1
Commercial and Industrial Buildings Fossil Fuels and Renewables Energy Consumption for Heating	505.4
Commercial and Industrial Buildings Electricity Consumption for Heating	40.1
Commercial and Industrial Buildings Non-Heating Electricity Consumption	303.8
Transport Sector Fossil Fuels Consumption	843.5
Transport Sector Electricity Consumption	2.9
Total Heat Demand (Including Electrical Heating Consumption)	1,726.3
Total Electricity Consumption (Including Electrical Heating Consumption and Transport Sector Electricity Consumption)	659.5
Total Transport Sector Energy Consumption	846.4
Total Energy Consumption	**3,097.5**

According to Table 8, B&NES consumed 3,097.5GWh of energy over the course of 2018. Of this, domestic buildings' energy consumption accounts for 1,401.8GWh, C&I sector 849.3GWh and transport sector 846.4GWh of the total consumption.

Total electricity consumption across B&NES was 659.5GWh in 2018, including 131.8GWh of electric heating and 2.9GWh for electric vehicles. The total figure is circa 0.5% of England's total reported electricity consumption in 2018.

Total heat consumption across B&NES was 1,726.3GWh. Of this, 131.8GWh was met via electrical heating, and the remaining heat demand, which was met by fuels other than electricity, was 1,594.4GWh. Figure 22 below illustrates energy demands across different sectors in B&NES.

The E1 and E2 maps illustrate total indicative heat and electricity consumption based on natural gas demand by MSOA respectively. The darker the coloured area on the map, the higher the gas or electricity consumption by middle layer super output areas in 2019 (MWh per year) for maps E1 and E2 respectively. Screenshots have been provided in the report as a visual aid. Higher resolution versions of these maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[42] Sub-national total final energy consumption statistics - 2018 (published on September 2020) and Regen analysis.

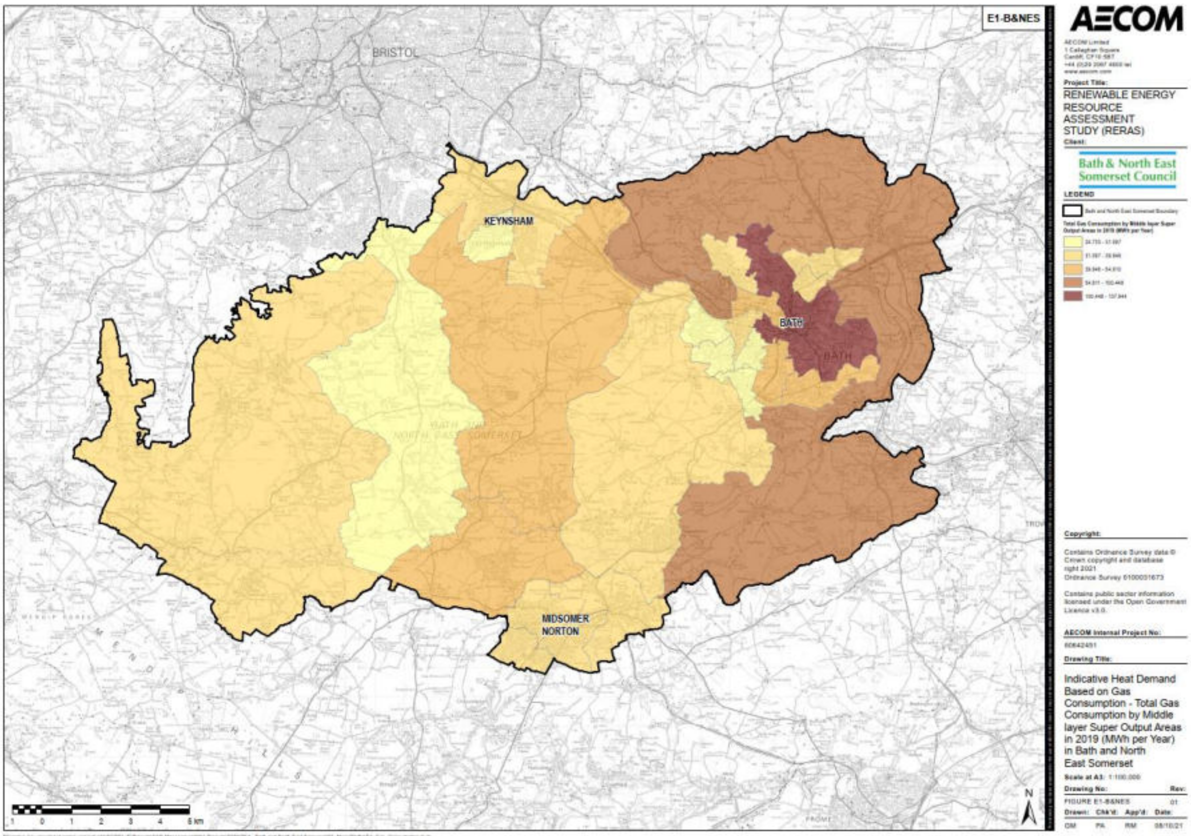


Figure 20: E1-B&NES: Indicative Heat Demand Based on Gas Consumption – Total Gas Consumption by MSOA in 2019 (MWh per Year) Map

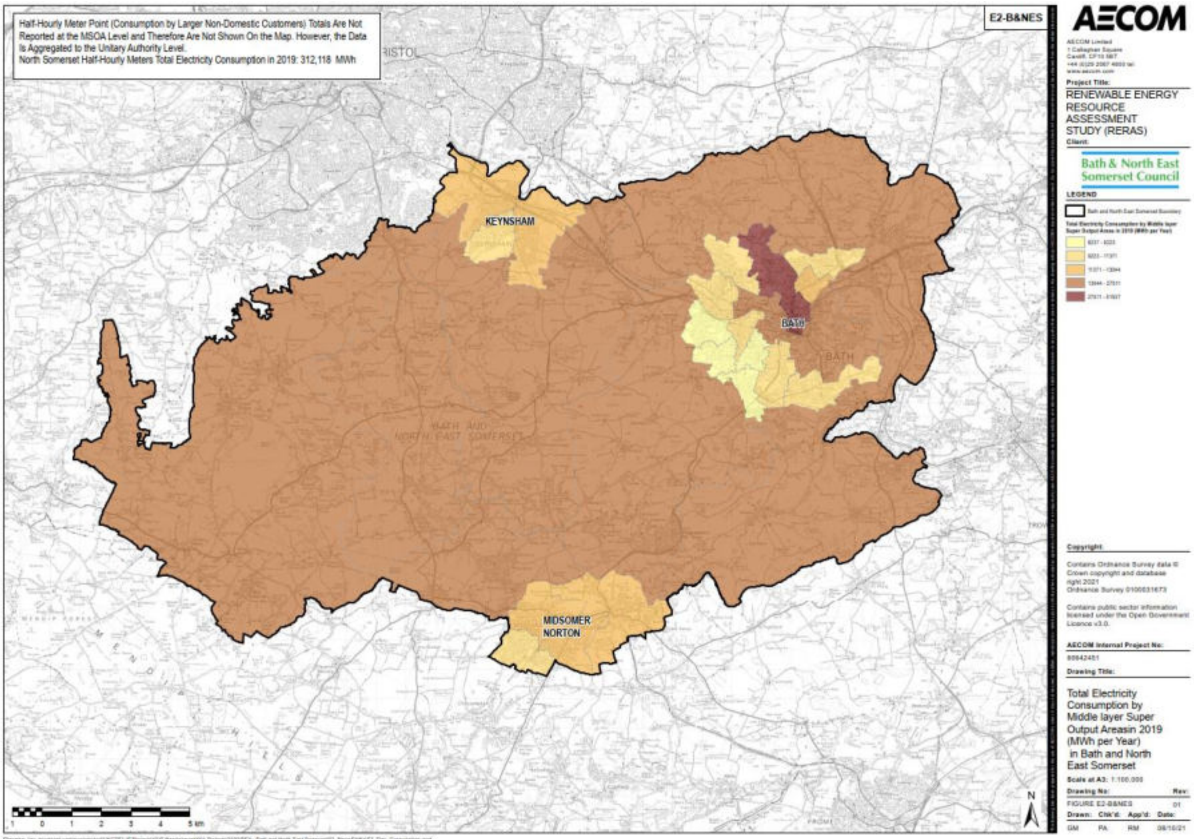


Figure 21: E2-B&NES: Total Electricity Consumption by MSOA in 2019 (MWh per Year) Map

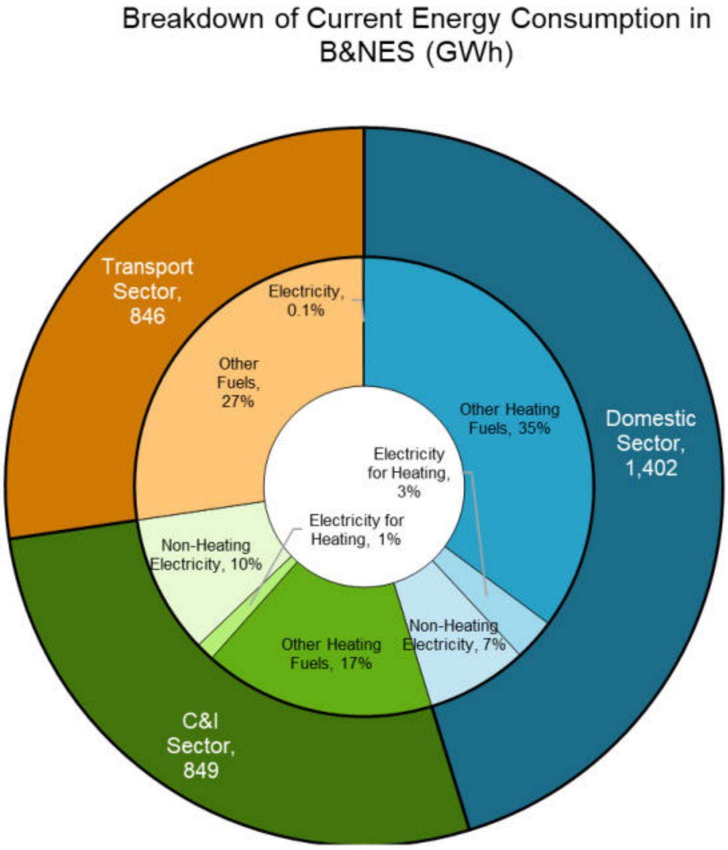


Figure 22: Breakdown of Existing Energy Consumption (GWh) in B&NES

When comparing B&NES to South Gloucestershire and North Somerset, B&NES consumed the least amount of energy over the course of 2018, with South Gloucestershire having the highest consumption as shown in Figure 23.

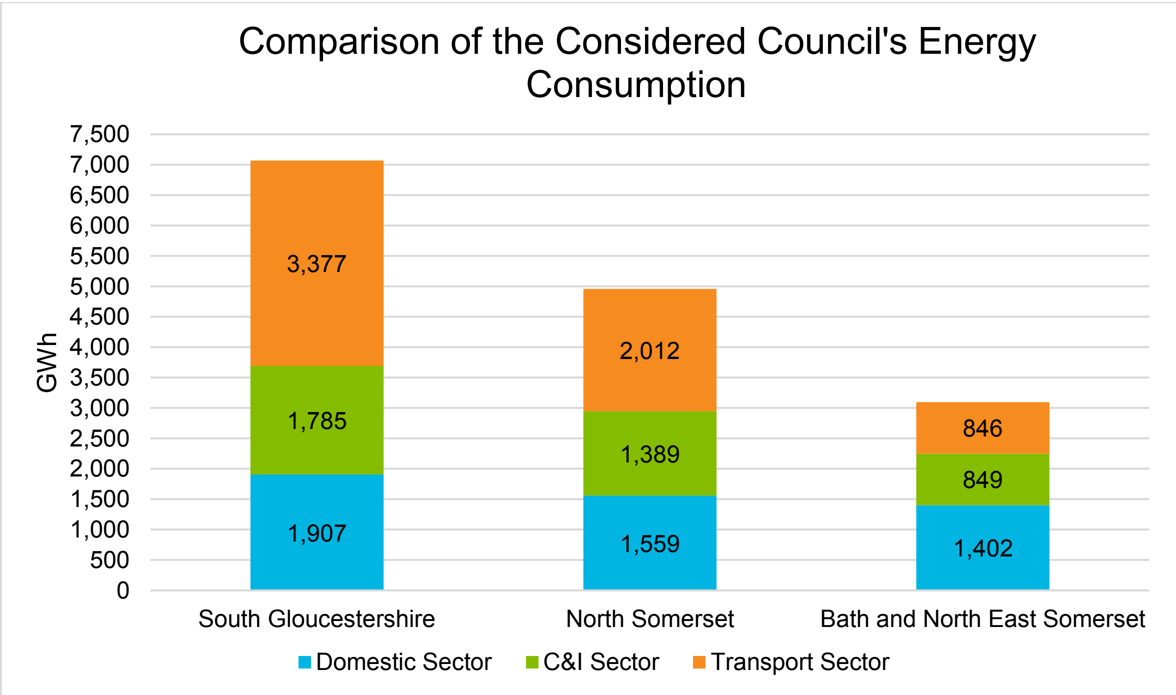


Figure 23: Chart Showing Comparison of Energy Consumption Data for the Councils Considered

B&NES has the lowest population however is the most densely populated council area, conversely, South Gloucestershire is the most populated council area in terms of numbers; however, it is the most sparsely populated. The difference in population density and the rurality of each council area are the primary reasons behind the significant differences in energy consumption.

3.3 Existing Capacity of Low and Zero Carbon Energy Technology Installations and Energy Generation in B&NES

Map Reference and Title:

1. R1-B&NES: Sites of Existing Renewable Energy in Bath and North East Somerset

To understand the progress being made with the development of Low and Zero Carbon (LZC) technologies, the existing capacity (as of 18/01/2021) of LZC technologies in the B&NES was established. Where LZC energy technologies already exist (including developments that are consented to be constructed as well as those already under construction), the installed capacities (measured in MegaWatts (MW)) were recorded to inform discussions about future developments.

This assessment of existing capacity includes technologies generating electricity, heat and both electricity and heat simultaneously. The assessment includes 'stand-alone' generators (such as wind farms) as well as those installed in buildings (e.g. biomass boilers).

The installed capacities of existing Energy from Waste (EfW) schemes and biomass schemes have also been marked for their potential contribution to supply heat to strategic new development sites. The renewable generators have been plotted using Geographic Information System (GIS) mapping, where location details of the sites have been made available.

Regen provided data for existing large-scale projects in B&NES. The data was cross-checked with BEIS (formerly DECC) Renewable Energy Planning Database (REPD)[43], NS planning data, RO and REGO datasets from Ofgem[44].

Data regarding LZC technologies that are providing energy to buildings are located within or on buildings was collected from the following sources:

- Regen;
- Renewable Heat Incentive (RHI) data[45];
- Feed-in Tariffs (FIT) data[46].

The breakdown of technology types for renewable heat generation in domestic and non-domestic buildings is not included in RHI dataset. Still, the database identifies 28 'non-domestic renewable heat installations with a total installed capacity of 5.47MWt.

The RHI database does not include total installed capacities for domestic installations at the regional level but provides average installation capacities in the UK for different domestic renewable heating technologies. Regen has provided a breakdown of the number of existing domestic thermal technologies (heat pump, biomass and solar thermal) in B&NES in 2020. The average installed capacities were used in conjunction with data provided by Regen to calculate renewable heat generation in domestic buildings.

Additionally, the current renewable energy generators in B&NES were mapped where location details were available. The map R1-B&NES is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'. The mapped sites were predominantly large installations from the following datasets, including a few additional small-scale installations.

[43] BEIS (2020) REPD Monthly Extract, https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract.
[44] https://www.renewablesandchp.ofgem.gov.uk/
[45] RHI monthly deployment data: January 2021 https://www.gov.uk/government/collections/renewable-heat-incentive-statistics
[46] Feed-in Tariffs: Quarterly statistics (March 2020)

- Renewables Obligation database (RO);
- Renewable Energy Guarantees of Origin database (REGO);
- Additional data provided by Regen on large renewable generators in B&NES;
- Renewable Energy Planning Database (REPD).
- Any additional wind turbines that were identified from the planning data.

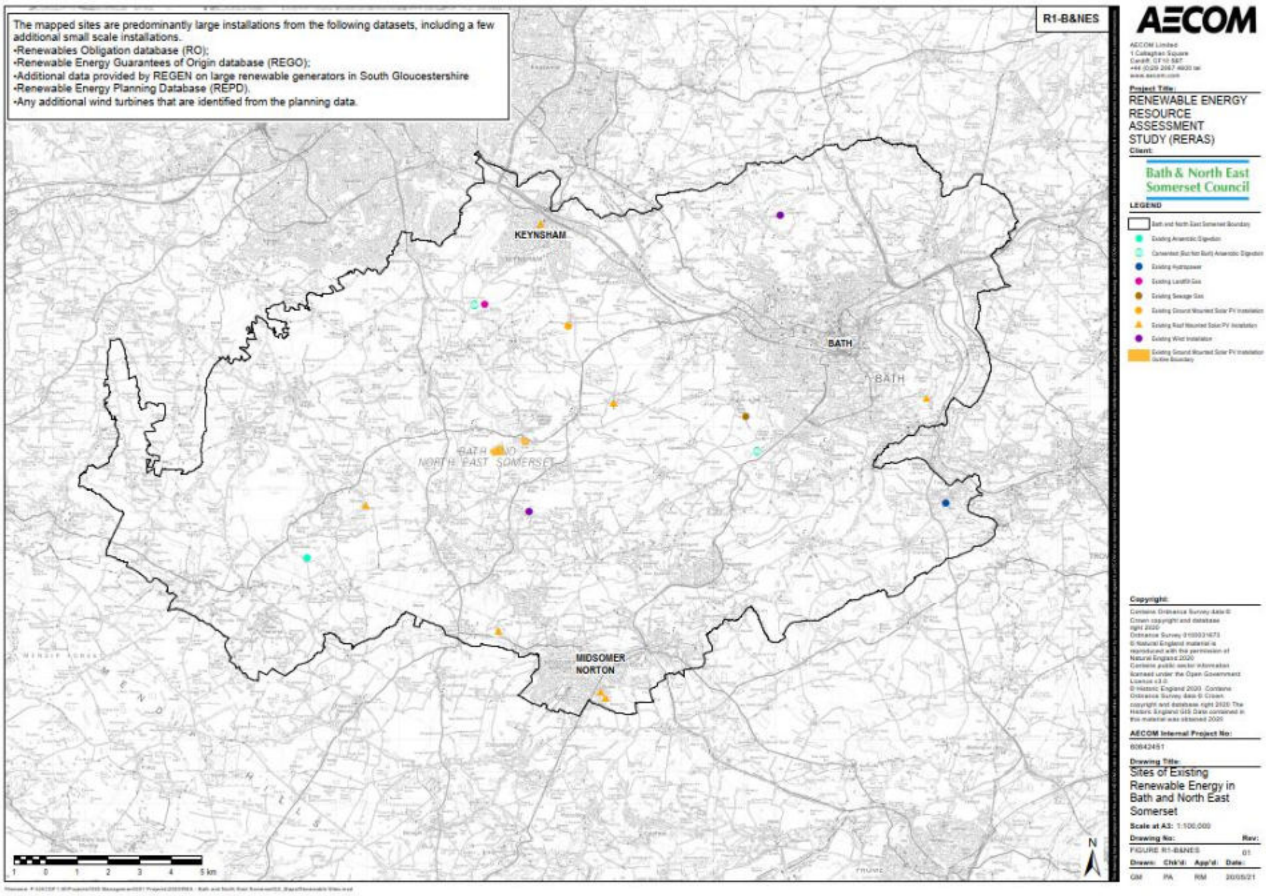


Figure 24: R1-B&NES: Sites of Existing Renewable Energy in Bath and North East Somerset

As outlined in Table 9 below, the total installed capacity of renewable energy generators in B&NES was calculated as 27.23MWe (Megawatts electrical), and 19.13MWt (Megawatts thermal).

Table 9: Existing Installed Capacity of Renewable Energy Generators in B&NES (Including Both Those Consented and to be Constructed; and Those Under Construction)

Technology	Electricity (MWe)	Thermal (MWt)
Hydropower	0.162	0.00
Wind-Onshore Wind <6kW[47]	0.006	0.00
Onshore Wind (6kW-1MW)	0.105	0.00
Onshore Wind >=1MW	0.00	0.00
Total Onshore Wind	**0.111**	**0.00**
PV-Commercial Rooftop (10kW - 1MW)	7.00	0.00
PV-Ground Mounted (>1MW)	5.87	0.00
PV-Domestic Rooftop (<10kW)	7.33	0.00
Total Solar PV	**20.19**	**0.00**
Anaerobic Digestion	2.45	3.68
Large Scale Biomass	2.03	4.06
Sewage Gas	0.63	0.94
Landfill Gas	1.60	0.00
Waste Incineration[48]	0.06	0.11
Domestic Renewable Thermal Technologies (Heat Pumps)	0.00	1.15
Domestic Renewable Thermal Technologies (Biomass)	0.00	3.60
Domestic Renewable Thermal Technologies (Solar Thermal)	0.00	0.12
Non-Domestic Renewable Thermal Technologies	0.00	5.47
Total	**27.23**	**19.13**

Of the above total electricity capacity, energy from solar PV accounts for 20.19MWe, AD 2.45MWe, landfill gas 1.60MWe and the remaining 2.99MWe is from onshore wind, hydropower, sewage gas, EfW and large scale biomass.

Of the 19.13MWt thermal capacity, 5.47MWt is provided by non-domestic installations, large scale biomass accounts for 4.06MWt, and the remaining 9.60MWt is from domestic renewable thermal technologies, EfW (incineration), AD and sewage gas.

It should be noted the large biomass generators and the landfill sites installation are large electricity generators.

[47] Building Integrated
[48] It has been assumed that 35% of the power and energy output of the waste facility counts as renewable. Refer to Energy from Waste section of the report.

Figure 25 and Figure 26 below provide a visual representation of the data in Table 9.

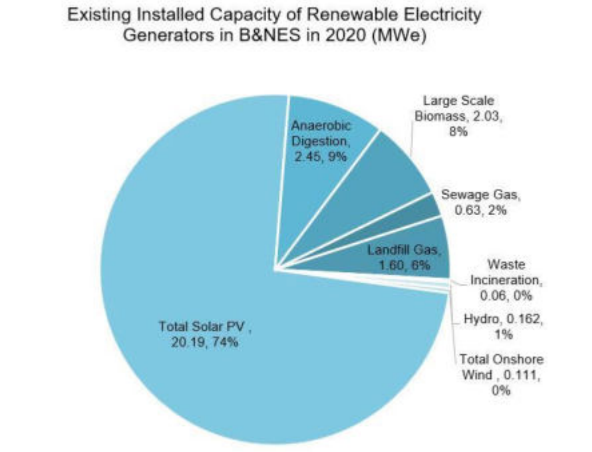


Figure 25: Existing Installed Capacity of Renewable Electricity Generators in B&NES

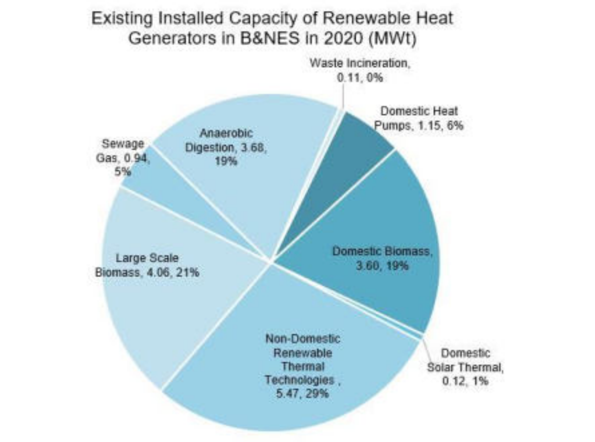


Figure 26: Existing Installed Capacity of Renewable Heat Generators in B&NES

The maximum amount of energy that could be generated from the above installations depends upon an assumed capacity factor, which is discussed in Section 15. A full table containing the technology, capacity factor, installed capacity and installed generation can be found in Appendix F.

Based on typical capacity factors, the total theoretical generation from existing renewable energy installations in B&NES at 18/01/2021is calculated as 50.8$GWh_{electricity}$ and 53.1$GWh_{thermal}$.

Figure 27 shows a comparison of the amount of renewable energy that is currently generated in B&NES and the current energy consumption across the area.

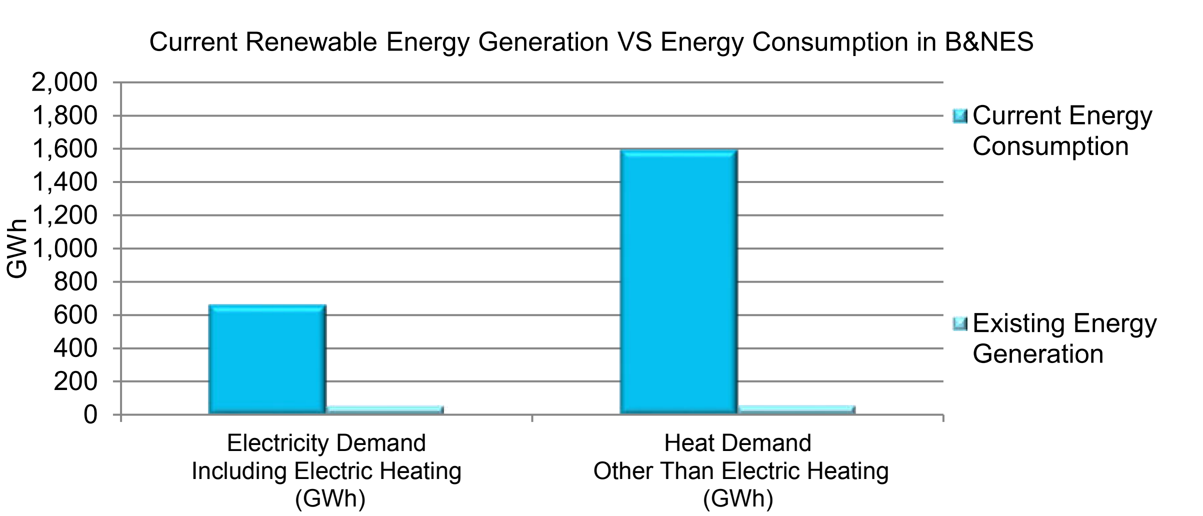


Figure 27: Difference Between the Existing Renewable Energy Generation (GWh) and Current Energy Consumption. Current Electricity Consumption Includes Electric Heating Consumption[49]

There is presently enough installed capacity for electricity generation to meet the equivalent of 7.7% of local electricity consumption; the consumption data includes 132GWh of electric heating

The amount of renewable heat generation at present is significantly low, covering only the equivalent of 3.3% of local heat demand.

[49] Sub-national total final energy consumption statistics - 2018 (published on September 2020) and Regen analysis.

4. Wind Energy Resource

4.1 Introduction

On-shore wind power is a 'mature technology' that is being used for electricity generation worldwide.

Most turbines are currently designed using a horizontal axis three-blade rotor system mounted on a steel mast. The blades drive a generator either directly or via a gearbox (generally for larger machines) to produce electricity. Turbines can produce electricity without carbon dioxide emissions, ranging from watts to megawatt outputs.

There are various wind turbines on the market ranging from smaller turbines that can be attached directly to a building, to larger stand-alone turbines. However, the performance of very small-scale wind turbines, i.e. building integrated turbines (<20 kW) are impacted disproportionately by turbulence and lower wind speeds from their positioning within their urban setting. Small turbines (≤500kW) are most commonly deployed as single machines supplying specific buildings or developments and sometimes used in community energy projects. Large scale commercial turbines (>2.5MW) are more often used in groups as part of larger wind farm developments, as shown in Figure 28 below.

Figure 28: Earthcott Wind Farm - Alverston[50]

Table 10 shows how turbine size increases the turbine output.

Table 10: Different Wind Turbines and Their Annual Energy Generation

Turbine Size (kW)	Annual Energy Generation (MWh)[51]
6	5
500	1,088
1,000	2,177
2,500	5,442

This section of the RERAS focuses on the identification of resource and potential generation from larger scale wind turbines across B&NES. For this study, the potential for installing wind turbines of 2.5 MW, 1 MW, and 500kW sizes were assessed, and primary constraints associated with wind energy development are considered. For an assessment of the potential for smaller scale turbines, it is suggested to refer to the existing B&NES Renewable Energy and Planning Research study[52].

In relation to wind energy, this RERAS is primarily concerned with the spatial identification of potential wind farm developments larger than 5MW total capacity[53], which is considered the minimum size of a

[50] South Gloucestershire Council, Earthcott Wind Farm.
[51] Refer to Appendix Q for load factors.
[52] https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/Evidence-Base/Sustainability/renewable_energy_and_planning_research_-_november_2010.pdf
[53] Each 2.5MW and 1.0MW Search Area can locate a minimum of 5MW wind farm containing 2.5MW or 1.0MW turbines respectively whereas the 500kW Search Areas can accommodate at least a single 500kW turbine

wind farm that could be financially viable without additional incentives[54]. Commercial-scale wind farms seek to install turbines at as large a scale as possible; however, it should be noted that any project (regardless of size) might be of interest to developers and community groups. Therefore, in the interest of completeness, additional suitable areas for installing smaller scale turbines (500kW) are included in the assessment. When assessing a 500kW wind turbine's resources, overlaps with areas suitable for larger turbines were prioritised to the larger turbines. It should be noted that there is a strong community energy resource within B&NES, 40% of the renewable energy capacity within B&NES is currently in community ownership[55].

The different turbine sizes result in varying cut off wind speeds, noise buffers, tip heights and topple distances, and therefore, each of the turbine sizes investigated has been individually mapped. Table 11 below presents the specifications of the wind turbines considered in this study.

Table 11: Wind Turbines Specifications Used Within This Study

Turbine Size (Rated Output)	Dimensions	Wind Speed Cut Off	Wind Turbine Density	Approx. Distance Between Turbines	Noise Buffer[56]	Topple Distance Buffer (Tip Height Plus 10%)
2.5 MW	Tip Height[57]: 135 m Rotor Diameter: 100 m Hub Height: 85 m	A lower limit of 5m/s measured at 45m above ground level (agl)	9 MW/km^2	595 m	600 m	148.5 m
1 MW	Tip Height[51]: 100 m Rotor Diameter: 55 m Hub Height: 60-80 m	A lower limit of 6m/s measured at 45m above ground level (agl)	8 MW/km^2	399 m	500 m	110 m
500 kW	Tip Height[51]: 70 m Rotor Diameter: 45 m Hub Height: 40-60 m	A lower limit of 6m/s measured at 45m above ground level (agl)	One turbine to be sited on each identified area	One turbine to be sited on each identified area	400 m	77 m

4.2 Mapping

The wind resource potential in B&NES was determined through a series of steps in which the primary constraints associated with wind development have been considered. The datasets corresponding to these constraints are overlaid in GIS maps in stages to produce the Search Areas shown in the RERAS. This assessment considers a combination of primary constraints comprising those that exclude certain places from being considered as potentially suitable as areas of search for locating wind farms (e.g., international nature conservation designations), as well as those that require further consideration (referred to as ‘other constraints’) as part of the Local Planning process (e.g. Areas of Outstanding Natural Beauty (AONB)). For the purposes of this study, these are shown for ‘information only’ purposes. These constraints and the stages at which the data layers were applied in the GIS mapping process was discussed and agreed with the Council.

Maps have been produced to illustrate each stage of the process of identifying primary constraints and opportunities.

The flowchart shown in Figure 29 shows the process steps and the output maps at each stage of the mapping. These maps are contained in the accompanying document ‘Bath and North East Somerset RERAS – Maps’.

For an in-depth, step-by-step explanation of the mapping process, please see Appendix G.

[54] 5MW was the cut-off point for eligibly of a wind farm to receive subsidies in the Feed-In Tariff (FIT) scheme.
[55] B&NES Council
[56] The noise buffers are based on SQW Energy Renewable and Low-Carbon Energy Capacity Methodology – Methodology for the English Regions.
[57] Height to blade tip at the highest point.

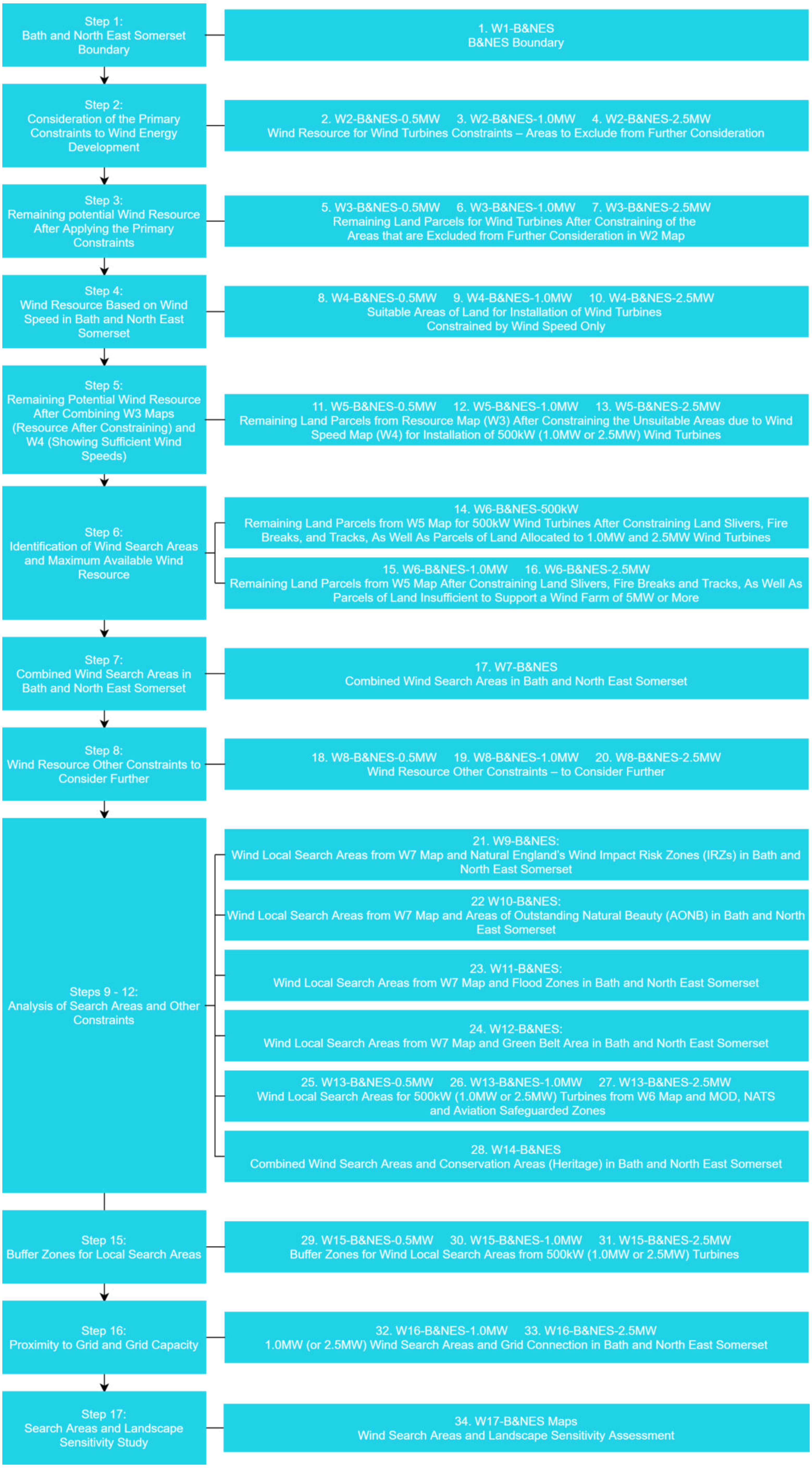


Figure 29: Flowchart of Wind Energy Resource Mapping Process

4.2.1 Primary Constraints

The list below illustrates the primary constraints to the development/ deployment of wind farms. The reason for mapping these areas of constraint is to remove them from consideration when deciding upon the final wind farm Search Areas. Items in brackets indicate that no areas of this type are present in B&NES. Figure 30 shows these constraints in the B&NES area.

Appendix G and Appendix H include further details regarding this analysis.

- Special Protection Areas (SPA) and foraging buffers;
- Special Areas of Conservation (SAC);
- Sites of Special Scientific Interest (SSSI);
- Scheduled Monuments;
- Listed Buildings, noise buffers have been applied if the building is residential;
- Registered Historic Parks and Gardens;
- Registered Battlefields;

The following constraints and their buffer distances (where one has been applied) are fixed for different turbine sizes.

- Ancient Woodlands – a 15 metre buffer has been applied to avoid root damage;
- Broadleaved Woodland a 15 metre buffer has been applied to avoid root damage;
- Existing buildings (extent);
- Watercourses – including major, secondary, and minor rivers, canals and lakes; - a 2 metre buffer has been applied to rivers and streams;
- Active mines/quarries;
- Local Nature Reserves;

The following constraints and their buffer distances (where one has been applied) are likely to change when considering different turbine sizes.

- Major transport infrastructure – topple distances +10% buffers have been applied;
- Minor transport infrastructure – topple distances + 10% buffers have been applied;
- Dwellings – noise buffers have been applied;
- Ministry of Defence (MoD) Sites;
- MoD Low Flying Zones
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind);

It should be noted that, whilst the above issues have been considered in the selection of the Search Areas (SAs), the SAs are not final because:

- The SAs remain subject to further investigation based on information provided in this report (e.g. grid connection or landscape sensitivity) and other considerations through the Local Plan process;
- The SAs are formed using specific technology typologies which, if different from the development proposals, may require the mapping exercise to be rerun;
- If a private landowner wanted a wind turbine closer to their building than was recommended, and nothing else was adversely affected, then loosening of noise restrictions could be considered.

Additionally, it is important to note that proposals for wind turbines above 2.5MW will change the shape and extent of the SAs, and further work will be needed when considering the proposals, particularly around reapplying the primary constraints listed above.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

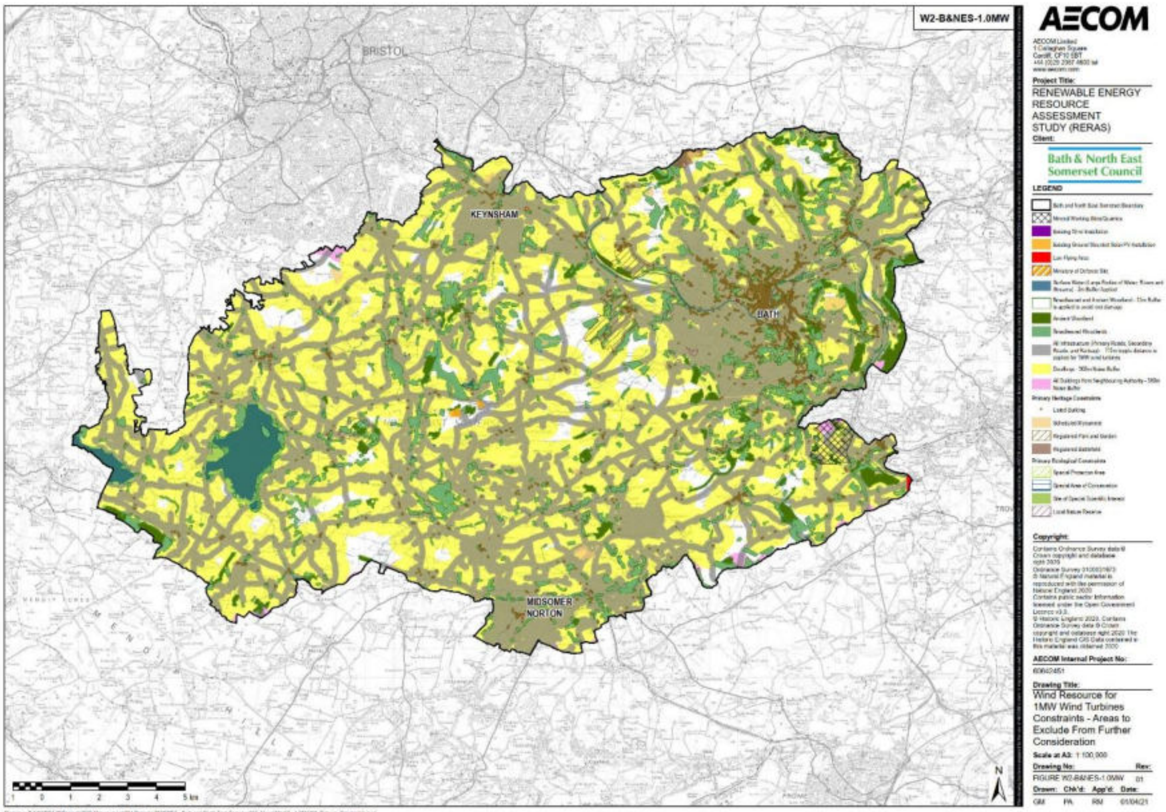


Figure 30: W2-B&NES-1.0MW: Wind Resource for 1.0MW Wind Turbines Constraints – Areas to Exclude from Further Consideration Map

Policy Recommendation

Policy Reference: WF-PR-8 (Refer to Table 41 in Section 17)

It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity will, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple-distances), site specific constraints, and other policy considerations should be looked upon favourably.

4.2.2 Identification of Wind Search Areas

As explained above, areas of constraint have been applied through mapping to identify the potentially suitable locations for the development of wind farms, and these are labelled as wind farm Search Areas. However, these search areas will need to be refined further through the Local Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

Policy Recommendation

Policy Reference: WF-PR-1 (Refer to Table 41 in Section 17)

It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints.

Policy Recommendation

Policy Reference: WF-PR-2 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines of the appropriate number and size (to make the most efficient use of the resource/ land) benefit from a presumption in favour of wind development when located within the areas identified for that use through the Local Plan.

Following the application of the primary constraints, the remaining area of potential wind resource[58] informs the calculation of the maximum potential generation capacity. This number then informs the identification of the theoretical maximum renewable energy generation in B&NES, see Section 15.

Figure 31 illustrates the identified wind Search Areas (SAs) for each of the three wind turbines sizes, the 500kW SAs are coloured orange, the 1.0MW SAs blue striped and the 2.5MW SAs in pink. There are 272, 6 and 3 LSAs identified for 500kW, 1.0MW and 2.5MW turbines, respectively. The SAs are referenced based on their corresponding wind turbine size and prioritised based on size (largest), e.g. 1.0MW-LSA-1 is the largest SA suitable for 1.0MW wind turbines installations. It was assumed that one 500kW turbine would be situated on each SA identified as suitable for a 500kW turbine. SAs identified for 500kW turbines could be promoted as areas suitable for community energy projects.

Policy Recommendation

Policy Reference: WF-PR-3 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines >2.5MW within the areas identified through the Local Plan will benefit from a presumption in favour of wind development, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple distances) and consideration of other site specific issues and constraints.

Policy Recommendation

Policy Reference: WF-PR-4 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines outside of areas identified as suitable for wind development through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.

[58] Labelled as “Unconstrained Wind Resource” on the W7 map.

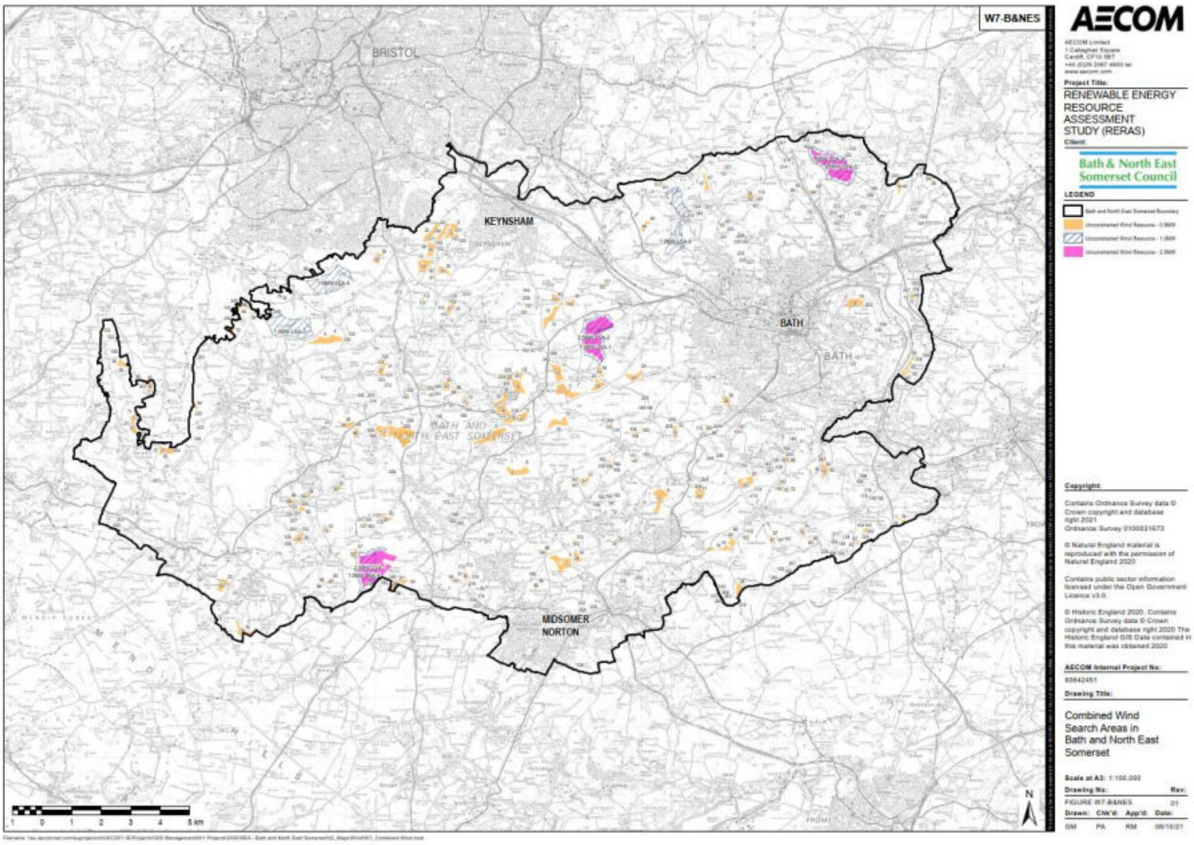


Figure 31: W7-B&NES: Combined Wind Search Areas in Bath and North East Somerset Map

A total of 6.84 km^2, 5.11 km^2 and 2.38 km^2 of land was identified as being potentially suitable for the installation of a 500kW, 1.0MW and 2.5MW wind turbines respectively. These areas comprise large parts of rural Bath and North East Somerset, as can be seen in Figure 31. It should be noted that these search areas will need to be refined further through the Local Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

Table 12: Identified Wind SAs in B&NES and Theoretical Maximum Potential Wind Resource

Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)[59]	Potential Total Electricity Generation (GWh)	Estimated Number of Turbines	Indicative Carbon Savings (2020 Grid Carbon Factor) tCO_{2e}
SAs for 500kW wind turbines in B&NES	6.84	136.00[60]	296.02	573	74,949
SAs for 1.0MW wind turbines in B&NES	5.11	40.88	88.98	41	22,529
SAs for 2.5MW wind turbines in B&NES	2.38	21.42	46.62	10	11,804
Total		180.01[61]	391.80		

59 It should be noted the areas for different wind turbines areas overlap and therefore the maximum potentials in this table cannot be added together.
60 573 additional small land parcels for 500kW turbines installations have been identified. It is assumed that one 500 kW turbine could be sited on each.
61 The potential from 1.0MW and 2.5MW Search Areas cannot be added together as some of the areas overlap. The maximum capacity in this table is taken from 1.0MW Search Areas plus and additional non-overlapping 2.5MW Search Areas.

Policy Recommendation

Policy Reference: WF-PR-5 (Refer to Table 41 in Section 17)

It is recommended that the SAs identified through the RERAS for 1MW and 2.5MW turbines are further refined and safeguarded through the Local Plan process.

Policy Recommendation

Policy Reference: WF-PR-7 (Refer to Table 41 in Section 17)

It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity, subject to compliance with noise, topple-distance, site specific constraints, and other policy considerations should be looked upon favourably.

The remaining land available and potential installed capacity for each of the 1.0MW and 2.5MW Search Areas are shown in Table 13 and Table 14 respectively.

Table 13: Individual Identified 1.0MW Wind SAs in B&NES and Their Theoretical Maximum Potential Installed Capacity

SA Reference on Maps	SA Area (km^2)	Potential Total Installed Capacity (MW)[62]
1.0MW-1	1.085	8.68
1.0MW-2	1.074	8.59
1.0MW-3	0.851	6.82
1.0MW-4	0.779	6.25
1.0MW-5	0.673	5.39
1.0MW-6	0.643	5.15

Table 14: Individual Identified 2.5MW Wind SAs in B&NES and Their Theoretical Maximum Potential Installed Capacity

SA Reference on Maps	SA Area (km^2)	Potential Total Installed Capacity (MW)[63]
2.5MW-1	0.864	7.77
2.5MW-2	0.805	7.25
2.5MW-3	0.709	6.38

[62] Potential total installed capacities are calculated using density factors provided in Table 11.
[63] Potential total installed capacities are calculated using density factors provided in Table 11.

4.2.3 Other Constraints for Further Consideration

Effects of some of the other constraints that may impact wind development within the SAs were analysed, however, it was agreed that these constraints will need to be examined as part of the planning balance. Therefore, the identified SAs on the W7 map have not been constrained utilising the 'other constraints'. Appendix G and Appendix I include further details regarding this analysis.

- Other woodlands (Other than Broadleaved Woodland and Ancient Woodland);
- Area of Outstanding Natural Beauty (AONB);
- Natural England's Impact Risk Zones for Wind Development (IRZs);
- Unlicensed Aerodromes;
- Minerals Safeguarding Areas;
- World Heritage Site and Setting;
- National Air Traffic Control Services (NATS) Radar Safeguarding Areas;
- Aviation Safeguarded Zone;
- Flood Zones;
- National Trust Inalienable Land;
- Green Belt[63];
- MoD Safeguarding Zones;
- Conservation Areas (Heritage)

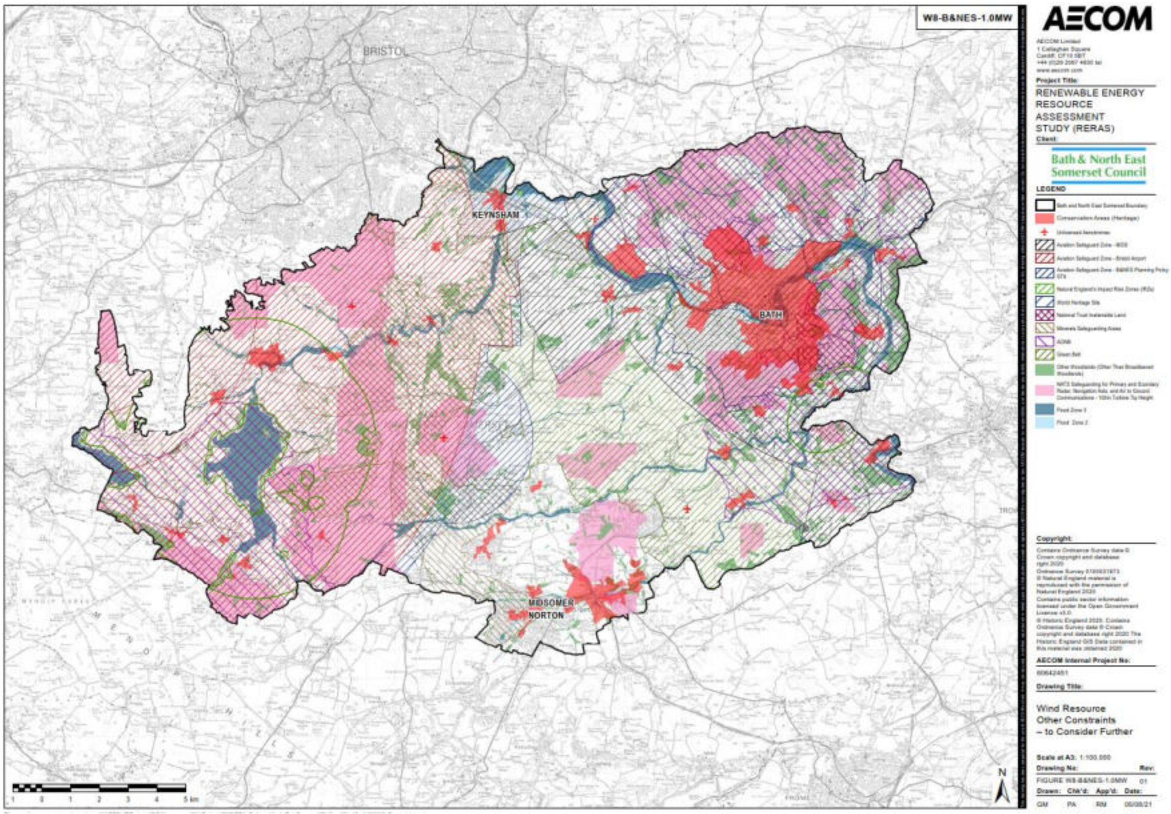


Figure 32: W8-B&NES-1.0MW: Wind Resource Other Constraints – to Consider Further Map

[64] As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources'*

4.3 Proximity to Grid and Grid Capacity

Issues related to grid connection are relevant to both wind and solar energy developments. Therefore, the findings of RERAS regarding this are combined and provided in Section 6.

4.4 Landscape Sensitively Assessment

An additional parameter that can be considered in prioritising the Search Areas is the sensitivity of the landscape to new wind/ solar PV development. To facilitate an understanding of this issue, Land Use Consultants (LUC) has conducted a landscape sensitivity assessment for wind and solar energy development, and the results of the assessment are provided in Section 7.

4.5 Further Constraints to Wind Energy sites

Further constraints to onshore wind development not considered within this RERAS may include (but are not restricted to):

- Practical access to sites required for development.
- Landowner willingness for development to go ahead.
- National planning policies, which are outside of the Council's control;
- Community support; and
- Time to complete planning procedures.

4.6 Summary and Potential Opportunities for Future Development

Wind generation has the potential to be a significant source of renewable energy generation in B&NES, with the identification of:

- 272 SAs for small (500kW) turbines;
- 6 SAs for medium (1.0MW) turbines; and,
- 3 SAs for large (2.5MW) turbines.

The W7map (Figure 31) highlights that there is a considerable overlap of 1.0MW and 2.5MW SAs, with there being significant opportunities for 500kW turbine installations across B&NES.

Table 15 shows details of the SAs and their potential installed capacity and energy generation.

Table 15: Identified Wind SAs in B&NES - Theoretical Maximum Potential Wind Resource

Map Reference	Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)	Potential Total Electricity Generation (GWh)
W6-B&NES-0.5MW	SAs for 500kW wind turbines in B&NES	6.84	136.00[65]	296.02
W6-B&NES-1.0MW	SAs for 1.0MW wind turbines in B&NES	5.11	40.88	88.98
W6-B&NES-2.5MW	SAs for 2.5MW wind turbines in B&NES	2.38	21.42	46.62
	Total		180.01[66]	391.80

Additionally, SAs have been further ranked (for information purposes only) using the WPD grid connection analysis and the LUC landscape sensitivity assessment. The WPD grid connection analysis can be used to identify the most favourable locations when considering updates to the grid.

[65] 272 additional small land parcels for 500kW turbines installations have been identified. It is assumed that one 500 kW turbine could be sited on each.
[66] The potential from 1.0MW and 2.5MW Search Areas cannot be added together as some of the areas overlap. The maximum capacity in this table is taken from 1.0MW Search Areas plus and additional non-overlapping 2.5MW Search Areas.

The LUC landscape sensitivity assessment can be used to guide the Council to the locations that will have the least impact on the landscape.

The only other technology addressed in this study with the potential to produce more renewable electricity was solar PV. However, when comparing wind to solar PV, wind turbines require significantly less land take than PV to generate the same amount of electricity.

Due to the benefits of wind developments (typically greater CO_2 saving per square metre) as well as the relatively smaller number of sites (and area) for such development as opposed to solar, consideration may be given to protecting such sites solely for wind development as well as against sterilisation from other forms of nearby development.

Moreover, the effects of additional constraints such as AONB and Green Belt would need to be examined as part of the Local Plan process. Therefore, these other constraints were analysed and included in the study as information to assist the Council in developing its proposed policy approach. Appendix G includes details of these other constraints and potential capacity of the SAs if the overlapping areas covering these constraints and SAs were removed. The additional maps also cover radar, MoD and aviation safeguarding as well as Conservation Areas (Heritage) to assist developers and councils with any dialogue/ consultation that may be required with these organisations regarding wind turbine installations.

5. Solar PV Farm

5.1 Introduction

5.1.1 Solar Photovoltaic Systems

Figure 33: A Rooftop and Ground Mounted Solar Array

Solar Photovoltaic (PV) systems use solar cells to generate electricity directly from sunlight. The solar cells are normally packaged together into panels or other modular forms and the technology is technically well-proven with numerous systems installed around the world ranging from small domestic systems (circa 3.5 kW) to large PV farms (several MWs) see Figure 33[67].

PV systems convert energy from the sun into direct current (DC) electricity using semi-conductor cells connected and mounted into modules. Modules are connected to an inverter that converts DC into alternating current (AC), enabling integration with the normal grid supply.

PV modules can be placed on a fixed stand/roof or can be equipped with tracking systems that allow the modules to follow the course of the sun. This can potentially increase electricity production compared with static modules, but can be an expensive addition, usually reserved for larger-scale installations.

PV technology is common in the UK and new technologies such as solar tiles, which can be integrated into new buildings or refurbishments alongside conventional roofing tiles are becoming more widely available. If the output of a PV system exceeds the building consumption at any time, the surplus electricity can then be exported to the grid.[68]

This section provides details of the assessment of the potential for solar PV Farms within Bath and North East Somerset (B&NES).

The Department for Business Energy and Industrial Strategy (BEIS) -formerly the Department for Energy and Climate Change (DECC) defines a “stand-alone” installation as a “solar photovoltaic electricity generating facility that is not wired through a building, or if it is wired through a building, the building does not have the ability to use 10% or more of the electricity generated”.

PV is recognised as one of the key technologies in meeting the UK target of net zero greenhouse gas emissions by 2050. Electricity will be increasingly important in supporting net zero delivery, potentially providing around half of the UK's final energy demand as its use for heat and in transport increases[69].

In 2019, 28% of renewable installations across the UK regarding installed capacity were solar PV. This figure is expected to increase due to the falling costs of PV modules leading to increasing viability of ground-mounted solar installations[70]. The Contracts for Difference (CfD) scheme is the Government’s main mechanism for supporting new low carbon electricity generation projects. The scheme is being updated to support the UK’s 2050 net zero target delivery whilst simultaneously minimising consumer costs[71].

This section provides the approach to a high-level assessment of the potential solar resource for ‘stand-alone’ PV farms. It is primarily concerned with identifying opportunities for solar PV development of larger than 5MW.

[67] AECOM Multi Media Library
[68] https://www.gov.uk/government/news/uk-solar-pv-roadmap-and-the-energy-economy
[69] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943714/Modelling-2050-Electricity-System-Analysis.pdf
[70] https://www.gov.uk/government/statistics/regional-renewable-statistics
[71] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945301/cfd-cm-scheme-update-2020.pdf

5.2 Mapping

The solar PV farm potential in B&NES was determined through a series of steps in which the primary constraints associated with such development have been considered. The datasets corresponding to these constraints are overlaid in stages, by applying to GIS mapping, to produce the Search Areas shown in the RERAS. This assessment considers a combination of primary constraints comprising those that exclude certain places from being considered as potentially suitable as areas of search for locating solar PV farms (e.g., international nature conservation designations), as well as those that require further consideration through the Local Plan process. These constraints and the GIS mapping stages at which they were applied was discussed and agreed with the Council.

Maps have been produced to illustrate, at each stage of the study process, the primary constraints and opportunities.

The flowchart in Figure 34 shows the steps taken and the output maps at each stage of the mapping. These maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'. For an in-depth, step-by-step explanation of the mapping process, please see Appendix J.

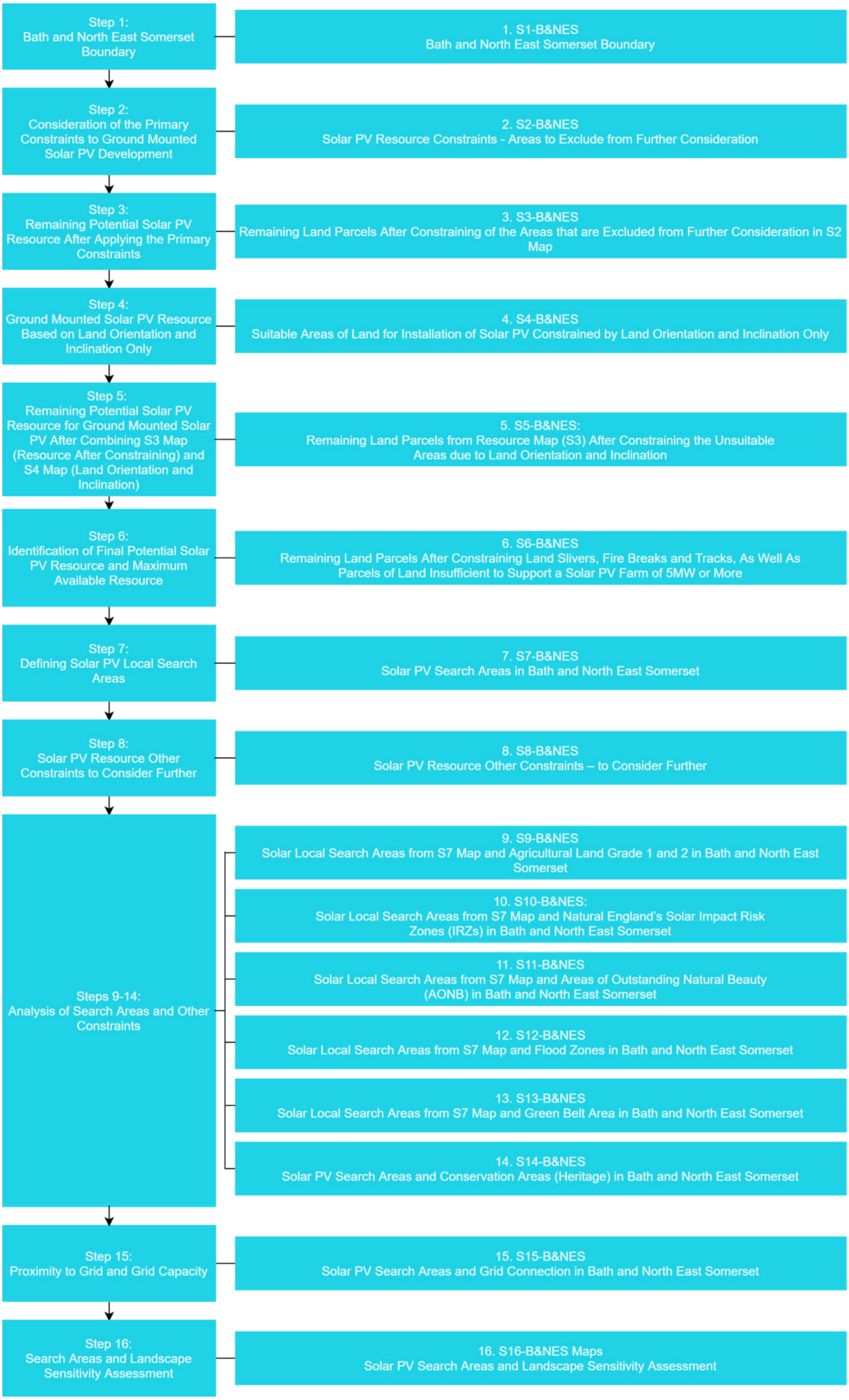


Figure 34: Flowchart of Solar PV Mapping Process

5.2.1 Primary Constraints

The list below illustrates the primary constraints to the development/ deployment of solar PV farms. The reason for mapping these areas of constraint is to remove them from consideration when deciding upon the final Search Areas. Items in brackets indicate that no areas of this type are present in B&NES. Figure 35 shows these constraints in the B&NES area and Appendix J and Appendix K include further details regarding this analysis.

- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC);
- Sites of Special Scientific Interest (SSSI);
- Scheduled Monuments;
- Listed Buildings;
- Registered Historic Parks and Gardens;
- Registered Battlefields;
- Ancient Woodlands – a 15-metre buffer has been applied to avoid root damage;
- Broadleaved Woodland – a 15-metre buffer has been applied to avoid root damage;
- Major transport infrastructure;
- Minor transport infrastructure;
- Existing buildings/settlements;
- Watercourses – including major, secondary, and minor rivers, canals, and lakes; - a 2-metre buffer has been applied to rivers and streams;
- Ministry of Defence (MoD) Sites;
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind);
- Active mines/quarries; and
- Local Nature Reserves.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset – Maps'.

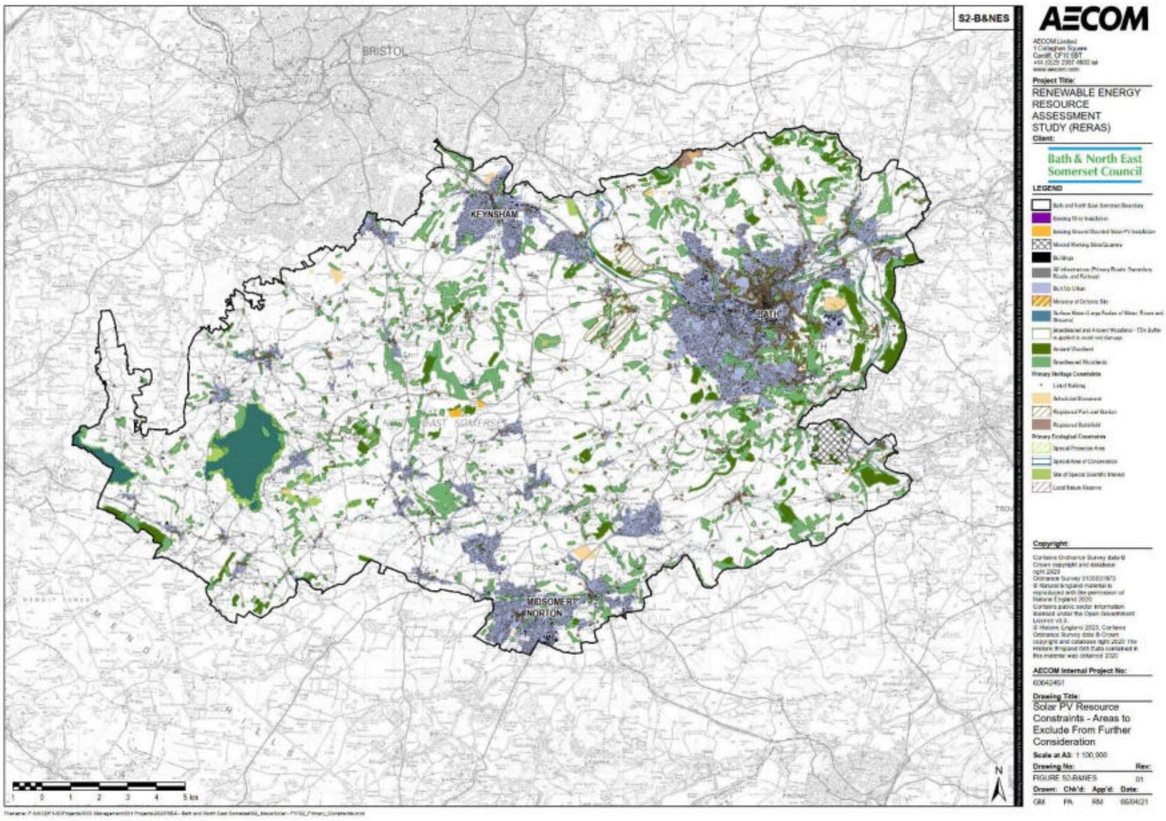


Figure 35: S2-B&NES: Solar PV Resource Constraints - Areas to Exclude from Further Consideration Map

Policy Recommendation

Policy Reference: SF-PR-4 (Refer to Table 42 in Section 17)

It is recommended that proposals for re-powering of solar PV farms at end-of-life to an equal or increased capacity, subject to compliance with primary constraints, site specific constraints, and other policy considerations should be looked upon favourably.

5.2.2 Identification of Solar PV Search Areas

As explained above, areas of constraint have been applied through mapping to identify potentially suitable locations for the development of solar PV farms, and these are labelled as solar PV farm Search Areas. However, these search areas will need to be refined further through the Local Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

Policy Recommendation

Policy Reference: SF-PR-1 (Refer to Table 42 in Section 17)

It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints. As part of this a strategy approach which takes account of clustering and the potential need to manage cumulative impact should be considered.

Policy Recommendation

Policy Reference: SF-PR-2 (Refer to Table 42 in Section 17)

It is recommended that proposals for solar PV farms within the areas identified for that use through the Local Plan benefit from a presumption in favour of solar development.

Following the application of the primary constraints, the total remaining area of potential solar PV resource informs the calculation of the maximum potential generation capacity. This number then informs the identification of the theoretical maximum renewable energy generation in B&NES, see Section 15.

As this study is primarily concerned with identifying solar PV development opportunities larger than 5MW, AECOM created a GIS grid layer. On this map, each square area is equivalent to the spatial requirement of a 5MW solar farm, and this layer was overlaid onto the potential solar PV resource map, the squares also provide the reader with a sense of scale of the potential solar PV farms.

Policy Recommendation

Policy Reference: SF-PR-3 (Refer to Table 42 in Section 17)

It is recommended that proposals for solar development outside of areas identified as suitable for that use through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.

A higher resolution version of this map is contained in the accompanying document ‘Bath and North East Somerset RERAS – Maps’.

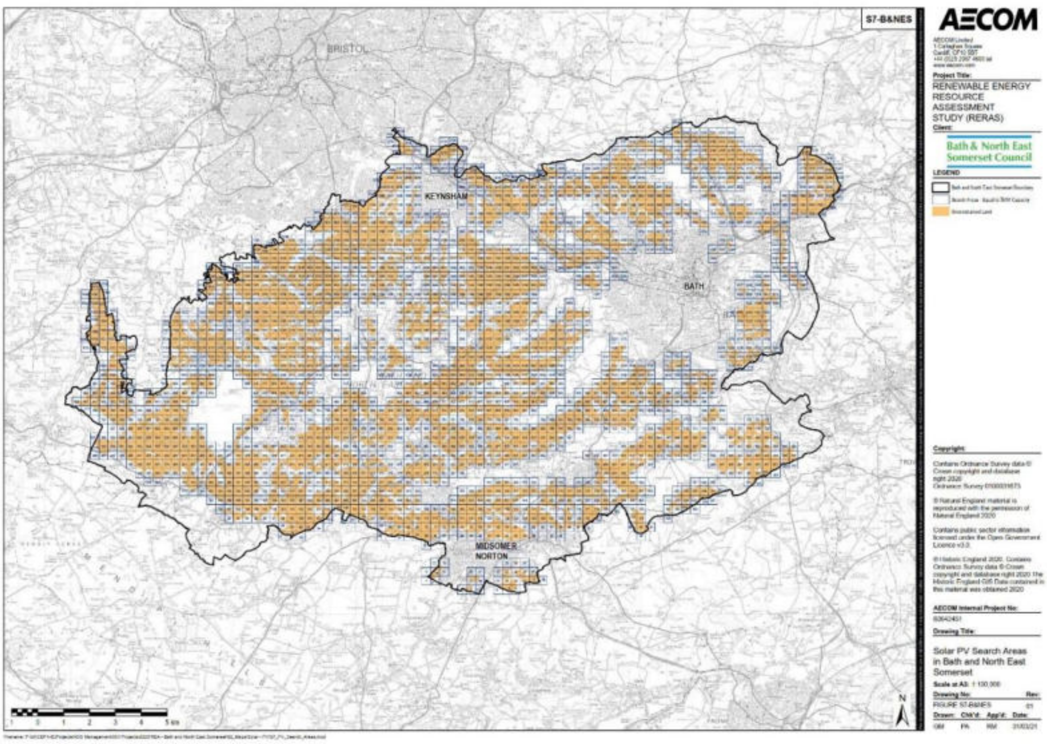


Figure 36: S7-B&NES: Solar PV Search Areas in Bath and North East Somerset Map

A total of 126.71km^2 of land was identified as being suitable potentially for the installation of a solar PV farm, with this area comprising of a majority of the rural areas within B&NES, this can be seen in Figure 36.

It was assumed the land area required for a 5MW fixed-tilt PV array is approximately 30 acres (or 12Ha or 0.12km^2)[72] and that a solar farm will generate energy at peak for 11% of the time (964 hours) over the course of a year[73].

Table 16: Remaining Land Available for Ground Mounted Solar PV Farms at this Stage of the and its Potential Total Installed Capacity

Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)	Potential Energy Generated (GWh)	Indicative Carbon Savings (2020 Grid Carbon Factor) CO_{2e}
126.71	5,279.6	5,121	1,296,586

5.2.3 Other Constraints for Further Consideration

Effects of some of 'other constraints' that may impact ground-mounted solar PV development within the SAs were analysed, however, it was agreed that these constraints would need to be examined as part of the planning balance and therefore, the identified SAs on the S7 map have not been constrained utilising the 'other constraints'. Appendix J includes further details regarding this analysis.

- Other woodlands (Other than Broadleaved Woodland and Ancient Woodland);
- Area of Outstanding Natural Beauty (AONB);
- Natural England's Impact Risk Zones for Solar Development (IRZs);
- Minerals Safeguarding Areas;
- World Heritage Sites and Setting;
- Flood Zones;
- National Trust Inalienable Land;
- Green Belt[74];
- Agricultural Land Classification (ALC); and
- Conservation Areas (Heritage)

[72] According to the DECC UK Solar PV Strategy Part 1: 'Roadmap to a Brighter Future', the land area required for a 1MW fixed-tilt PV array is approximately 6acres (or 2.4Ha or 0.024km^2). *See above link*
[73] Average of the five previous years' regional standard load factors published by BEIS.
[74] As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources.'*

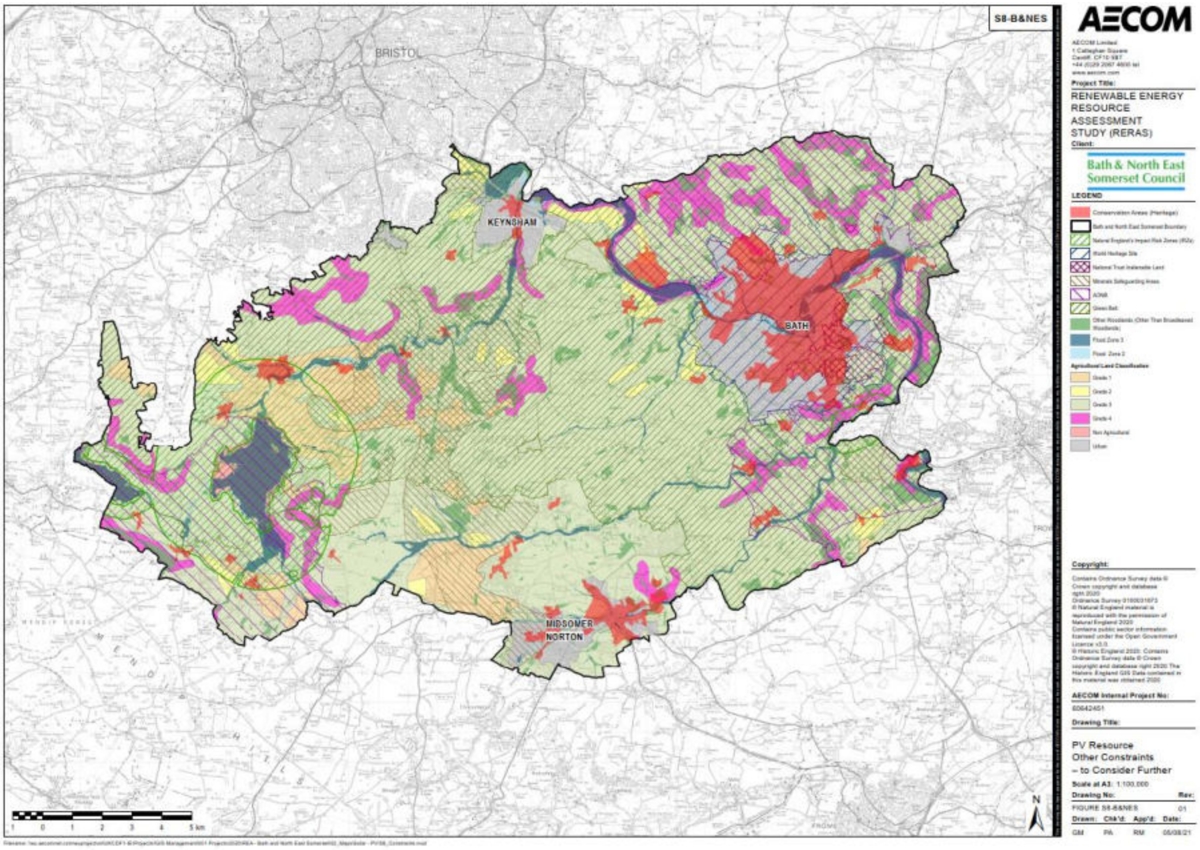


Figure 37: S8-B&NES: Solar PV Resource Other Constraints – to Consider Further Map

5.3 Proximity to Grid and Grid Capacity

Issues related to grid connection are relevant to both wind and solar energy developments. Therefore, the findings of RERAS regarding this are combined and provided in Section 6.

5.4 Landscape Sensitivity Assessment

An additional parameter that can be considered in prioritising the Search Areas is the sensitivity of the landscape to new wind/ solar PV development. To facilitate an understanding of this issue, LUC has conducted a landscape sensitivity assessment for wind and solar energy development, and the results of the assessment are provided in Section 7.

5.5 Further Constraints to Solar PV Farm Sites

Further constraints to solar PV farm development that are not considered within this RERAS include (but are not necessarily restricted to):

- Practical access to sites required for the development.
- Landowner willingness for development to go ahead;
- National planning policies, which are outside of the Council's control;
- Harnessing community support; and
- Time to complete planning procedures.

5.6 Summary and Potential Opportunities for Future Development

Solar PV has the potential to be a significant source of renewable energy generation in B&NES, with the largest potential of any of the technologies in the study.

Across B&NES, 126.71km^2 of land was identified as suitable for solar PV development, covering a significant amount of the rural land within B&NES. Table 17 below shows the potential installed capacity and energy generation from the identified solar SAs in this study.

Table 17: Potential Installed Capacity and Energy Generation from the Identified Search Areas for Ground Mounted Solar PV Farms

Map Reference	Total Land Area (km^2)	Potential Total Installed Capacity (MW)	Potential Energy Generated (GWh)
S6-B&NES	126.71	5,279.6	5,121

Moreover, the effects of other constraints such as Agricultural Land Classification (ALC) or Green Belt areas that may impact ground-mounted solar PV development within the SAs were considered by spatial mapping the SAs and the constraints on separate maps. A comprehensive list of these additional constraints is provided in Appendix J. As part of the analysis, the impact of a selected number of the other constraints on the SAs was assessed by removing the overlapping areas covering these constraints and SAs. Table 18 below includes details of the assessment.

Table 18: Remaining Area of SAs After Applying Selected Other Constraints for Illustrative Purposes Only

Map Reference	Additional Constraint Shown on the Map	Area of the Final Solar SAs Identified in Step 6 (km^2)	Potential Installed Capacity of the Final Solar SAs (MW)	Remaining SAs if Area of the Additional Constraint Is Removed (km^2)	Remaining Potential Installed Capacity of the SAs if Area of the Additional Constraint Is Removed (MW)
S9-B&NES	Agricultural Land Grade 1 and 2	126.71	5,279.6	111.17	4,632.1
S10-B&NES	Natural England's IRZs for Solar	126.71	5,279.6	108.31	4,512.9
S11-B&NES	AONB	126.71	5,279.6	98.38	3,849.2
S12-B&NES	Flood Zones	126.71	5,279.6	120.75	5,031.3
S13-B&NES	Green Belt	126.71	5,279.6	29.87	1,244.6

Furthermore, SAs have been further ranked (for information purposes only) using the WPD grid connection analysis results and the LUC landscape sensitivity assessment. The WPD grid connection analysis can be used to identify the most favourable locations when considering the connection to the grid. The LUC landscape sensitivity assessment can be used to guide the Council to the locations that will have the least impact on the landscape.

Due to the substantial amount of solar PV SAs identified within this study, the Council can consider its options in terms of safeguarding, as the available resource is significantly greater than that required. For example, the Council could consider whether it wishes to further constrain the available resource to narrow down the areas where it would support development of PV farms. It could also choose not to safeguard land for solar PV farms, as the scale of opportunity is so great in comparison to that for wind farms.

6. Proximity to Grid and Grid Capacity for Wind and Solar PV SAs

Whilst private wire schemes are an option, and some already exist in the UK, onshore wind and solar farms usually have a connection to the grid to export electricity, albeit with increasing curtailments.

Consideration of a viable connection point is an important factor when considering sites for new solar or wind energy development. The cost of a grid connection depends on the distance to the nearest connection point the works needed to make that connection (there can be a number of complexities such as land ownership issues, whether the dig is hard or soft, etc) and the availability of capacity in the distribution network to take the additional power output. For this study, grid connection is assumed to be a discussion matter for national-level decision-makers and has not been used to constrain wind and solar PV energy generation potential. In addition, as renewable deployment is a national priority, it is assumed that the grid requirement will be met to allow for sufficient additional capacity.

A high-level analysis has been undertaken in consultation with the Distribution Network Operator, Western Power Distribution (WPD). This analysis was undertaken to rank the 1.0MW and 2.5MW wind SAs as well as the solar PV SAs in terms of their proximity to a likely grid connection point. The solar SAs have been divided into 50MW parcels to allow WPD to perform their assessment of the sites. There has been a rise in 50MW or lower solar PV farms proposal in the South West of England region. This could be due to the fact that electricity generators that generate lower that 50MWe are exempts from the requirement for an electricity licence[75].WPD reviewed the existing available capacity within the wind SAs and aligned that information to the proximity of existing conductors/cables, and any other accepted or offered connections that may also be seeking capacity. The Search Areas were ranked based on the high-level analysis undertaken in consultation with WPD. The Search Areas are ranked from low priority (coloured red in the maps) to high priority (coloured blue in the maps), with high priority being most favourable for a new connection to the grid as shown in Figure 38.

Figure 38: SAs Proximity to Grid and Grid Capacity Ranking Key (Refer to W16 and S15 Maps in Accompanying Document 'Bath and North East Somerset RERAS - Maps')

This ranking has only been taken as a single snapshot based on the latest information. It does not account for any future reinforcement that may be triggered by other new connections or condition-based replacement. Increases or decreases in future demand may also affect capacity and have not been considered within this study. Sites over 1MW may be required to go through the Statement of Works process to confirm acceptance of the connection on the transmission network.

Network access may be accelerated or achieved with reduced costs by progressing an alternative connection, which allows export to be limited at times of high export from other users.

Higher resolution versions of these maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[75] Class A: Small generators – Generates lower than 50 megawatts with a declared net capacity of up to 100 megawatts. https://www.legislation.gov.uk/uksi/2001/3270/schedule/2/made

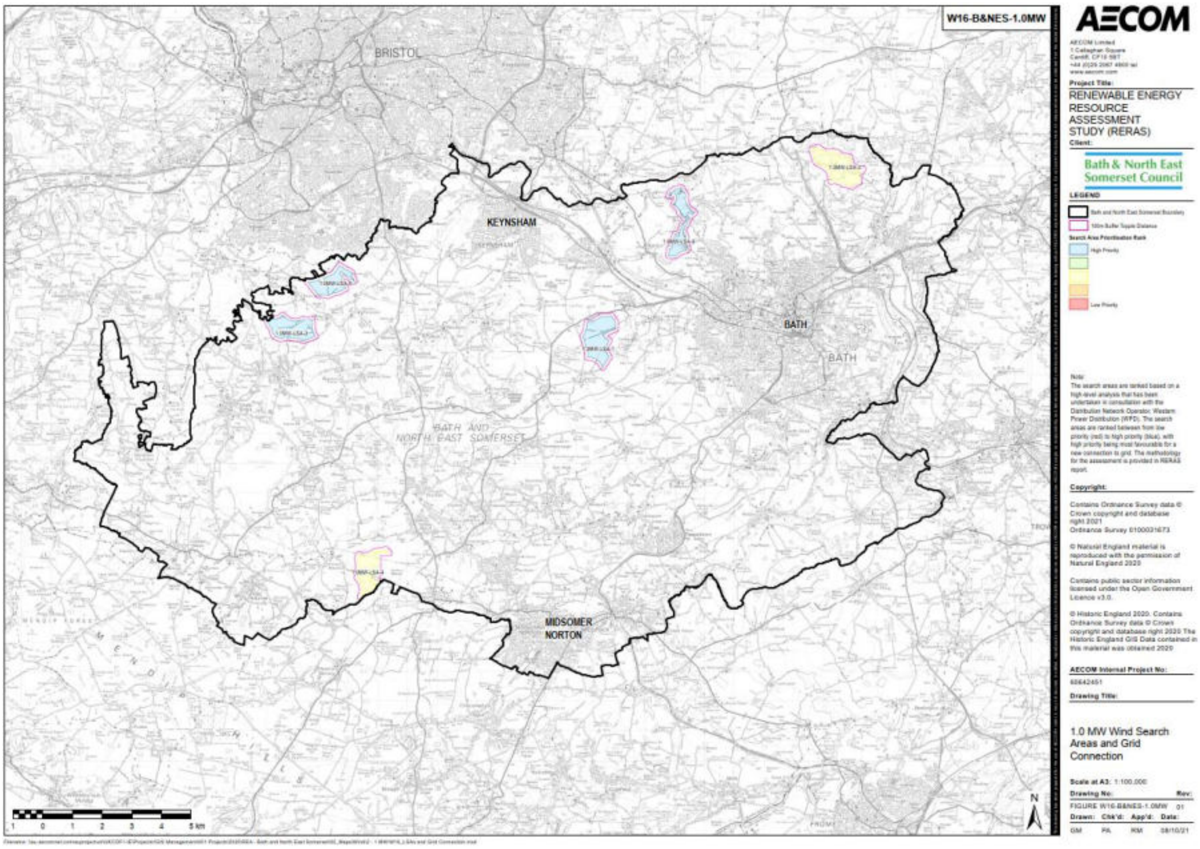


Figure 39: W16-B&NES-1.0MW: 1.0MW Wind Search Areas and Grid Connection

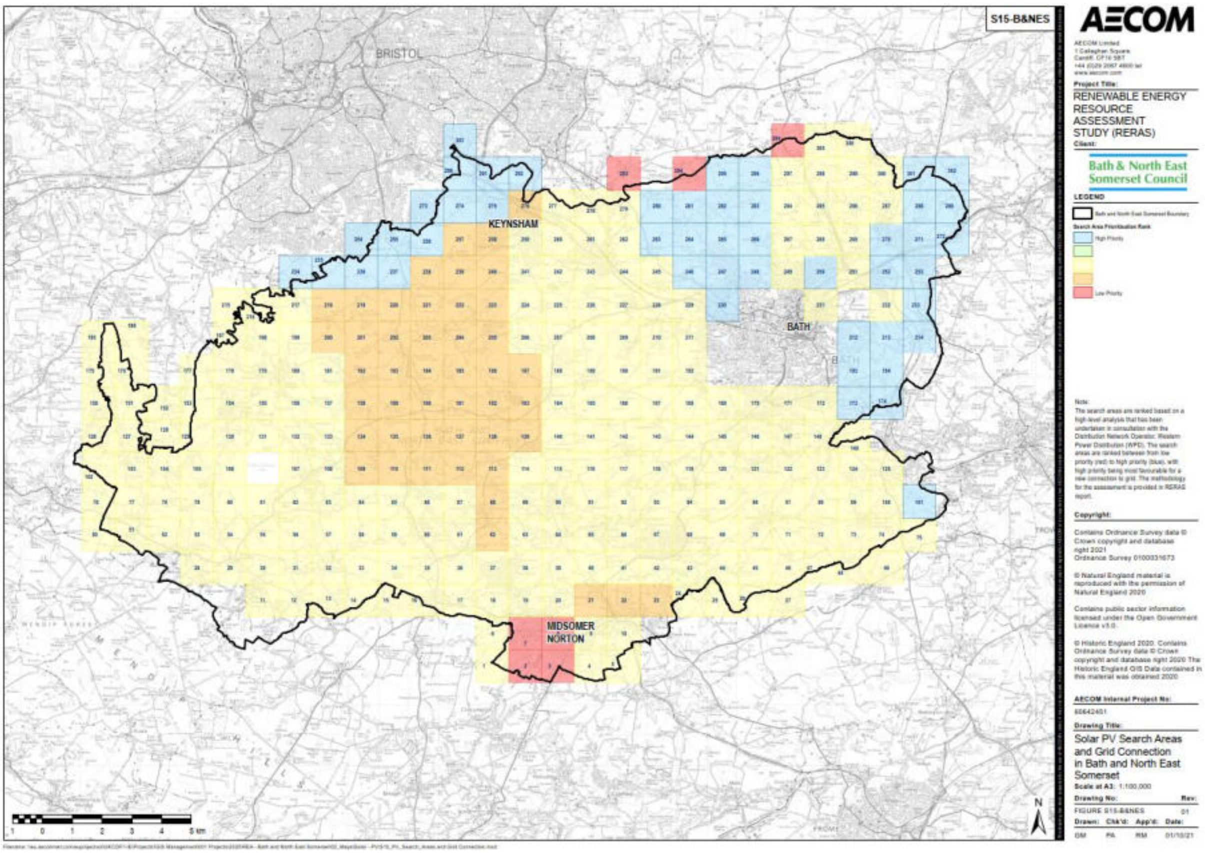


Figure 40: S15-B&NES: Solar PV Search Areas and Grid Connection in Bath and North East Somerset

7. Wind and Solar PV Search Areas and Landscape Sensitivity Assessment

An additional parameter that can be considered in prioritising the Search Areas is Landscape Character Areas and the sensitivity of these landscapes to new wind farm and solar PV farm developments. A flowchart presenting the steps taken in completing mapping the results of a landscape sensitivity for both wind farms and solar PV farms is shown in Figure 41 and Figure 42 respectively.

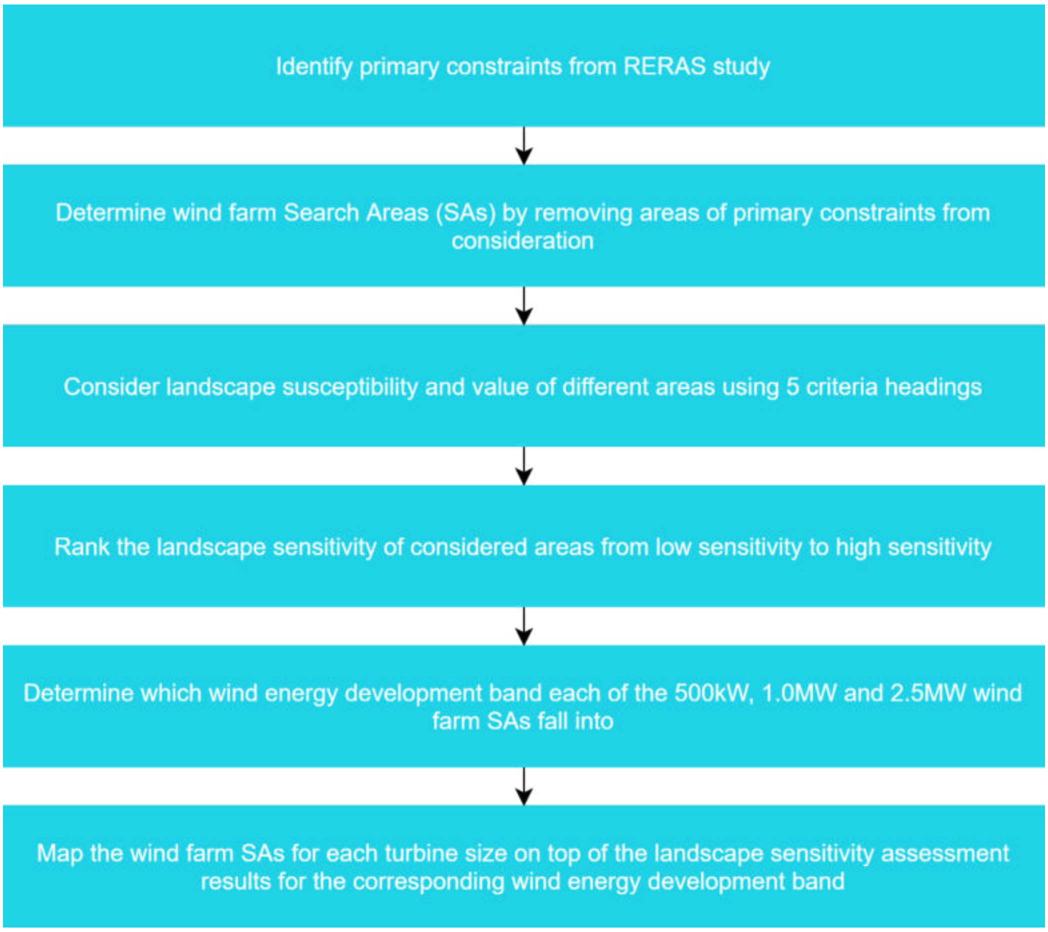


Figure 41 Steps Taken in Landscape Sensitivity Study for Wind Farm Search Areas

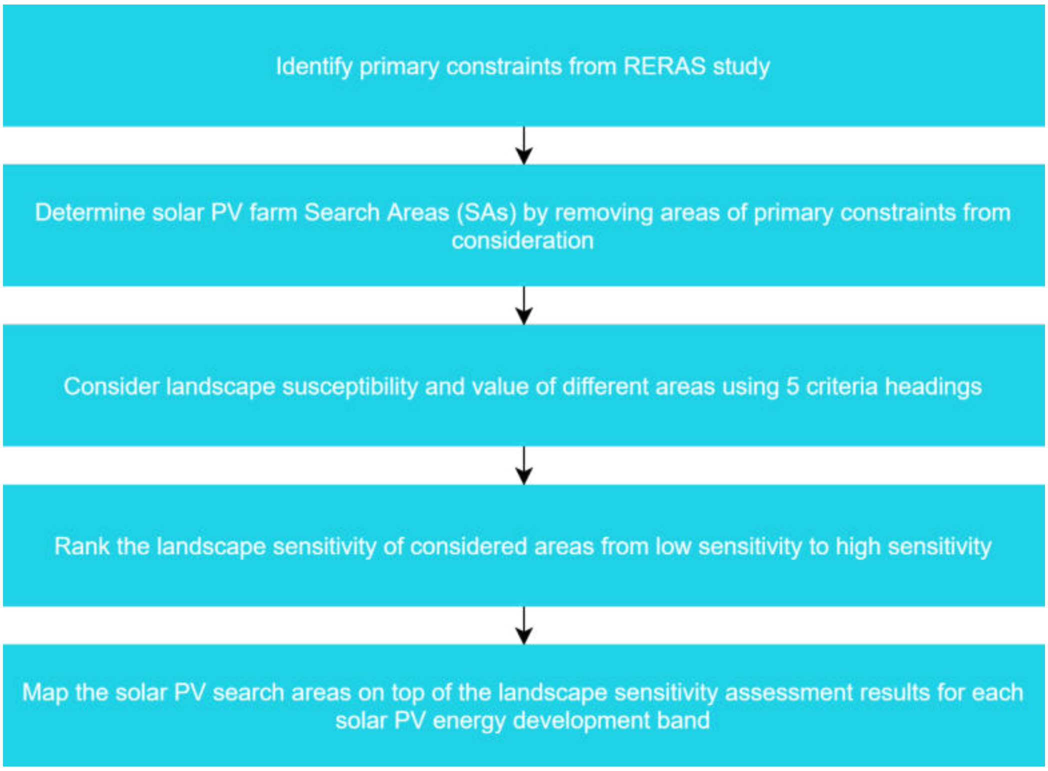


Figure 42 Steps Taken in Landscape Sensitivity Study for Solar PV farm Search Areas

Land Use Consultants (LUC) has conducted a landscape sensitivity assessment for wind and solar PV energy development as part of this RERAS. Results of the assessment provide an initial indication of the relative landscape sensitivity of different areas within B&NES to accommodate wind farm and solar PV farm energy developments. The findings of the study, combined with the identified Search Areas (SAs), are presented in this section of the report. The landscape sensitivity assessment considers the landscape susceptibility[76] and landscape value[77] using 5 criteria headings:

- Landform and scale (including sense of openness / enclosure);
- Landcover (including field and settlement patterns);
- Historic landscape character;
- Visual character (including skylines); and
- Perceptual and scenic qualities.

Once the above criteria were assessed individually, the results were combined to produce an overall sensitivity level, as shown in Table 19.

Table 19: The Five-Point Scale Landscape Sensitivity Scale

Sensitivity Level	Definition
High (H)	Key characteristics and qualities of the landscape are highly vulnerable to change from wind and solar energy development. Such development is likely to result in a significant change in character.
Moderate - High (M-H)	Key characteristics and qualities of the landscape are vulnerable to change from wind and solar energy development. There may be some limited opportunity to accommodate wind turbines/ solar panels without significantly changing landscape character. Great care would be needed in siting and design.
Moderate (M)	Some of the key characteristics and qualities of the landscape are vulnerable to change. Although the landscape may have some ability to absorb wind and solar energy development, it is likely to cause a degree of change in character. Care would be needed in siting and design.
Low - Moderate (L-M)	Fewer of the key characteristics and qualities of the landscape are vulnerable to change. The landscape is likely to be able to accommodate wind and solar energy development with limited change in character. Care is still needed when siting and designing to avoid adversely affecting key characteristics.
Low (L)	Key characteristics and qualities of the landscape are robust in that they can withstand change from the introduction of wind turbines and solar panels. The landscape is likely to be able to accommodate wind and solar energy development without a significant change in character. Care is still needed when siting and designing these developments to ensure best fit with the landscape.

Additionally, the assessment considers the suitability of different turbine heights (to blade tip), based on bandings that reflect those most likely to be put forward by developers (now and in the future). These are set out in Table 20 below.

Table 20: Wind Turbine Development Sizes Considered in the Landscape Sensitivity Assessment

Wind Energy Development Banding	Turbine Height (to blade tip)
Band A	18 – 25m
Band B	26 – 60m
Band C	61– 100m
Band D	101– 120m
Band E	121 – 150m

[76] How vulnerable the landscape is to change from the type being assessed, in this case solar PV and wind energy developments
[77] Consensus about importance, which can be recognised through designation as well as through descriptions within the 2014 Landscape Character Assessment

The assessment also judges the suitability of different scales of solar PV developments based on bandings that reflect those that are most likely to be put forward by developers. The sizes[78] used for the assessment are set out in Table 21.

Table 21: Solar PV Farm Development Sizes Considered in the Landscape Sensitivity Assessment

Solar PV Development Banding	Area
Band A	≤5ha
Band B	6ha – 10ha
Band C	11ha – 15ha
Band D	16ha – 30ha

The complete assessment methodology and results of a landscape sensitivity assessment in included in the accompanying document 'Landscape Sensitivity Assessment Solar PV and Wind Energy Development – Prepared by LUC – 2021'.

W17 and S16 maps show the landscape sensitivity assessment results overlayed on the identified wind farm search and solar PV farm Search Areas respectively. The figures rank the areas considered for the landscape sensitivity study in line with the sensitivity levels shown in Table 19 and provide guidance on the potential effects of different scale wind development on the landscape. Higher resolution versions of these maps including 500kW, 1.0MW and 2.5MW turbine wind SAs and for bands A to D for solar PV SAs are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'. Table 22 and Table 23 below present the results of the landscape sensitively assessment for 1.0MW and 2.5MW wind SAs.

Table 22: Individual Identified 1.0MW Wind SA's in B&NES and Their Landscape Sensitivity Levels

SA Reference on Maps	Sensitivity Level	
1.0MW-1	Moderate - High	High
1.0MW-2	High	
1.0MW-3	High	
1.0MW-4	Moderate - High	High
1.0MW-5	High	
1.0MW-6	High	

Table 23: Individual Identified 2.5MW Wind SA's in B&NES and Their Landscape Sensitivity Levels

SA Reference on Maps	Sensitivity Level
2.5MW-1	High
2.5MW-2	High
2.5MW-3	High

[78] The sizes of solar PV developments indicate the areas taken up by solar PV panels only.

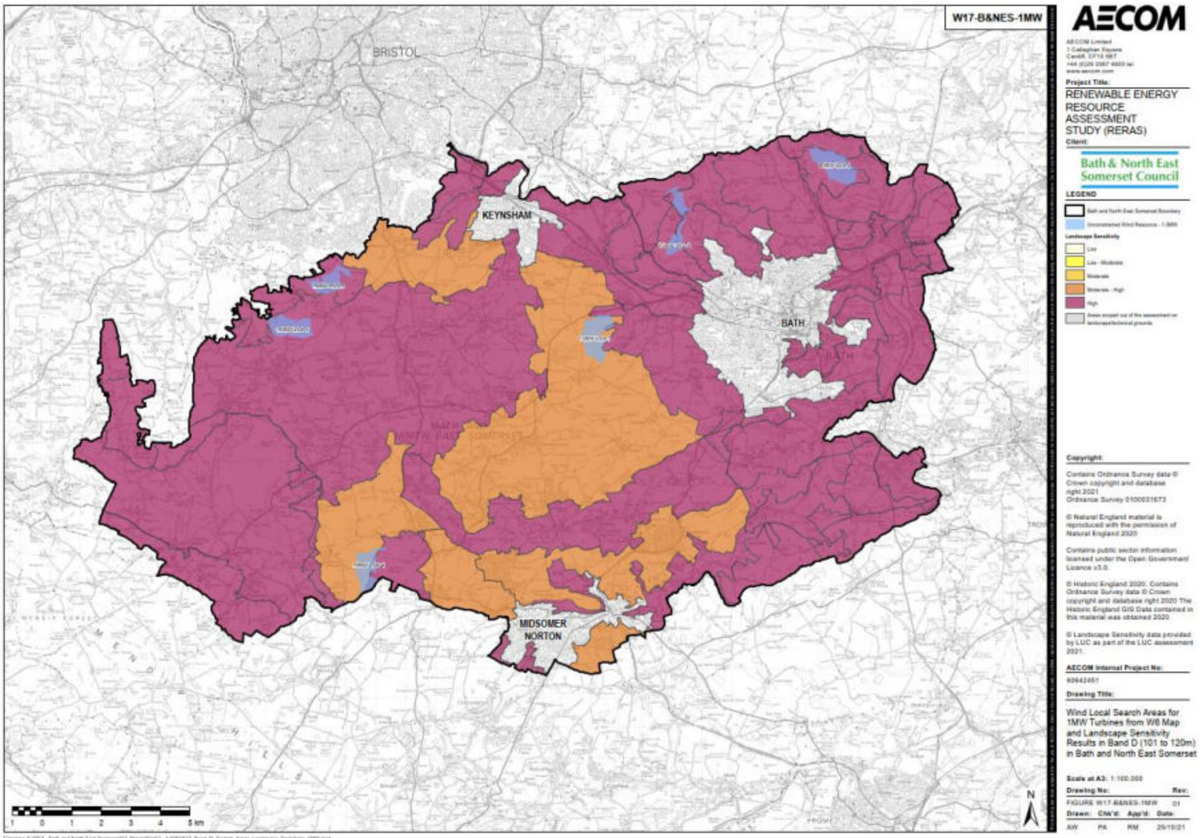


Figure 43: W17-B&NES-1MW: Wind Local Search Areas for 1 MW Wind Turbines from W6 map and Landscape Sensitivity Results in Band D (101m to 120m) in Bath and North East Somerset Map

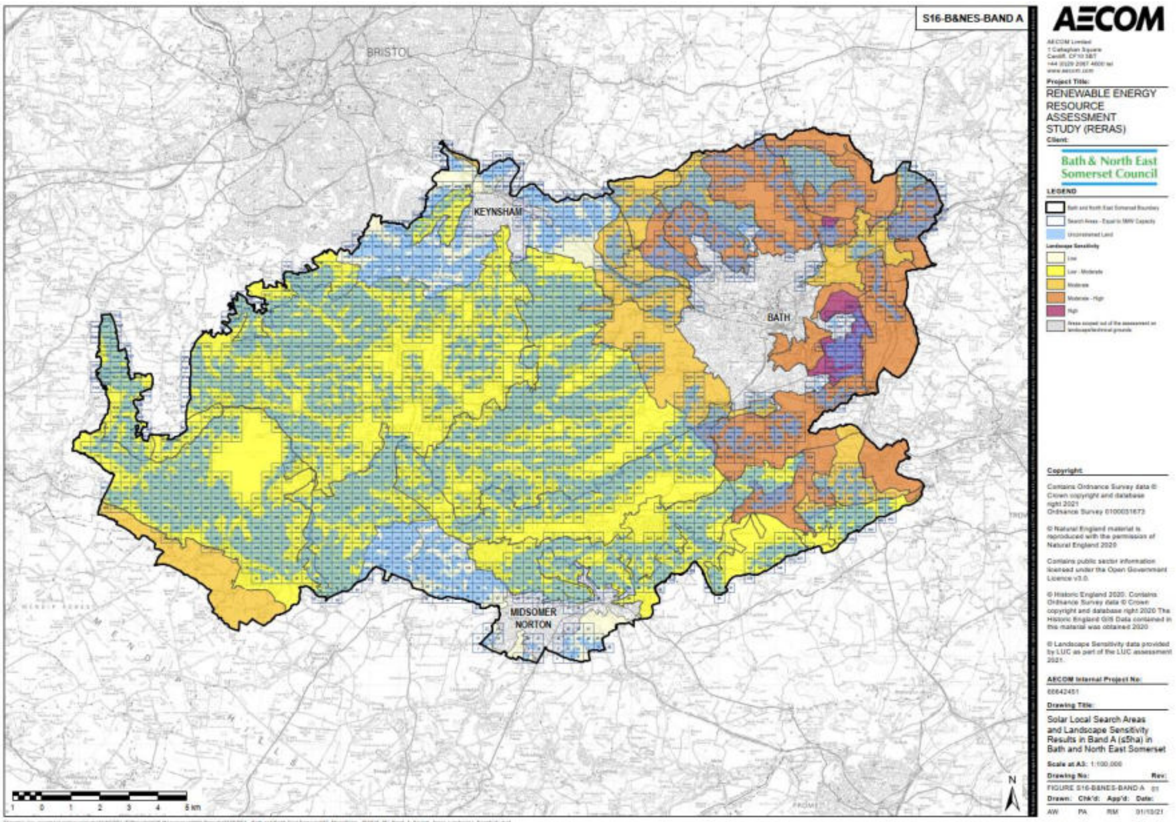


Figure 44: S16-B&NES-Band A: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band A (≤5ha) in Bath and North East Somerset Map

8. Biomass Energy Resource

8.1 Introduction

The focus of this section of the study is on establishing the potential biomass resource defined as either:

- Energy crops (e.g. miscanthus, short-rotation coppice, etc.); or,
- Wood fuel resource.

Biomass is a broad term covering all organic material and can be generally defined as material of recent biological origin, derived from plant or animal matter. This could include materials from plants (for example forestry residues, Miscanthus and short rotation coppice) and animals (for example poultry litter)[79]. Whilst scientific debate continues on this subject, biomass is normally considered a carbon neutral fuel, as the carbon dioxide emitted during burning has been (relatively) recently absorbed from the atmosphere by photosynthesis and no fossil fuel is involved. However, there are carbon emissions associated with the sourcing, processing and transportation of the biomass that should be accounted for.

This section mainly focuses on the type of 'dry' biomass that is more commonly combusted either to generate heat or to produce electricity.

Unlike solar and wind renewable energy sources, biomass fuel is not abundant and free. When comparing costs, wood chips and pellets are becoming progressively more competitive compared to increasing gas prices. However, biomass prices are known to fluctuate due to various market forces.

In relation to biomass, the Biomass in a Low Carbon Economy[80] report by the Climate Change Committee (CCC) states:

> *"Sustainably harvested biomass can play a significant role in meeting long-term climate targets, provided it is prioritised for the most valuable end-uses."*

The report also confirms a significant potential to increase domestic production of sustainable biomass to meet between the equivalent of 5% and 10% of energy demand from UK sources by 2050.

The biomass heating is an established and proven technology; however, it is relatively rare when compared to solar panels and wind farms. The technology can be used to provide heat to buildings of all sizes, either through individual boilers or via district heating networks. Biomass can also be incorporated in a fuel electricity plant or CHP plant due to the low carbon emissions associated with its use[81].

8.1.1 Combined Heat and Power (CHP)

A combined heat and power engine (CHP) is a highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process. By generating heat and power simultaneously, CHP can potentially produce less carbon emissions compared to the separate means of conventional generation via individual boilers in buildings coupled with electricity from centralised power stations[82]. The technology is well established, and there is a wealth of options for different fuel types, and system design. However, it should be noted that due to changing carbon factors, fossil fuelled systems on their own will no longer achieve carbon savings against a gas boiler counterfactual over the plant lifecycle.

The economic viability of the system is normally achieved due to the difference in cost between grid electricity and the CHP fuel source, known as the 'spark spread', and the general principle that operating the CHP system for longer usually provides greater benefits because savings are typically

79 https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
80 https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
81 https://gov.wales/sites/default/files/publications/2018-10/planning-implications-renewable-energy-development.pdf
82 https://www.gov.uk/guidance/combined-heat-and-power DECC, June 2021

achieved for each unit of electricity and useful heat which are generated. There can be a substantial greenhouse gas emission benefit due to the difference in emission factors for delivered energy and the improved energy utilisation. Energy export is also possible, depending on the site energy demand profile.

For the engine to operate safely, the heat it generates must be removed; a CHP system requires a suitable thermal energy demand in order to operate properly. The correct sizing of a CHP system is critical because an over-sized system may not be able to run for long hours if the thermal demand is insufficient, often leading to increased maintenance costs and engine failures.

CHP plants are available in various scales, from micro-CHP domestic applications to large industrial applications and CHP plants serving district heating schemes[83].

Building integrated woodchip-fuelled systems are typically fed automatically by screw-drives from fuel hoppers and incorporate gas firing and automatic de-ashing. Systems are designed to burn without emitting smoke and must meet strict air quality emission limits to comply with the Clean Air Act [84].

It should be noted that the current trend is to move away from centralised electricity plants that do not utilise any of the waste heat. Therefore, any new large plant is likely to be required to have a higher thermal efficiency and linked in with some processes to use heat (e.g. steam, waste treatment, etc).

There is currently a large-scale biomass installation in Bath and North East Somerset. The installation is a 2.0MW CHP at Queen Charlton Quarry, Keynsham[85].

8.1.2 Advantages of Biomass

Unlike wind farms, biomass can be utilised to generate electricity and heat and domestic hot water (DHW). The use of energy crops, forestry residues and recycled wood waste for energy generation can have a number of advantages:

- Provide opportunities for agricultural diversification;
- Encourage increased management of woodland;
- Can have positive effects on biodiversity;
- Remove biodegradable elements from the waste stream;
- Potential CO_2 savings;
- Miscanthus planting increases the soil organic carbon[86].

8.1.3 Key Issues for Biomass

Some of the potential issues of using biomass are as follows:

- Guarantee that there will be a sustainable and quality fuel source once a biomass plant is built;
- Assessing the conflict of land use and virgin feedstocks;
- The extensive time taken for plant stocks to grow;
- The carbon emissions released in the processing and transportation of the biomass fuels and the need for re-planting; and
- The health concerns relating to the emissions of burning biomass.

[83] https://gov.wales/sites/default/files/publications/2018-09/generating-your-own-energy-combined-heat-power.pdf
[84] Clean Air Act 1993 - https://www.legislation.gov.uk/ukpga/1993/11/contents
[85] This is from the REGO database
[86] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5340280/

8.1.3.1 Health Concerns

If strict air quality requirements are not met, there can be concerns about the impact on human health from the resulting emissions. These emissions include particulate matter (PM) and gases such as carbon monoxide (CO), carbon dioxide (CO_2) and nitrogen oxides (NO_x).

Small PM, less than 10 micrometres in diameter, can lead to severe health problems as they can affect both the heart and the lungs. Biomass burning leads to emissions of PM_{10} and $PM_{2.5}$, putting the size of the PM released below the 10-micrometre diameter. NO_x emissions also impose health issues, including breathing problems, headaches and reduced lung function[87].

8.1.3.2 Future Direction of Biomass

As biomass in a finite supply, it is crucial to prioritise optimum use of biomass. The Climate Change Committee report 'Biomass in a Low-Carbon Economy'[88] states that harvested biomass should be used to sequester atmospheric carbon whilst simultaneously providing a useful energy service. This means that the use of biomass for heating buildings or using biomass for generating power without carbon capture and storage should be phased out.

These concerns may mean that the use of biomass is only considered in limited circumstances.

8.2 Energy Crops

8.2.1 Mapping

The potential energy crop resource in B&NES was determined by, utilising GIS maps, overlaying potential primary constraints onto the areas identified as having potential for growing such crops. The constraints were identified in consultation with B&NES Council and are provided in detail in Appendix M. In order to avoid competition between land uses (i.e. food crops, livestock grazing, energy crops, etc), Agricultural Land Classification (ALC) land grades 1, 2 and 3 are constrained out and not considered further. Therefore, this study assumed that energy crops could only be grown on agricultural land of Grade 4[89,90] which is not constrained by environmental or historical protected areas. Maps have been produced to illustrate each stage of the process of identifying primary constraints and also maps that identify the extent of the area of land with potential opportunities. The flowchart shown in Figure 45 shows the process steps and the output maps at each stage of the mapping. These maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

For an in-depth, step-by-step explanation of the mapping process, please see Appendix M.

[87] https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1708081027_170807_AQEG_Biomass_report.pdf
[88] Climate Change Committee, 'Biomass in a Low-Carbon Economy, 2018; https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
[89] Poor quality agricultural land. Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.
[90] The Bioeconomy Consultants (2012), Domestic Energy Crops; Potential and Constraints Review, A report for DECC, URN: 12D/081; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48342/5138-domestic-energy-crops-potential-and-constraints-r.PDF

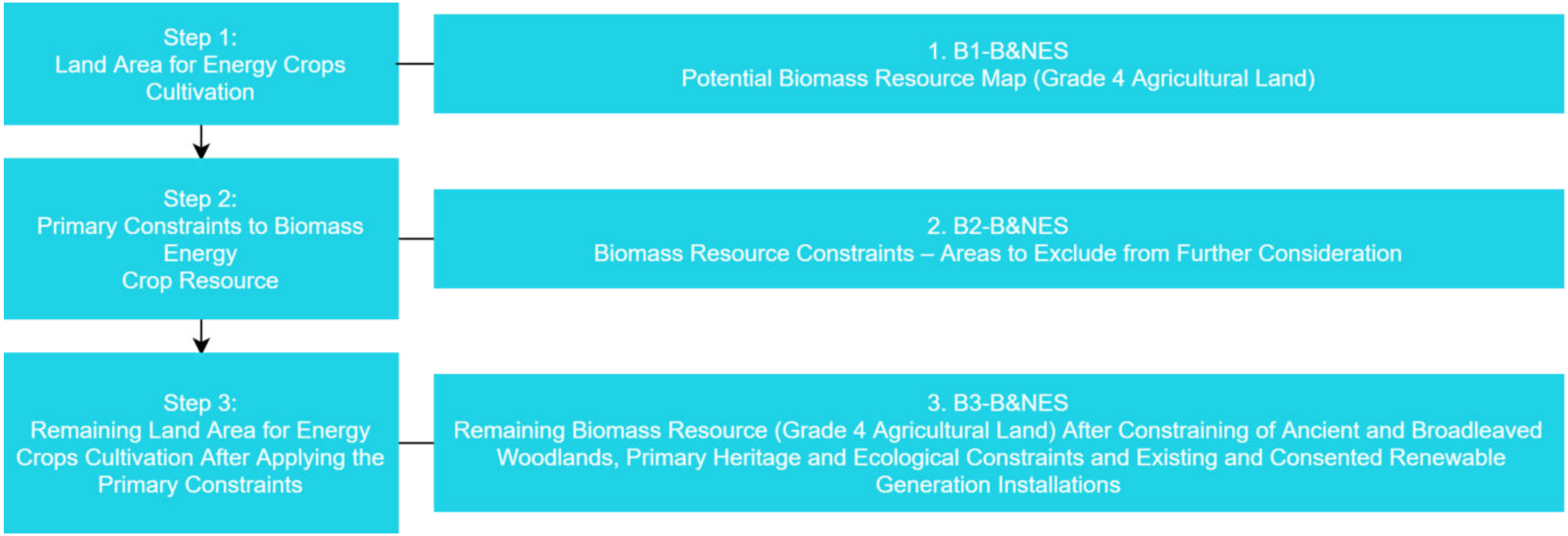


Figure 45: Flowchart of Energy Crop Mapping Process

8.2.1.1 Primary Constraints

- Areas of broadleaved woodland;
- Areas of environmental protection (including ancient woodlands);
- Areas of historical and cultural importance; and
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind).

B2 map illustrates these primary constraints that are associated with restrictions to harvesting energy crops. A comprehensive table of the constraints is provided at Appendix N. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

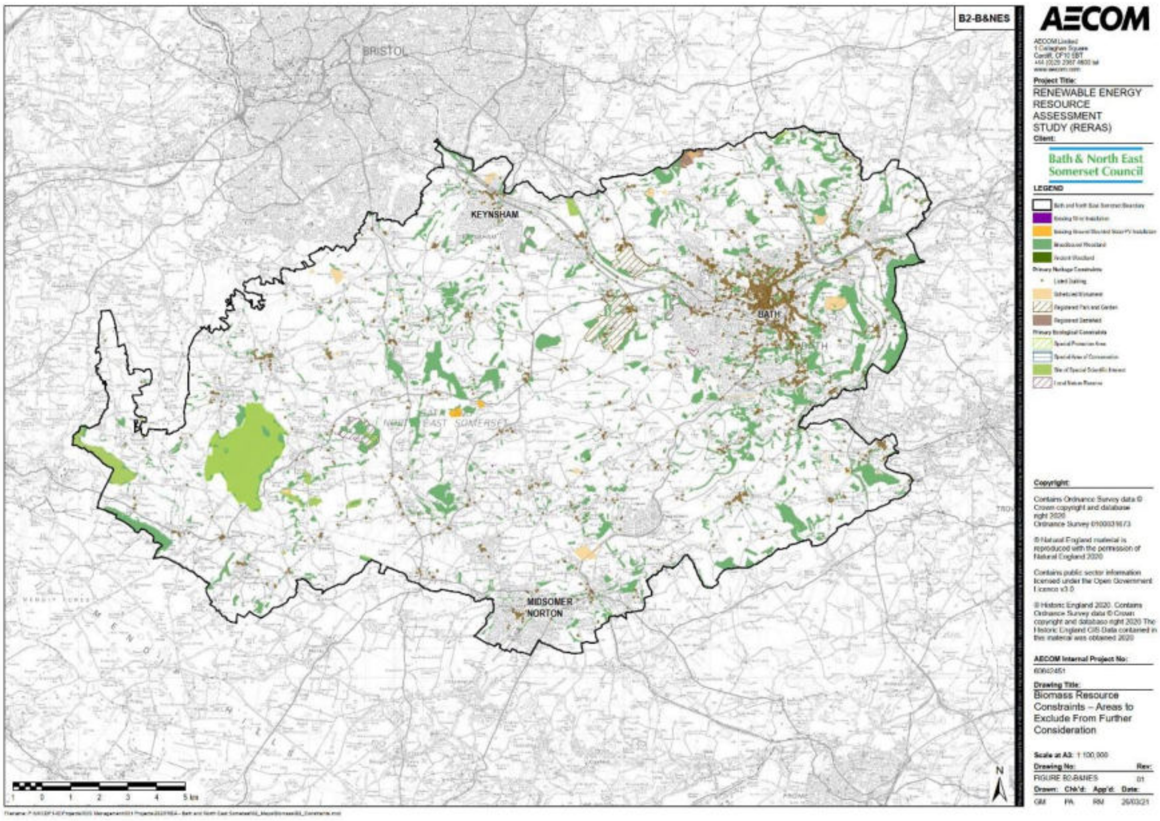


Figure 46: B2-B&NES: Biomass Resource Primary Constraints – Areas to Exclude from Further Consideration Map

8.2.1.2 Identification of Biomass Resource

The remaining available land for energy crop cultivation after removing the constrained areas is shown below in Figure 47, showing a theoretical maximum area of land that could be planted with energy crops as 38.67km^2.

Policy Recommendation

Policy Reference: BM-PR-1 (Refer to Table 45 in Section 17)

It is recommended that proposals utilising biomass are looked upon favourably where:

a. a whole life carbon benefit can be evidenced; and
b. the development should be located away from urban areas (and preferably in areas off the gas grid).

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

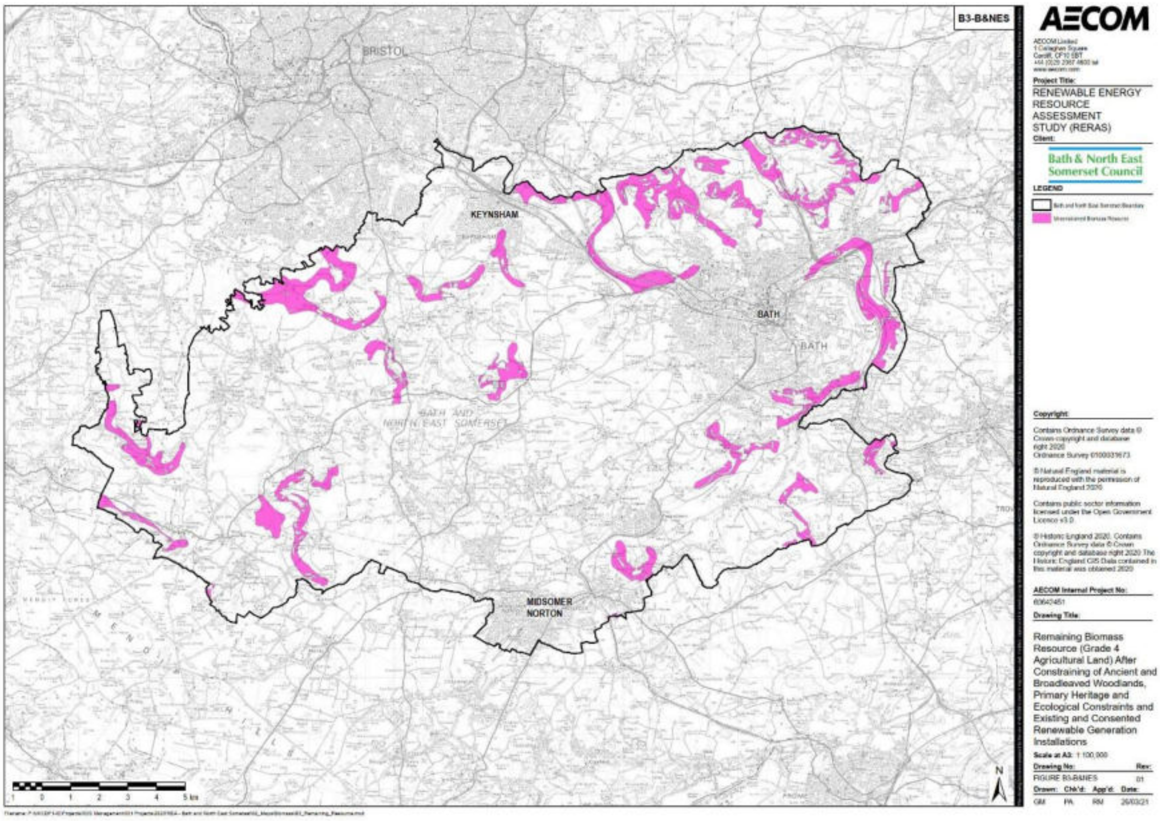


Figure 47: B3-B&NES: Remaining Biomass Resource (Grade 4 Agricultural Land) After Constraining of Ancient and Broadleaved Woodlands, Primary Heritage and Ecological Constraints and Existing and Consented Renewable Generation Installations Map

Competition with other crops, existing areas of energy crop cultivation, livestock grazing, solar PV farms, and unsuitable topography provide limitations on where energy crops can be planted.

It is assumed that only 10% of the suitable land area identified for energy crops could actually be planted with energy crops. This reflects a range of factors, including competition with other crops, existing areas of energy crops cultivation, livestock grazing, solar PV farms, and unsuitable topography.

It was assumed that only 10% of the suitable land area identified for energy crops could actually be planted with energy crops

Therefore, the total usable area of land for energy crops across Bath and North East Somerset is 2.98 km^2

8.2.2 Installed Power and Heat Generation Capacity

Forest Research[91] gives a figure of 7 to 12 oven-dry tonnes/ha/annum yield for short rotation coppice and 12 to 14 oven-dry tonnes (odt)/ha/annum yield for miscanthus. However, in reality, the actual yield will vary within a range, depending on a number of factors such as land grade, crop species, soil types, how many years a particular crop has been established at a site, and so on. Therefore, an average figure of 11 odt per hectare for energy crop yield was assumed in potential installed capacity calculations.

The amount of energy that could potentially be produced from biomass will depend on whether the fuel is burnt in boilers that only generate heat or combusted in Combined Heat and Power units (where the heat is used).

For the purposes of this assessment, it was assumed that the energy crop resource is used to fuel a biomass CHP system to produce electricity and heat[92]. A biomass CHP system can be used to supply small off-grid heat networks, or it could be combined with a small green hydrogen demonstrator where the electricity is to be used to generate hydrogen for transport fuel and/or for use in an industrial setting. Carbon capture, utilisation, and storage (CCUS) may need to be considered for such a hydrogen-related project.

A typical biomass CHP system will require about 6,000odt (oven-dry tonnes) of energy crops for each 1MWe of installed power generation capacity

The biomass CHP system will also simultaneously produce about 2MWt

The total potential installed capacity from energy crops across Bath and North East Somerset is 0.55MWe and 1.09MWt

Table 24 below confirms the maximum potential energy crop resource in B&NES.

Table 24: Total Potential Energy Crop Resource in Bath and North East Somerset

Energy Crop Resource	
Total Available Area (km^2)	29.82
Usable Area (km^2)	2.98
Yield (odt per km^2)	1,100
Yield (odt)	3,280
Required Yield per MWt	6.000
Potential Installed Capacity (MWe)	**0.55**
Heat to Power Ratio	2:1
Potential Installed Capacity (MWt)	**1.09**

There is a potential installed capacity across B&NES of 0.55MWe and 1.09MWt, which, for comparison, the energy generation potential is equal to supplying energy to 47 primary schools annually[79].

8.3 Wood Fuel

Wood fuel can be harvested from the small round wood stems, tips and branches of felled timber trees and thinning and poor-quality round wood.[94]

For the purposes of this assessment, it was assumed that the energy resource from wood fuel is utilised for SH or DHW or both (i.e. a biomass boiler[95]). For the detailed calculation of the wood fuel

[91] https://www.forestresearch.gov.uk/tools-and-resources/biomass-energy-resources/fuel/energy-crops/
[92] This is an average figure to cover a range of different technology types, and sizes, with different efficiencies. For example, a smaller scale facility (about 2MWe) using a steam turbine with an efficiency of about 20%, might require up to 8,000 oven dry tonnes/annum. However, a larger facility (5-10MWe), using gasification, with an efficiency of up to 30%, might require about 5,000 oven dry tonnes per annum.
[93] DEC database is used to calculate average annual heat demand in a typical primary school.
[94] National forest is all wood land within the National Forestry Inventory. i.e. All woodland 0.5 hectares and over; https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/about-the-nfi/
[95] Assuming a boiler efficiency of 80% and a capacity factor of 0.3.

resource, please see Appendix M. Table 25 below confirms the maximum potential wood fuel biomass resource in B&NES. It has been assumed that a biomass boiler may be used to displace coal or oil without necessitating structural, fabric and services changes in buildings, this could be relevant to the buildings in off gas areas in B&NES.

Table 25: Total Potential Energy Resource from Wood Fuel in Bath and North East Somerset

	Wood Fuel Resource
Available Area (km^2)	35.28
Yield (odt per km^2)	200
Yield (odt)	7,056
Required Yield per MWt	660
Potential Installed Capacity (MWt) [96]	**10.7**

There is a maximum potential installed capacity across B&NES of 10.7MWt, equivalent to supplying energy to 153 typical primary schools annually[96].

It should be noted this is the maximum potential resource (yield) which in reality will be reduced further by other constraints such as local demand, economic viability and other use of the wood. Some of the constraints are discussed in the following section.

8.4 Further Constraints to Biomass Energy Resource

Where areas of land have been indicated as having potential for the growing of energy crops, further detailed studies are required prior to action. Furthermore, market demand is likely to play a vital role in what type of crop is grown, the location and quantity.

Even where there is a local demand for a biomass supply, constraints (not considered within this RERAS) can persist, including the proximity of supply to the plant and practical access to sites required to prepare and deliver fuel.

Further constraints to biomass that are not considered within this RERAS include (but are not necessarily restricted to:

- Landowner willingness;
- National planning policies, which is outside of the Council's control; and
- The time involved in the planning process.

Biomass is most usually utilised in CHP for industrial purposes (typically situated away from residential development) or for heating non-domestic buildings, particularly in non-urban off-gas areas where there are less likely to be Air Quality issues and sufficient room for fuel storage and access for delivery vehicles.

8.5 Potential Opportunities for Future Development

The potential available biomass resource within B&NES amounts to 0.55MWe and 11.79MWt which equates to 41.29GWht annually. This resource can be used to meet part of the heating demand in B&NES via renewables, including for use in individual boilers, via district heating networks or incorporated in a fuel electricity plant or CHP plant It should be noted that the projected biomass use in B&NES (in Section 14 of this report) is less than the resource identified above. The amount of generation set out in future sections relates to the 2030 target and aligns with projected demand (including the assumption that all biomass is sourced locally)..

[96] DEC database is used to calculate average annual heat demand in a typical primary school.

Due to the finite supply of biomass, it is essential to ensure that the resource is used to its biggest advantage. A recent report from the Climate Change Committee[97] (CCC) states that biomass should only be used to sequester atmospheric carbon whilst simultaneously providing useful energy; this could include future opportunities for bioenergy with carbon capture and storage, which can provide a useful method for offsetting residual greenhouse gas emissions. Biomass should also only be considered in situations where there are few alternatives.

Alongside concerns relating to the finite supply of biomass resource, there are also health concerns associated with the emissions released as part of the process of burning biomass. The above concerns should not deter the Council from maximising the use of the available biomass resource; however, consideration must be taken to ensure the most appropriate way of exploiting this resource is determined. Because of the flexibility of biomass fuel, it is suggested that a bespoke, independent and thorough investigation is conducted into any proposals received in respect of biomass projects, to ensure environmental benefit is secured.

Given the cost of CCUS projects, it may be that such projects are limited in the B&NES area. However, other projects potentially involving industrial manufacture/process, green hydrogen demonstration and production of biofuels may well be environmentally beneficial, particularly in off-gas grid areas where coal or oil is being displaced and where the biomass source is local and from sustainably managed sources.

In relation to biomass energy generation, potential opportunities for B&NES Council are:

- Investment interest of Energy Services Companies (ESCOs) may be secured through the identification of appropriate sites and heat demand; and
- Biomass fed renewable installations can provide significant revenue streams to the Council, including the Renewable Heat Incentive.

[97] Climate Change Committee, 'Biomass in a Low-Carbon Economy, 2018; https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf

9. Energy from Waste

9.1 Introduction

The Waste Management Plan for England[98] sets out the Government's ambitions to work towards a more sustainable and efficient approach to resource use and waste management. The plan states that all waste management plans must include measures so that, by 2035:

- Re-use and the recycling of municipal waste is increased to a minimum of 65% by weight.
- The amount of municipal waste landfilled is reduced by 10% or less of the total amount of municipal waste generated (by weight).

The West of England Joint Waste Core Strategy[99] (JWCS) sets out the strategic spatial planning policy to provide waste management infrastructure across the planning area. The plan aims to reduce waste taken to landfill minimising waste production, increasing recycling and composting, then recovering further value from any remaining waste.

The JWCS highlights that, although material recovery takes priority, energy recovery has a beneficial role to play in both sustainable waste management and as a low carbon energy source from an Energy from Waste (EfW) plant.

Part of the pathway to achieving these waste aims, includes using Energy Recovery Facilities (ERFs) for non-recyclable waste. The West of England Partnership (South Gloucestershire, North Somerset, Bath and North East Somerset and Bristol City) uses two ERFs to incinerate waste and produce energy for the National Grid.

This section determines the amount of potential electricity and heat generation available from the following waste streams in 2030:

Municipal Solid Waste (MSW)	• The 2030 MSW figure was determined by the council's waste prediction model and aligned with the 70% recycling rate target. • It was assumed that the MSW would be used as fuel in a Combined Heat and Power (CHP) facility to produce energy and heat.
Commercial and Industrial Waste (C&I)	• The 2030 C&I waste figure was determined using the 2019 figure from the Waste Data Interrogator (WDI), the "Sustainability Turn" scenario of the DEFRA "Scenario-Building for Future Waste Policy" report and aligned with the 70% recycling rate target. • It was assumed that the C&I would be utilised as a fuel in a Combined Heat and Power (CHP) facility to produce energy and heat.
Food Waste	• The 2030 food waste figure was determined by using the 2019 DEFRA value, assuming that the waste breakdown will remain constant and will increase at the same rate as the MSW between 2019 and 2030. • Food waste can be anaerobically digested to produce a suitable gas for combustion and, if the plant is suitably enabled, generate both electricity and heat.
Agricultural Waste - Animal Manure	• The 2030 animal manure figure was determined using the assumption that the farming mix will not change significantly in B&NES, and therefore the latest livestock statistics can be used. • Animal manure can be treated by anaerobic digestion and utilised in a CHP plant to generate both electricity and heat.

[98] Waste Management Plan for England, DEFRA, 2021; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955897/waste-management-plan-for-england-2021.pdf
[99] West of England Joint Waste Core Strategy, WEP, March 2011; https://www.westofengland.org/waste-planning/adopted-joint-waste-core-strategy

Agricultural Waste - Poultry Litter	• The 2030 poultry litter figure was determined using the assumption that the farming mix will not change significantly in B&NES, and therefore, the latest statistics for the number of poultry can be used. • A bespoke CHP facility would be required to facilitate the use of the poultry litter.
Sewage Sludge	• The 2030 sewage sludge figure was determined by the tonnes of sewage produced per person per year and the predicted 2030 population of B&NES • A CHP enabled anaerobic digestion plant would be suitable for utilising sewage sludge to produce both electricity and heat.

9.1.1 Anaerobic Digestion

Anaerobic Digestion (AD) can be defined as:

> *"a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is used for industrial or domestic purposes to manage waste and/or to release energy. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion[86]"*

The AD process produces a gas (biogas) with a high methane content. This methane can be captured and burned to produce heat and/or electricity and utilised as a transport fuel. The material that is left after AD occurs is called "digestate", a nitrogen-rich mixture that can be used as fertiliser for crops. AD plants utilise heat for their own process (parasitic load); therefore, some of the biogas can be used on-site to maintain the temperature of the digester.

Sewage sludge, farm slurry, and some Municipal Solid Waste (MSW) elements could be used as feedstock for an AD plant to generate gas and/ heat and electricity if CHP enabled.

AD can be incorporated in a farm-based integrated waste management system, but larger-scale centralised anaerobic digesters also exist, which use feedstocks imported from different sources. The larger schemes usually have a better return on investment and shorter payback times which justifies the initial capital cost required for the system. AD systems often require bulk inputs to be economically viable, but this can be challenging when sourcing material from dispersed (rural) locations. Once built, ADs are often linked to on-farm processes, energy supply, and the grid. Figure 48, shows an example of an AD plant configured to produce energy and bio-fertiliser from biowaste feedstock.

[100] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284612/pb14130-energy-waste-201402.pdf

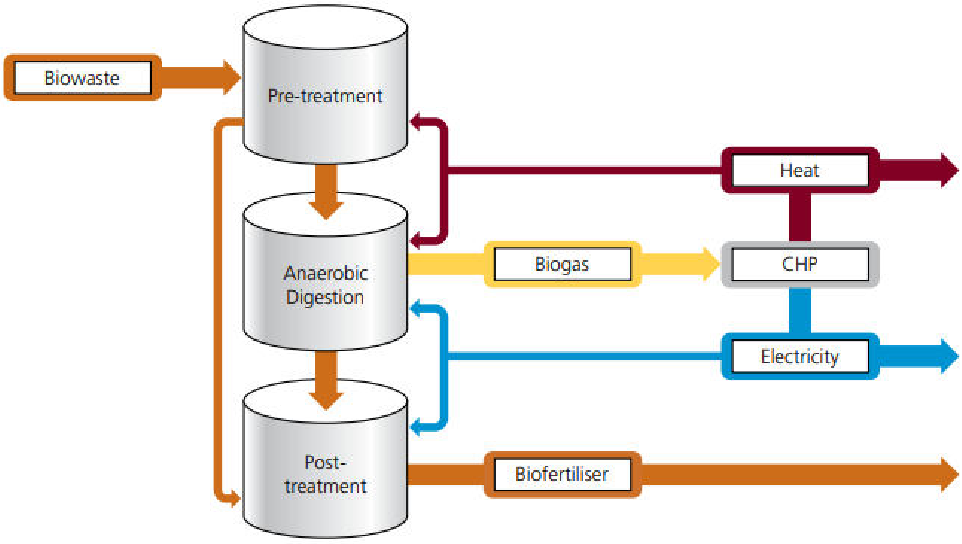


Figure 48: Example of an Anaerobic Digestion (AD) System from Feedstock to Final Use[101]

9.1.2 Incineration (Energy from Waste)

Incineration can be defined as controlled thermal treatment of waste by burning. Energy recovered from waste through this method can be used in the following ways:

1. Generation of Power (electricity),
2. Generation of Heat,
3. Generation of Heat and Power (this is referred to as CHP)[102].

However, EfW is almost always from a bespoke plant that produces both power and heat. The system could generate heat from sources including waste wood, municipal waste and industrial and commercial waste. However, the selection of energy generation option is dictated by end-user requirements and their utilisation of the heat and/or power.
Option three above includes a CHP for simultaneous generation of heat and power. The power can be consumed on-site or exported and sold to the national grid. Local heat demand and a dedicated heat network is required for the generated heat unless all the available heat can be used in the generating facility. For more information on CHP, see Section 8.1.1.
If waste (used as the fuel) includes materials that are not capable of degradation by plants and animals, the fraction of heat output generated due to incineration of these wastes is considered low carbon. It should be noted that this fraction of waste could include plastics, which may impact the low carbon status of the heat generated.

Any new centralised electricity plant is likely to be required to have higher thermal efficiency and linked in with some process to use heat (e.g. steam, waste treatment, etc.).
There are issues linked with incineration, including:

- Greater focus on circularity will mean a diminishing resource;
- EfW plants must comply with strict emissions requirements;

9.1.3 Landfill Gas

Landfill Gas is the methane-rich gas released from biodegradable waste as it decomposes. Landfill gas can be captured through vertical pipes drilled into a capped site.

[101] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69400/anaerobic-digestion-strat-action-plan.pdf
[102] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf

Landfill Gas can be to generate electricity that can be exported to the electricity grid.

A detailed analysis of each waste stream can be found in Appendix O.

9.2 Waste Summary

A summary of the potential energy generation from the waste resource in B&NES is provided below. There are a number of key considerations which would impact whether the resource can be exploited:

- Viability of any investment in a plant;
- Existing arrangements and contracts;
- Origin and price/gate fees of the resource.

High level consideration is given to the likelihood of the resource being exploited.

Although there is available MSW resource in the area, Waste is taken to facilities in Ashton Gate, Bristol where it is segregated into constituent materials and sent for onward processing. Waste unsuitable for EfW is landfilled in sites outside B&NES.

Given that there is already recovery of landfill gas as well as AD plant utilising sewage and other resources, it is assumed that all economic opportunities have already been exploited and there is no further potential for generation from these resources in B&NES in 2030.When considering all of the above, the final potential for renewable energy from the waste resource is shown in Table 26 below.

Table 26: Summary of Energy from Waste

	Prior to Consideration of Likelihood of Utilisation for RE Generation			Reason for Adjustment / Change of Technology	Post Consideration of Likelihood of Utilisation for RE Generation 2030		
		2030					
Resource	Technology	MWe	MWt		Technology	MWe	MWt
C&I Waste	EfW with CHP	0.52	1.05	Currently the residual waste that is sent for landfill or incineration is exported to facilities outside B&NES. Therefore, counted as existing generation elsewhere.	None	-	-
MSW	EfW with CHP	1.26	2.53	Currently, the waste is exported to EfW and landfill sites outside the B&NES. It has been assumed that the existing arrangement are likely to be in place until the end of 2030 therefore the resource is counted as generation elsewhere.	None	-	-
Food Waste	AD with CHP	0.41	0.62	Food waste from B&NES is currently exported out of the Council area. Assuming the arrangement stays in place until 2030, the resource is counted as existing generation elsewhere	None	-	-
Animal Slurry	AD with CHP	0.47	0.698	RHI database confirms 2.45MW of installed capacity. It is assumed that all economic opportunities have already been exploited	None		
Poultry Litter	Bespoke plant with CHP	0.95	1.90	Not likely to be enough resource for bespoke plant. A bespoke CHP plant would need to be used to facilitate the poultry litter resource. However, in practice, as the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant.	None	-	-
Sewage Sludge	AD with CHP	0.38	0.57	There is a 0.63MWe installed capacity, it is assumed that all economic opportunities have already been exploited	None		
Landfill Gas	Landfill gas recovery engine			There is a 1.60MWe installed capacity, it is assumed that all economic opportunities have already been exploited.	None		
Potential installed capacity		3.99	8.69			0	0

10. Hydropower Energy Resource

10.1 Introduction

Hydropower is the energy derived from flowing water. This can be from rivers or built installations, where water flows from a high-level reservoir down through a tunnel and away from a dam[103]. Water drives a turbine connected to an electrical generator, with the energy generated proportional to the volume of water and vertical drop or head. It should be noted the only generation of electricity from inland (non-coastal) water courses are considered in this section.

The technology is well-established, and most large-scale resources are exploited in the UK. However, the potential exists for small scale 'run of river' schemes (where no water storage is required). These are relatively small systems, with some flexibility in sitting along a length of river or stream.

"Run-of-river schemes use the natural flow of a river, where a weir can enhance the continuity of the flow. Both storage and run-of-river schemes can be diversion schemes, where water is channelled from a river, lake or dammed reservoir to a remote powerhouse containing the turbine and generator." [90]

Large hydropower generation schemes are usually connected to the electricity grid due to the larger loads and the absence of a demand in the immediate vicinity. However, small micro schemes could be linked to buildings and/or processes (signals/lights, etc.).

Figure 49 shows a run-of-river hydropower scheme.

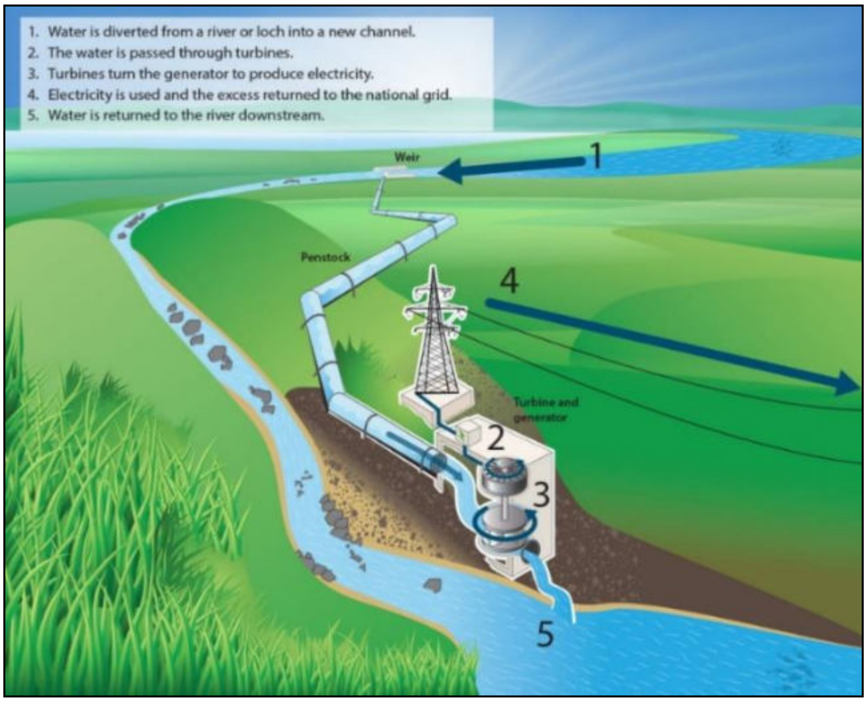


Figure 49: A Run-of-River Hydropower Scheme[105]

[103] https://www.gov.uk/guidance/harnessing-hydroelectric-power
[104] Run-of-river schemes https://www.gov.uk/guidance/harnessing-hydroelectric-power
[105] https://www.sepa.org.uk/media/148411/run_of_river_hydropower_scheme.jpg

Existing hydropower generations across B&NES have a combined installed electrical capacity of 0.162MWe.

The Environment Agency published a high level national desk based study[106] into the potential for small scale hydro power generation across England and Wales in 2010, which was updated in September 2020[107]. Table 27 below confirms the total potential hydropower capacity including a breakdown of the potential hydropower sites' sensitivity to exploitation in the B&NES area. Where the sensitivity categories of a potential sites were not given, the worst-case scenario was assumed, and it was assigned to have high environmental sensitivities.

For a list of potential hydro sites from the Environment Agency study, see Appendix S.

10.2 Hydropower Potential

Based on AECOM's previous studies investigating evidence in support of renewable energy potential on behalf of other local authorities, it was found that there was more generation occurring than could have been delivered by low and medium combined. Hence, it is an assumption that even where sites have a 'high' sensitivity rating, this does not necessarily preclude the development of such sites for power generation, presumably with environmental mitigation. It is therefore proposed that that the potential hydropower resource across B&NES could comprise those sites of medium sensitivity and 25% of the high sensitivity sites[108].

There is a potential hydropower installation of 1.49MWe in total without considering potential uptake, deliverability, and existing schemes

Table 27: Potential Hydropower Capacity in B&NES According to Environmental Sensitivity

Environmental Sensitivity	Installed Capacity (MWe)
Low	0.00
Medium	0.28
High	4.83
Total	**5.11**
Proportion High Sensitivity Included	25%
Potential Hydro Power Resource	**1.49**

Moreover, within the study published by the Environmental Agency, some of the sites were highlighted as win-win sites[109]. This information is shown in Table 28.

Table 28: Proportion of Potential Sites in B&NES Outlined as Win-Win Sites

Win-Win Sites	
River Obstruction Sites	126
Win-Win Sites	9
Percentage Win-Win Sites	7.14%

When considering all hydropotential areas, the most significant potential for hydro is Twerton Sluice – a non-designated artificial weir with an unconstrained potential power of 0.56MWe. Twerton Sluice however is of high environmental sensitivity and therefore a potential installed capacity of 0.14MWe is assumed. When considering cHMWBs, Weston Lock offers the most hydropotential with a potential

[106] Mapping Hydropower Opportunities and Sensitivities in England and Wales: Technical Report, Entec UK on behalf of Environment Agency (2010) – note, this was a high level, desk-based study and is therefore likely to have a margin of error when compared with the exact resource.
[107] Potential Sites of Hydropower Opportunity, Environment Agency, revised 2020; https://data.gov.uk/dataset/cda61957-f48b-4b75-b855-a18060302ed1/potential-sites-of-hydropower-opportunity
[108] Sites with high environmental sensitivity will be less desirable that those with medium or low sensitivities due to their environmental impact. The sites are highly sensitive, mainly due to the presence of migratory fish species such as salmon and eel. However, they become more environmentally compatible opportunities when a new scheme has a fish pass built on it. Based on this and AECOM's experience, it is deemed that 25% of the high sensitivity sites should be considered when determining potential hydropower installed capacity because there could be lower uptake of the sites due to higher cost of additional environmental mitigations as well required permits.
[109] The Environmental Agency's judgement on whether the site is a potential "win-win" for both hydropower and the environment.

capacity of 0.37MWe. As Weston Lock is part of the same lock system as Twerton Sluice, it is also high environmental sensitivity and therefore a potential installed capacity of only 0.09MWe is assumed.

10.3 Summary

There are potential opportunities for hydropower in B&NES; this includes 11 sites with a hydropotential capacity exceeding 100kW, prior to apportioning capacity based on environmental sensitivity. The most significant area of potential for hydro in B&NES is the Twerton Sluice. There are a number of areas with small potential for additional hydro power generation within B&NES although a significant number of the potential sites lie within areas of high sensitivity. Therefore, of all of the Win-Win sites, all of sites with low and medium sensitivity and 25% of the sites with high sensitivity are assumed to be an accessible hydropower resource in B&NES, this amounts to 0.403MWe.

Table 29: Win-Win Site Installed Capacity in B&NES

Environmental Sensitivity	Installed Capacity (MWe)
Low	0.00
Medium	0.0381
High	1.459
Total	1.497
Proportion High Sensitivity Included	25%
Potential Hydro Power Resource	0.403

It should be noted that, in addition to the environmental sensitivity of the hydropower sites, there are other constraints that need to be considered, for example, land ownership or ecological mitigation requirements.

11. Role of Storage in the Network

11.1 Introduction

As part of the RERAS, analysis undertaken of the role of storage in the network has been conducted by Regen[110]. This section sets out the key findings of this analysis.

> Electricity storage has a vital role to play in enabling a zero-carbon electricity system and facilitating the UK's transition to net zero. Electricity can be stored using several technologies, and then exported to provide various services to the electricity system.

Reserve (reserves, time shifting, back-up supply)

The fundamental use for storage is storing electricity for use at a later time. As renewable output varies according to weather conditions, storage provides reserves for use when demand is high, when supply is low, or at other times of system stress.

For individual customers, storage can provide the ability to 'time shift' energy or to provide back-up supply behind-the-meter when an existing network connection is lost or interrupted. This could be for a variety of reasons but is most often to take advantage of market price fluctuations and avoid peak electricity network charges.

Frequency Control (system inertia, frequency response)

As the amount of renewable generation on the system increases, the variability of the system's frequency also increases. An optimal frequency range is needed to maintain the grid's stability - an imbalance between demand and generation will affect frequency. Most renewable generation does not currently provide the required inertia. Overall, system inertia decreases, and as a result, the frequency can change very quickly and cause instability in the system.

Storage can help address this issue in two ways: by providing inertia, either real or synthetic, or through frequency response. Storage, particularly battery storage, can respond in milliseconds, helping the system deal with rapid changes in frequency.

Flexibility (constraint management, investment deferral)

Grid infrastructure (wires, transformers etc.) requires regular upgrades to handle increases in demand and generation. As the electricity system becomes increasingly decentralised, with generation connecting to lower voltage networks, existing infrastructure is not able to cope, resulting in constraints.

Expensive, time-consuming infrastructure upgrades may be necessary, but storage can help reduce these costs by supporting the network during periods of constrained generation or high demand, thus alleviating such constraints at a local level. This reduces the amount of new infrastructure needed or allows upgrades to be deferred to a more appropriate time.

Co-location with renewables

Storage can provide reserve and time-shifting directly to the renewable generating plant, storing excess energy when it is not needed by the grid.

There are times of low-demand and high generation, for example, during the summer months. Renewable generation is increasing, whilst the requirement for this energy is decreasing,

Generators are paid by the Electricity System Operator (ESO) to 'turn down' at times of high generation and low demand; however, these payments may not be commercially viable or even available in future, making co-located storage a more attractive prospect.

However, storage may be underutilised if it is only used for this purpose and may also need to provide other services in order to make full use of the asset. Currently, there are several co-located storage

[110] https://www.regen.co.uk/about-us/

sites, but most only share a grid connection with renewable generation, not an operating model. Therefore, although the storage sites and renewable generation are in the same place, they are not being used together, e.g. the battery is not being used to store excess generation from the renewable generator to avoid curtailments.

Long duration and seasonal storage

Currently, many of the services described above are either being met with lithium-ion battery storage, with around 0.5 - 2hour duration, or pumped hydro, lasting several hours. However, the case for longer-duration storage is growing. There is no agreed-upon definition of 'long-duration storage' but splitting storage into broad categories may help focus the debate.

Currently, the ESO is not asking for services from storage for a duration beyond a few hours, but the need for longer duration and even seasonal storage may increase as we see high renewable penetration and electrification of heat, for example, storing some surplus solar generation in the summer, for use on winter evenings.

11.2 Local insights

11.2.1 Distribution Future Energy Scenarios projections

Western Power Distribution's (WPD) Distribution Future Energy Scenarios (DFES) scenario-based projections of battery storage uptake falls under four key business models:

Standalone Network Services
Typically multiple MW scale projects that provide balancing, flexibility and support services to the electricity network.

Generation Co-Location
Typically multiple MW scale projects, sited alongside renewable energy (or occasionally fossil fuel) generation projects.

Behind-the-Meter High Energy User
Single MW or 'hundreds of kW' scale projects, sited at large energy user operational sites to support onsite energy management or to avoid high electricity cost periods.

Domestic Batteries
Typically 10-20kW scale batteries that households buy to operate alongside rooftop PV or to provide backup services to the home.

The four business models for battery storage above are driven by different factors.

- Standalone storage accounts for most of the existing storage market activity and there is significant growth in capacity for this business model across all scenarios by 2035.
- Generation co-location is driven by a strong ground mounted solar PV deployment and a moderate onshore wind deployment in the South West licence area in the medium term.
- It is suggested that storage assets co-located with high energy users could be the business model that sees the highest deployment, and high uptake of behind-the-meter storage projects has been projected in the licence area.
- With a higher-than-average uptake of rooftop PV in the South West licence area, an above-average deployment of domestic batteries has been modelled in the medium and long term.

These models are all viable in their own way, but it is not necessarily suitable to compare their respective viability due to their individuality and very different circumstances.

[111] For further information on electricity storage's role in a net zero future see Regen's 2020 paper: Electricity Storage: Pathways to a Net Zero Future.

Figure 50 below illustrate the scenario-based projections of battery storage installed capacity in each Council's area.

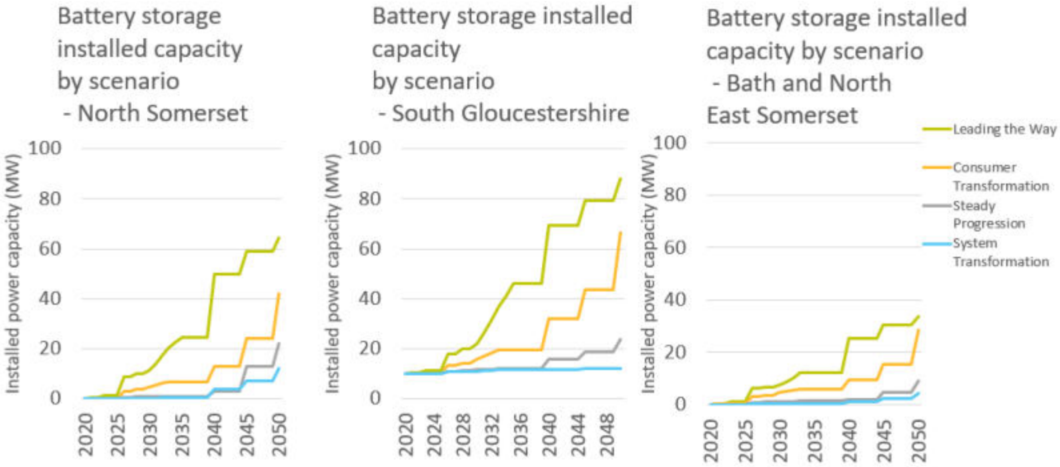


Figure 50: DFES Battery Storage Projections[112]

The majority of projected battery storage capacity under the DFES analysis is from domestic batteries and high energy users within the region. There are small increases in batteries co-located with the generation due to a relatively small increase in generation sites within the region when compared to elsewhere in WPD's network. Furthermore, there is little projected increase in standalone grid service batteries due to fewer estimated suitable connection opportunities in the region compared to elsewhere in WPD's network.

11.2.2 Planning activity

No planned battery storage projects have been identified in the Council's area from reviewing the BEIS Renewable Energy Planning Database.

11.2.3 District Network Operator Constraint Management Zones

Distribution Network Operators (DNOs), including WPD, are looking to procure flexibility services at a local level to support the network. There are three flexibility services within so-called Constraint Management Zones (CMZs), and each caters to different network requirements. These are as follows:

Secure Service (pre-fault constraint management)

Used to manage peak demand loading on the network and pre-emptively reduce network loading.

Dynamic Service (post-fault constraint management)

Used to support the network in the event of specific fault conditions, often during summer maintenance work.

Restore Service (restoration support management)

Intended to help with restoration following rare fault conditions. Such events are rare and offer no warning as they depend on failure of equipment.

It should be noted that all of these services could support storage projects. However, they are all circumstantial and will not always be suitable or available to all storage projects. They would need to

[112] WPD, 2020. Distribution Future Energy Scenarios 2020 South West Licence Area: Results and Assumptions report.

be in a location in which all services are required. A key limiting factor is the duration that these services will require a response for versus the energy storage capacity.

11.3 Summary

As renewable energy development and heat electrification increase, the need for longer duration and seasonal storage will increase.

The Consumer Transformation DFES scenario shows a continual increase in battery storage capacity within B&NES between 2020 and 2050. It is likely that the majority of the projected battery storage capacity is from domestic batteries, as the Consumer Transformation scenario assumes a shift to the integration of renewable energy generation technologies into homes.

However, there is likely be a need to increase the amount of co-located batteries in conjunction with installations of solar and wind farms due to insufficient capacity on the grid and to avoid any curtailment. A ranking exercise has therefore been undertaken by WPD in relation to ease of grid connectivity of the Search Areas (SAs) for wind and solar PV farms identified in this study (see Figure 39 and Figure 40 in Section 6). The highest ranked (coloured blue in the relevant maps) may not require storage to avoid curtailment but other SAs, might.

In such cases, developers will need to explore options as part of project development to understand viability. Part of such viability studies will include discussions with WPD but also proximity to electricity demands and the ability to sell any electricity produced to third parties. The Council, other public and private sector might co-locate to take advantage of any available renewable electricity, and this should be considered when sieving potential candidate sites for the Local Plan or when the public and/or private sector are considering options for locating services that are significantly power dependent.

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Policy Recommendation

Policy Reference: ES-PR-1 (Refer to Table 43 in Section 17)

It is recommended that policy encourages applicants promoting schemes for renewable electricity generation of >1MW, regardless of technology, to consider including storage as part of their proposal. This could include some form of energy storage (green hydrogen production, seasonal or battery storage), private wire supply or evidence as to why this is not feasible or viable.

12. Hydrogen

12.1 Introduction

Hydrogen is not a renewable energy source, but rather an energy carrier which can be produced using renewable energy. Hydrogen is included under a separate subheading because it can be produced using renewable electricity or high temperature heat.

Hydrogen can be produced through several methods, but the main two options are included and explained further in this section.

- Steam Methane Reforming (SMR) – In this method hydrogen is produced from a methane source, such as natural gas via a high temperature process. Hydrogen generated via this process is considered low carbon (not zero) only if a carbon dioxide capture and storage system (CCS) is utilised.

> *"Carbon dioxide capture and storage is a process consisting of the separation of CO^2 from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere"*

The SMR method is a fully developed commercial process and currently it is the dominant technology used to produce hydrogen.

- Electrolysis – Electrolysis is the process of using electricity to split water into hydrogen and oxygen. Renewable electricity can be used in an electrolysis plant.

Hydrogen is typically classified by its generation technology which is denoted by different colours. There are three main colours of hydrogen[113]. These colours are as follows:

Grey Hydrogen

Grey hydrogen is made using fossil fuels. This process emmits CO_2 into the atmosphere as they combust

Blue Hydrogen

Blue hydrogen is made using fossil fuels, but carbon capture technology is used to prevent the emission of the CO_2 produced

Green Hydrogen

Green hydrogen is the cleanest, producing zero carbon emissions. Green hydrogen is produced via electrolysis powered by renewable energy

The production and use of hydrogen is generally less efficient than electrification due to the loss of energy through the conversion process from electricity to hydrogen, but hydrogen is more readily storable than electricity at a very large scale. In relation to this, the Hydrogen in a Low Carbon Economy [114] report by the Climate Change Committee (CCC) states:

[113] Turquoise hydrogen is created when natural gas is broken down with the help of methane pyrolysis, additionally pink hydrogen is generated through electrolysis powered by nuclear energy. Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.

[114] https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf

"…hydrogen has particular value as a low-carbon replacement for natural gas (and potentially oil) in applications where full electrification is very difficult, disruptive and/or expensive"

As renewable energy generation constantly fluctuates (e.g. solar panels only generate during the day), without energy storage technologies, renewable energy is unable to accommodate a constant energy consumption or meet peak demands. Electricity can be stored in batteries, thermal stores and pumped hydro-storage, however these do not provide long term, cost effective solutions and there is likely to remain a role for storable fuels, such as natural gas or hydrogen.

Hydrogen can be utilised as:

- a heating fuel in homes or industry[115];
- large scale power generation [116];
- fuel for hydrogen fuel cell vehicles especially for heavy-duty vehicles (e.g. buses, trains and lorries)[117].

As the CCC report confirms, low or zero carbon hydrogen can potentially be a valuable complement to electrification in reducing emissions from energy use.

The Regen Hydrogen Insight Paper[118] confirms that hydrogen could become a balancing fuel across energy uses, enabling the transmission and storage of low-cost renewable electricity produced at times when electricity supply exceeds demand. As the energy density by volume of hydrogen (3.3 kWh per cubic metre) is much lower compared to that of natural gas (11 kWh per cubic meter), hydrogen requires compressing to a much higher pressure, and delivering at a higher flow rate, in order to deliver the same energy content. This creates complications in the transport and storage of hydrogen. Due to this, the initial market driver for hydrogen is towards production plants located within industrial and chemical process clusters and transport hubs with short or onsite distribution channels.

Although the cost of blue and green hydrogen is currently high in comparison to its competitors (natural gas and 'grey' hydrogen), the insight paper suggests that it is predicted that the price will reduce considerably over the coming decade due to the economies of scale and innovation.

Whether the optimal supply chain for a particular hydrogen market is best served by a small number of very large manufacturing plants, enjoying economies of scale in production, or by a larger number of distributed production facilities located near to consumers to allow lower storage and distribution costs is yet to be seen. However, evidence from the existing hydrogen market suggests that the initial market driver is towards production plants that are located within industrial and chemical process clusters and transport hubs, with relatively short or onsite distribution channels.

There are also very different value chains for hydrogen, with gas network blending low value, but also relatively low cost, whereas hydrogen for transport is likely to command a higher price per energy unit. This is important as the cost of hydrogen is not yet competitive with electricity or traditional fuels, so if used in a low value application, it is unlikely to be economically viable

The CCC report concludes that hydrogen is best implemented selectively, in circumstances where it adds most value. This means using hydrogen where there are limits to electrification or where the only other viable option would be to burn fossil fuels. Although selective implementation is the suggested method for the roll of hydrogen in meeting the 2030 net zero aim, hydrogen will still enable emission reductions to reach the required levels than would be possible without it.

[115] Although there are plans to start testing this, conversions of the gas network are unlikely to take place until at least 2030. Page 23; https://www.cse.org.uk/downloads/reports-and-publications/policy/insulation-and-heating/energy-justice/renewables/behaviour-change/building-performance/Bristol_net_zero_by_2030_study_CSE_26_Feb_2020.pdf
[116] Hydrogen can replace natural gas to have back-up role in the future electricity grid.
[117] Hydrogen can replace natural gas to have back-up role in the future electricity grid.
[118] Building the Hydrogen Value Chain, Regen, 2021 (https://www.regen.co.uk/wp-content/uploads/Hydrogen-Insight-Paper-v4.pdf)

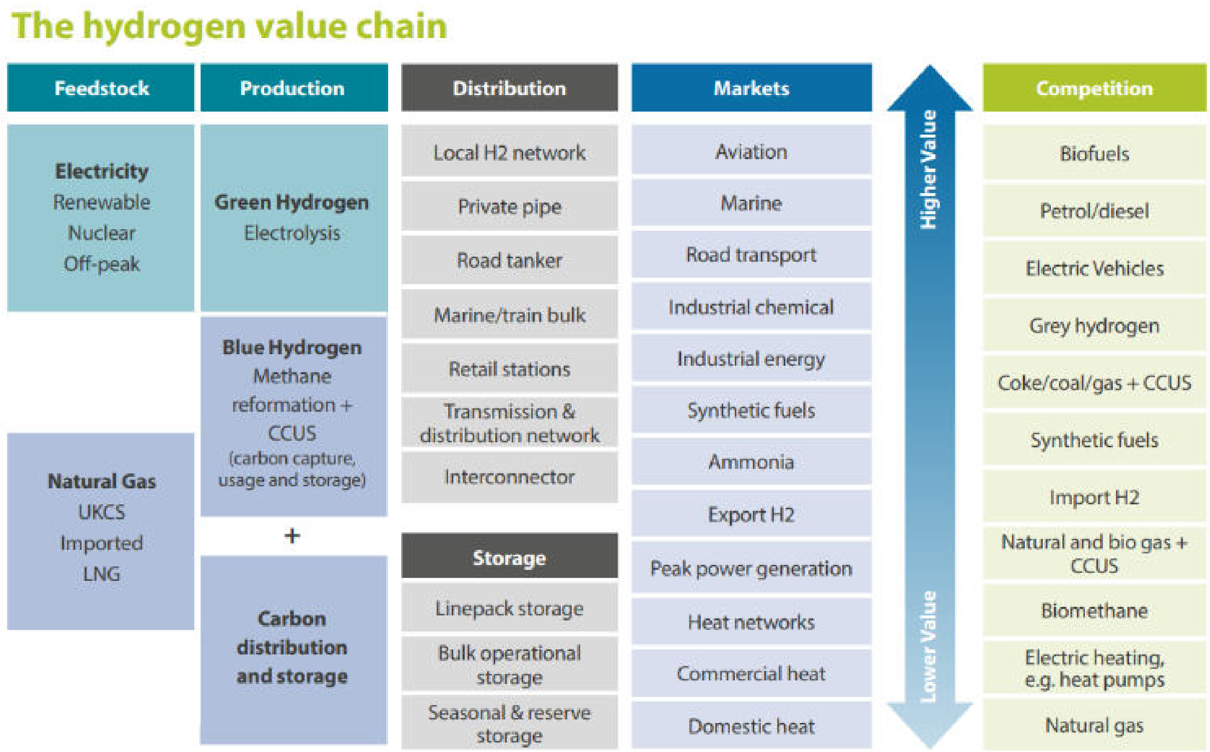


Figure 51: The hydrogen value chain. Source: Regen, 2021[119].

As Figure 51 above illustrates, there are distinct markets and value propositions for hydrogen products; these range from existing uses, new high-value applications in transport and industrial processes, and potentially lower-value applications as a fuel for heating or to generate electricity.

Pushing hydrogen as a replacement for natural gas for heating would be a significant strategic decision. It would require long-term policy interventions at a national level, such as applying a very high carbon tax while providing a long-term fuel subsidy. It is likely that hydrogen for heating will emerge from a much more targeted strategy, providing fuel for heat networks and localised distribution networks in areas that are otherwise hard to decarbonise.

Some commentators have suggested that using hydrogen for domestic heating would allow consumers to avoid the cost and disruption of energy efficiency measures. This would be a mistake; high hydrogen costs and seasonal peak demand mean that using hydrogen for domestic heating would require just as high levels of energy efficiency as any other low carbon heating option.

In the short term, hydrogen innovation projects are likely to take advantage of surplus renewable energy, existing gas networks or large-scale industry to develop hydrogen hubs. Innovative projects such as these could facilitate the creation of a route to market for hydrogen in what is still a relatively young industry[120].

12.2 Hydrogen Projects in the West of England

No existing hydrogen production facilities have been identified within the West of England region, nor have any planned pipeline hydrogen production facilities. However, a number of projects have been identified at various stages of development that may consume hydrogen, including:

- GKN hydrogen-powered plane project lands £54m as part of UK drive towards innovation (Jan 2021);
- ZeroAvia to develop a HyFlyer II at Cotswold Airport (April 2021);
- Hydrogen trams could be transport solution for Bath (Aug 2020);

[119] Building the Hydrogen Value Chain https://www.regen.co.uk/publications/building-the-hydrogen-value-chain/
[120] For further information on the hydrogen value chain, see Regen's 2021 Insight Paper on 'Building the Hydrogen Value Chain'; https://www.regen.co.uk/publications/building-the-hydrogen-value-chain/

- [Ambition to launch hydrogen-powered water taxis between Bristol and Cardiff (July 2020),]
- [Bristol hydrogen taxis (existing project);]
- [M4 hydrogen corridor could extend into the region.]

Furthermore, National Grid's 'Future of Gas' paper[121] does not identify any hydrogen projects in the region and the closest hydrogen project is in Swindon.

12.3 Local Opportunities

There are potentially some industrial processes in B&NES for which green hydrogen could provide a critical low carbon energy source. The map below identifies potential industrial clusters in the region, prioritising those more likely to entail chemical processes and high-grade heat requirements for which hydrogen could be a feedstock or low carbon fuel.

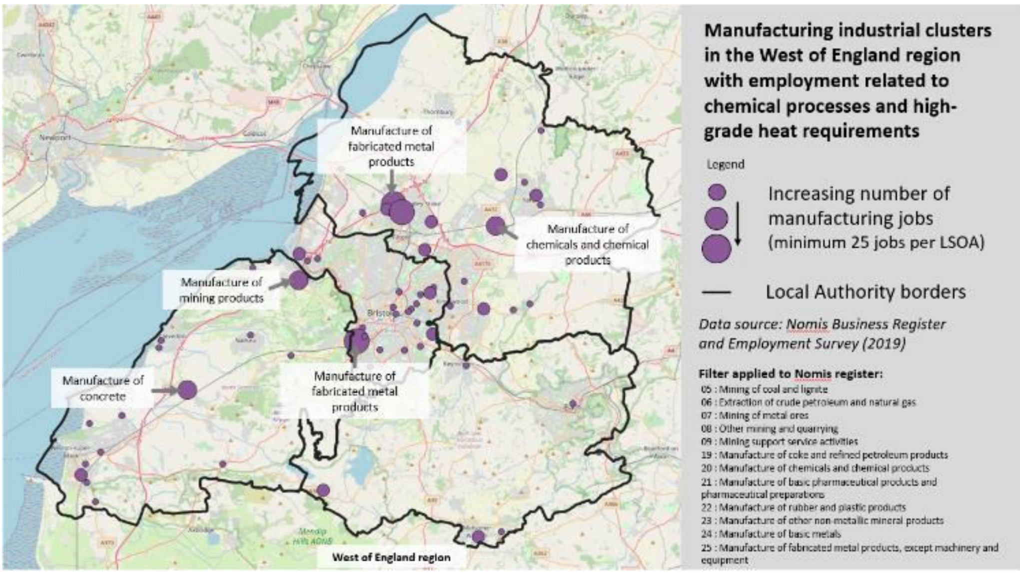


Figure 52: Manufacturing Industrial Clusters in the West of England With Employment Related to Chemical Process and High-Grade Heat Demand[122].

Synthetic hydrocarbon fuels could play a significant role in achieving net zero in otherwise difficult to decarbonise industries such as aviation. Aerospace supplier GKN, based in South Gloucestershire, is working with partners on a project called H2GEAR which has received funding to develop a way to power planes using hydrogen. Hypothetically, work from this project could contribute to decarbonising the aviation industry.

12.4 2030 Hydrogen Demand in B&NES

It is projected in DFES[123] and Regen calculations that a total of 306GWh of electricity will be required for grid-connected (electrolysis) hydrogen generation in 2030; it should be noted that the aims for B&NES have been condensed from 2050 to 2030 to align with the Climate Emergency. See Section 14 for more detail.

The Consumer Transformation scenario from DFES (see Figure 53), utilised in this RERAS, assumes a proportion of the total hydrogen demand will be met from hydrogen generation via methane reformation and carbon capture and storage (see Figure 54)[124].

Whilst green hydrogen production requires renewable electricity that could be available in 2030, as hydrogen is a new energy carrier, it could be that the required infrastructure (e.g. the electrolysers,

[121] https://www.nationalgrid.com/uk/gas-transmission/document/132471/download
[122] Data source: Regen analysis - Nomis employment survey data.
[123] See Section14.1 for more information regarding DFES.
[124] Future Energy Scenarios, National Grid ESO, July 2020; https://www.nationalgrideso.com/document/173821/download

gas distribution network and/or domestic and commercial hydrogen boilers assumed in DFES) to employ the green hydrogen will be challenging to put in place by 2030.

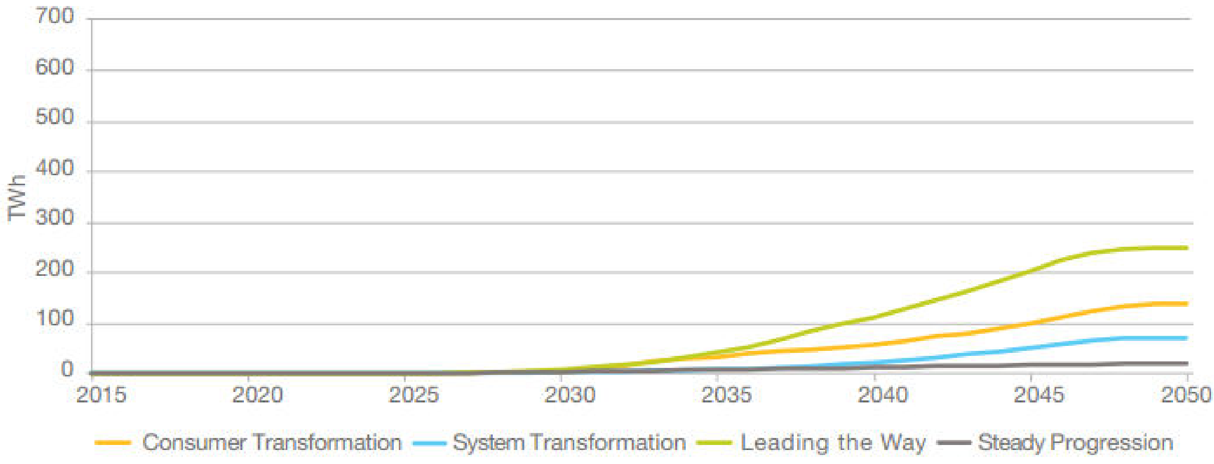


Figure 53: Electricity Demand for Hydrogen Production in the UK[125]

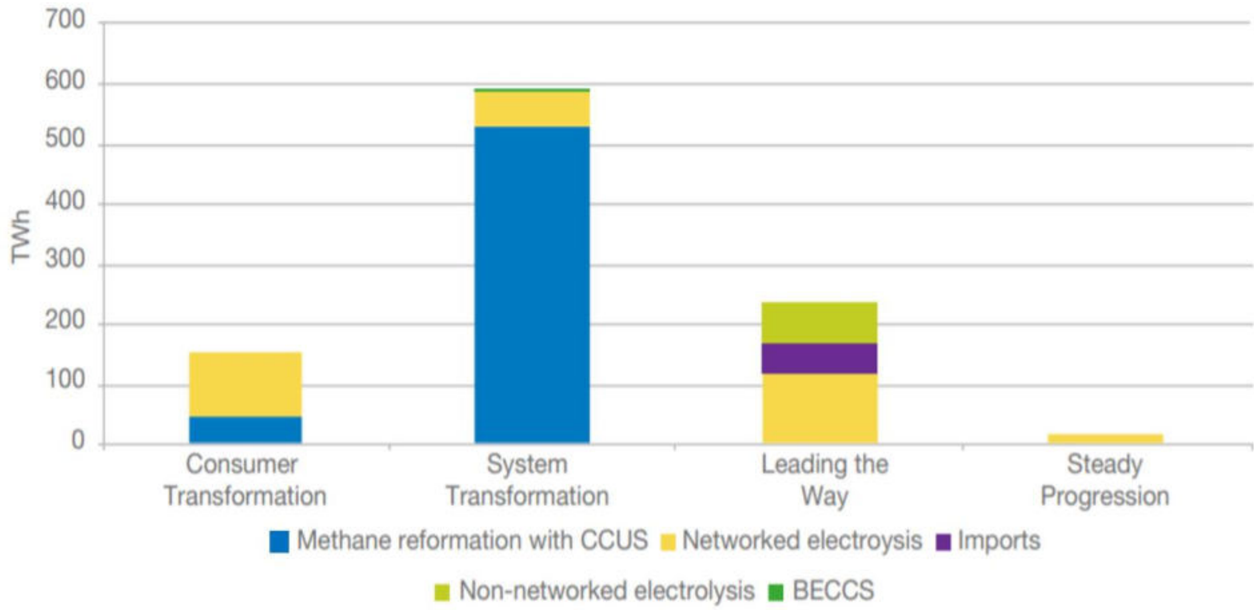


Figure 54: FES 2050 Hydrogen Supply 2050 for the UK[126]

12.5 Mapping

Map Titles and References:

1. H1-B&NES: Wind Local Search Areas and Industrial Clusters for Potential Green Hydrogen Generation and Demand
2. H2-B&NES: Solar PV Local Search Areas and Industrial Clusters for Potential Green Hydrogen Generation and Demand

H1 and H2 maps illustrate locations of the identified solar PV and wind Search Areas in relation to the industrial manufacturing clusters in B&NES with employment related to chemical processes and high-grade heat demand. It should be noted since RERAS does not appraise consideration of hydrogen infrastructures such as hydrogen transport or storage, the mapping is concentrated on identification of industrial use and does not cover all of the hydrogen usage envisaged in DFES. The Search Areas

[125] National Grid, Future Energy Scenarios, July 2020: https://www.nationalgrideso.com/document/173821/download
[126] National Grid, Future Energy Scenarios, July 2020: https://www.nationalgrideso.com/document/173821/download

(SAs) in proximity to the industrial clusters can potentially be utilised for green hydrogen generation. Additionally, the maps include large surface waters, which are required for electrolysis hydrogen generation production.

Policy Recommendation

Policy Reference: ES-PR-2 (Refer to Table 43 in Section 17)

It is recommended that applications for renewable electricity generation of >1MW located within 1km of an industrial cluster identified as having potential for hydrogen production consider utilising outputs (via private wire) for such purposes.

Policy Recommendation

Policy Reference: ES-PR-3 (Refer to Table 43 in Section 17)

Building on ES-PR-2, it is recommended that applications for new industrial development that may have a use for green hydrogen should be guided towards locations near/in 'hydrogen clusters' wherever practical.

Higher resolution versions of these maps are contained in the accompanying document 'B&NES RERAS – Maps'.

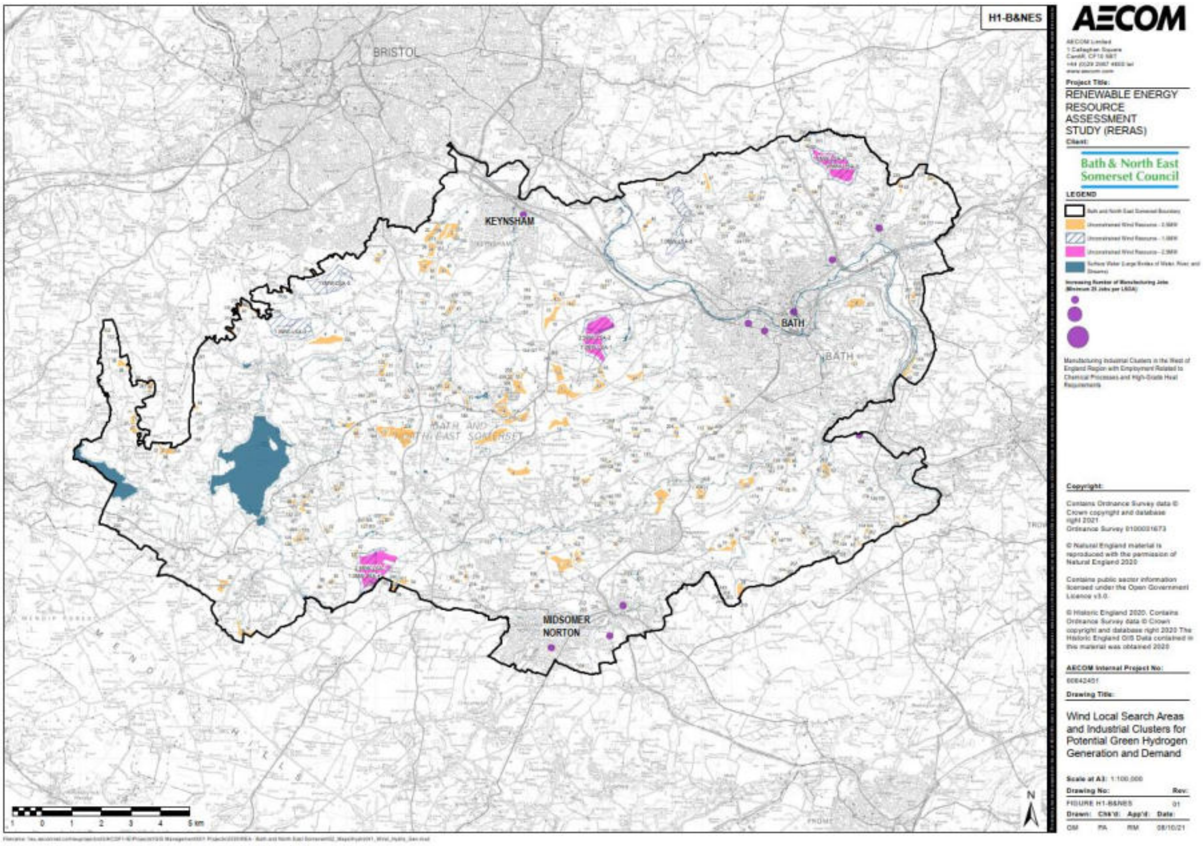


Figure 55: H1-B&NES: Wind Local Search Areas and Industrial Clusters for Potential Green Hydrogen Generation and Demand Map

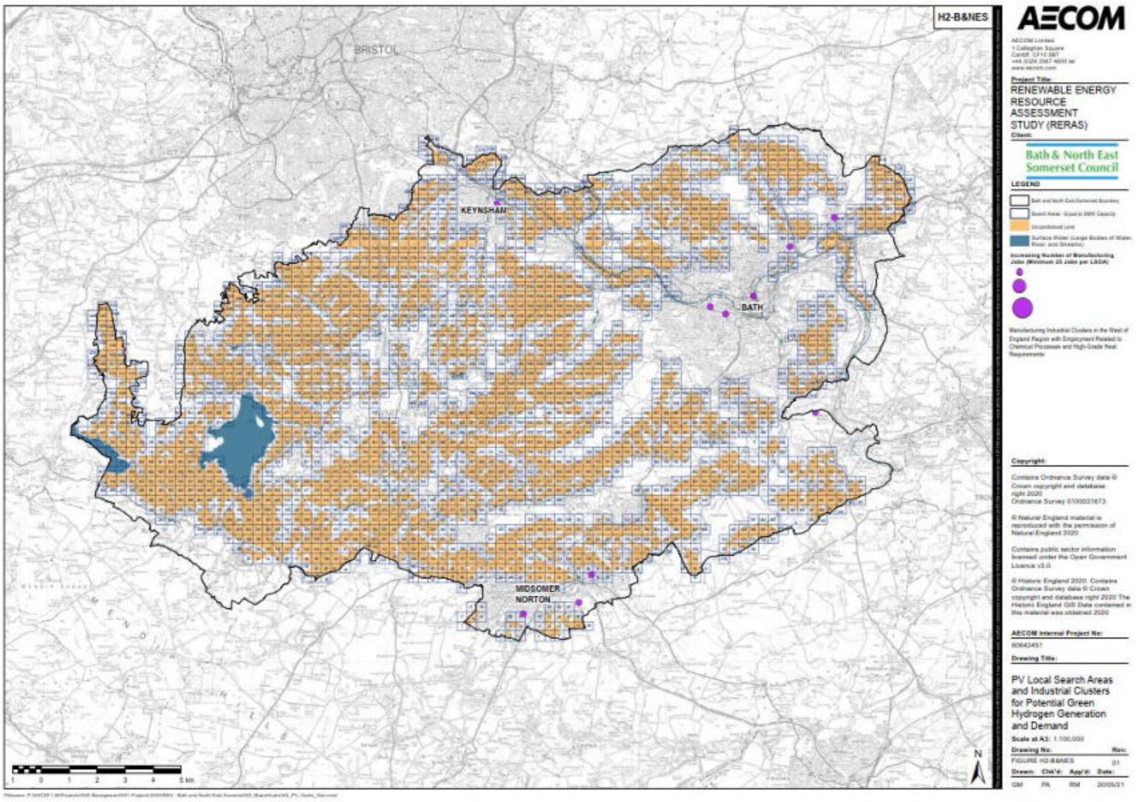


Figure 56: H2-B&NES: Solar PV Local Search Areas and Industrial Clusters for Potential Green Hydrogen Generation and Demand Map

12.6 Potential Opportunities for Future Development

Some potential industrial clusters were identified in the mapping process; a significant number being sites located near the identified solar PV and wind SAs. As it stands, infrastructure with the potential to support hydrogen generation is likely to be developed in these locations. The SAs could provide renewable electricity to produce ‘green hydrogen’ and so it is suggested that these sites are kept in mind so that all potential opportunities to generate green hydrogen are realised.

13. Heat Opportunity and Strategic Site Assessment

13.1 Introduction

Heat is typically generated at a building level, which means that only small-scale technologies can be used (most commonly gas boilers), limiting the use of other forms of low and zero-carbon heat generation technologies. Unlike decarbonisation of the power sector, decarbonising heat at scale could directly impact consumers, requiring changes to the majority of the heating systems currently in buildings and industrial sites[127]. Additionally, sufficient heat demand should exist in proximity of a heat source to make development viable, making decarbonisation of heat more challenging. A 'Heat Opportunities Map' is created in this section of the study for B&NES that presents locations of heat demand clusters and potential heat sources in B&NES.

A District Heating Network (DHN) refers to a distribution system providing multiple individual buildings with heat generated from one or more. The plant is generally housed in a building known as an energy centre. DHNs comprise a system of insulated pipes, known as heat mains, which distribute hot water from the energy centre to several different buildings to provide space heating and hot water. Each building has a heat interface unit (HIU) that supplies heat from the network to the local building distribution system instead of individual boilers. New controllers are provided (very similar to those fitted and linked with gas boilers) to operate the system, and buildings can usually retain their internal distribution system (e.g. radiators). Heat is metered and billed to consumers in much the same way that gas or electricity is. This is combined with a service charge to cover maintenance of the shared distribution system (electricity and gas bills also incorporate a charge for these services). Schemes can range in size from simply linking two buildings together to spanning entire cities.

NPPF requires planning authorities to identify a range of suitable sites within their area to meet the scale and type of development likely to be needed. The identification could cover housing and employment sites, and the planning policies and decisions need to reflect changes in the demand for land. They should be informed by regular reviews of both the land allocated for development in plans and of land availability[128]. Heat opportunities mapping presented in this section can assist the Council to identify or rank potential development sites based on DHN potential.

District heat offers an alternative to the typical arrangement, offering efficiencies of scale by generating and distributing heat to a number of buildings or utilising a source of heat that would otherwise be wasted. This would include access to otherwise wasted forms of heat, not viable at a building scale, including the use of waste heat from local power generation or energy from waste plants, local rivers, bodies of water or mines. Waste heat can be considered a low carbon option as it offsets the new end-users need for additional heating fuel. Deployment of low-carbon technologies at a network level can also utilise large thermal storage allowing for wider energy system balancing at a cost far lower than many chemical or alternative batteries.

Assessing the potential for a district heat network within B&NES could offer many potential benefits for the Council:

- CO_2 emissions reductions – the combination of more efficient generation and the ability to use alternative technologies and fuels means that district heat networks can provide significant CO_2 reductions.
- Emissions reductions in hard-to-treat buildings – where retrofitting fabric improvements to existing stock is challenging (e.g. for listed buildings), district heat provides an alternative method by which to reduce CO_2 emissions.
- Reduction in energy prices – increased efficiencies can lead to reduced energy costs for customers. This can mean improved competitiveness for local businesses and reduced energy bills and the alleviation of fuel poverty for households.

[127] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf

[128] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

- Identification or ranking of potential development sites for future development based on DHN potential.

The consideration of a district heat network could be a viable method to help bridge the gap between the projected 2030 heat demand and the maximum theoretical resource identified in this study (see Section 14). When analysing the viability of a DHN, there are multiple stages that vary in complexity:

- Heat opportunities mapping
- Assessing the technical and financial viability of district heating networks
- Developing a heat-opportunities plan for district heating networks

Heat opportunities mapping, which is presented in this study, provides sufficient levels of detail to allow the Council to identify or rank potential development sites based on DHN potential. The data and maps can also be utilised in setting policies requiring developers to investigate heat networks. However, any policy requiring site/building specific CO_2 reduction targets, or connections to DHN, will require a more detailed economic and technical appraisal.

13.2 Heat Opportunities Mapping Process

The nature of existing energy demand and infrastructure is identified in this section. There are multiple reasons for this, including (but not limited to):

- Identification of public sector buildings to act as anchor 'heat' loads (AHLs);
- To establish the energy densities of particular areas. District Heating technology installations are more likely to be economically viable in areas of high-density energy demand but can be more complex to install.
- The proportions of the relative demand for electricity and heat are also useful indicators as to what type of Low and Zero Carbon (LZC) technologies might be appropriate in a particular area;
- Areas of high-density energy demand may not always present the greatest opportunities. Energy density data needs to be combined with other data, such as the nature of energy demand, the composition of building types and uses, the accessible renewable energy resource, land and building ownership, existing infrastructure and any proposed development in order to identify the greatest opportunity. These opportunities should also be reviewed against community priorities to align delivery to local requirements.

13.2.1 Identifying Anchor "Heat" Loads and "Clusters"

Anchor Heat Loads (AHLs) pertain to buildings with a high and continuous demand that could provide economically viable and practical opportunities for utilising heat. It is known as an 'anchor' load because further opportunities may arise for connecting nearby buildings to the original anchor load. An AHL, therefore, refers to a building energy load that can act as a base for a District Heating (DH) scheme.

Buildings (such as social housing, etc.) located near an AHL and which may benefit from and contribute to the viability of DH schemes are known as a 'cluster'. A 'cluster' usually refers to a mix of residential and non-residential buildings which, together, represent opportunities due to their:

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

The identification of AHLs and clusters requires the mapping of:

- Buildings owned by organisations with corporate climate change mitigation policies and an active commitment to reducing their carbon footprint;
- Social housing schemes. These organisations are often tasked with achieving greater than the minimum environmental performance standards. Including such developments in DH

schemes often enhances the energy profile to provide further evening, weekend and night-time energy demands; and

- New planned developments

AHLs can help a DH scheme to become a realistic prospect, and there are usually particular conditions that need to be in place, such as planned new development and/ or an AHL building/ group of buildings with significant demand for heat and/ or with an energy profile suitable for the installation of a particular technology.

Privately owned buildings are less often utilised as AHLs due to more attractive returns from competing investments, reduced willingness to commit to long term energy procurement contracts and other issues such as a greater tendency for private companies to rent property rather than own it. In the residential market, it is preferable for district heating schemes to connect to social housing, particularly apartment blocks, due to the increased heat demand density offered. It is often impractical for developers to have to negotiate with many individual private householders, whereas social landlords can more readily act on behalf of their tenants. It should be noted that in this RERAS, the buildings are identified and mapped based on the Council's Local Land and Property Gazetteer (LLPG) data, which allows for identification of building type and use but does not provide information on the ownership type of the buildings, however, the council-owned sites are identified and marked on the maps.

In order to calculate the heat demand of the non-residential buildings, the following methods and sources are used.

- Metered energy data, where provided by the Council;
- Display Energy Certificates (DEC), if metered data is not available;
- Chartered Institute of Building Services Engineers Technical Memorandum TM46 energy benchmarking conversions (only incorporated if DEC or metered data are not provided);

13.2.1.1 Social Housing Associations in B&NES

Housing Associations in B&NES included on the maps are as follows:

- Alliance Homes
- Anchor Hanover
- Stonewater
- Selwood Housing
- United Communities

This list is not intended to be an exhaustive list of organisations active in the area as only the above organisations responded to the request for information document sent to collect the relevant information.

13.2.2 Mapping Residential Heat Demand and Density

A report for BEIS (formerly DECC[129]) suggests that DHNs are not feasible unless a heat demand of at least 3MW/km^2 is present.

'Density' of heat demand refers to kilowatt-hour (kWh) / square kilometre (km^2) of heat energy consumed in dwellings. When allocating energy consumptions to existing residential buildings, the publicly available domestic gas consumption estimates per Lower Super Output Area (LSOA) for 2019 was used to allocate each area a heat density figure and quantify the heat demand.

The importance of identifying residential heat demand and density pertains to:

- The potential demand for heat in any one particular area;
- Contributing to the identification of AHLs;

[129] The Potential and Costs of District Heating Networks. A Report to the Department of Energy and Climate Change, April 2009.

- Feeding into the analysis of potential LZC solutions.
- A mix of buildings and energy uses which, together, represent a potential complementary energy demand profile (dwellings providing evening, weekend and nighttime energy demands as opposed to the regular weekday energy demands of commercial organisations); and
- The identification of opportunities relating to social housing providers who are often tasked with achieving greater than the minimum environmental performance standards.

Map E1-B&NES (see Section 3.2) in the accompanying document 'B&NES RERAS – Maps' shows indicative heat demands in B&NES based on total gas consumption by Middle Layer Super Output Area (MSOA).

Map E3-B&NES shows the indicative residential only heat demand within B&NES by Lower Layer Super Output Areas (LSOA).

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

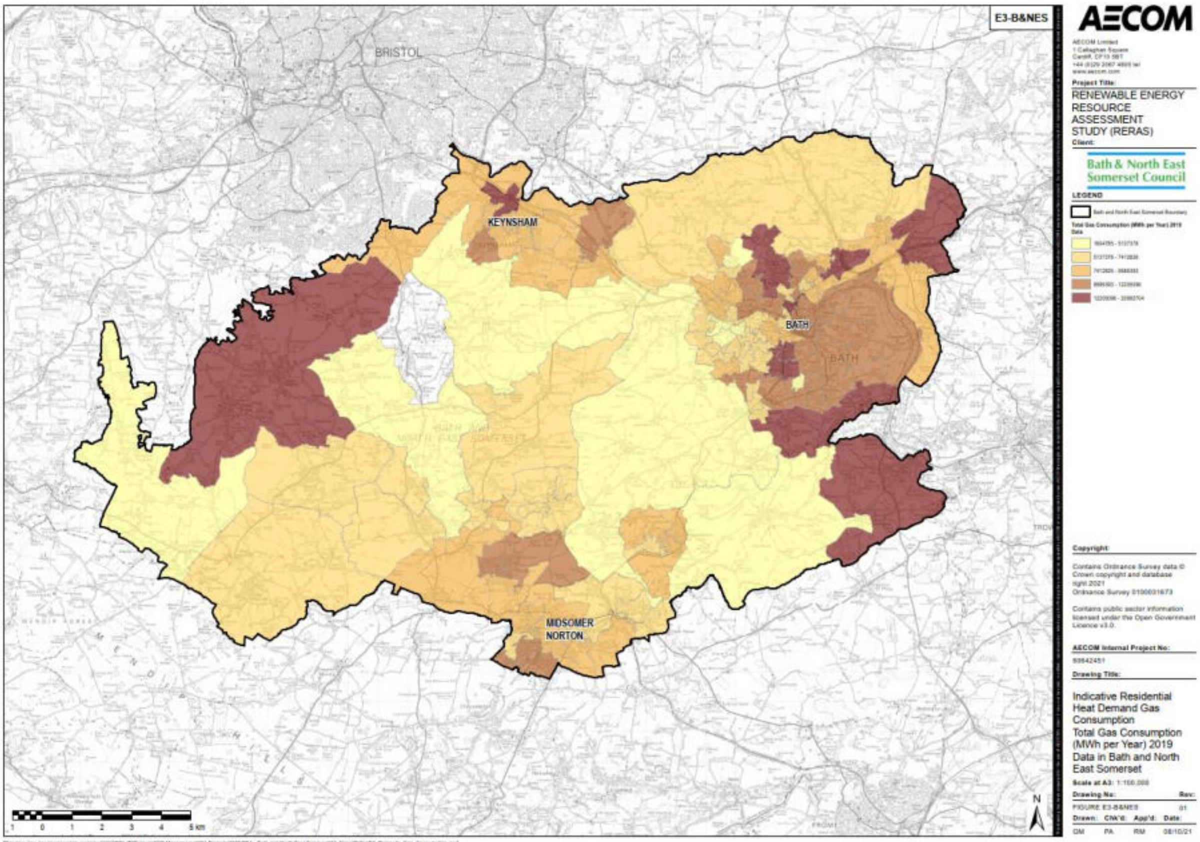


Figure 57: E3-B&NES: Indicative Residential Heat Demand Total Gas Consumption (MWh per Year) 2019 Data for B&NES

13.2.3 Map Locations of Strategic New Development Sites

This involves mapping the location of the strategic sites from the Development Plan using Geographic Information System (GIS). District Heat schemes are most cost-effective when installed as part of new development rather than retrofitting. At the time of writing the report, the new Local Plan for B&NES was under development and, as such, work to identify the location of potential strategic sites was ongoing. Relevant policies from the existing plan are included on the maps. Additionally, the heat mapping data can be used to assess development sites for the emerging plan for heat network potential.

13.2.4 Identifying Existing Energy Infrastructure and District Heating Networks

It is important to establish the nature of the existing energy infrastructure as it may provide opportunities for expanded connectivity or increased efficiency/ viability. There is an existing heat network at University of Bath which is marked on the E4 map.

Identification of current utilisation of renewable energy resources is covered by this RERAS which includes existing anaerobic digestions, landfill gas and energy from waste sites installations.

The utilisation of current waste heat sources can provide opportunities to improve fuel efficiency and secure CO_2 emission reductions. Extending existing infrastructure to additional users can increase the viability of a particular scheme.

13.2.5 Identifying Potential Renewable or Low Carbon Heat Sources

Currently, most of the existing heat networks across the UK are powered by natural gas. However, considering the Council's carbon-neutral ambition by 2030 and the fact that delivering the net zero target means transforming the gas sector, potential renewable or low carbon heat sources are included in the maps in this study section. Section 13.3.5 includes details of the heat sources, the data can be used to identify opportunities to foster renewable heat energy.

13.3 Mapping of Heat Demand and Viability Assessment

The heat demand of each building is illustrated on the maps by a circle. The circle size indicates the relative size of the heat load in question and allows for easily identifiable comparisons between different heat loads. The mapping informs a very high-level assessment of potential viability using an equation that links the value of potential energy sales with the length of pipe.

The radius of each circle is calculated based on the rule of thumb for the length of capital investment in a heat network and that which the revenue from heat sales to that load could support.

The equation used is:

$$R \approx \frac{AHL \times HP \times Y}{C}$$

Where:

- R = radius of circle, in metres
- AHL = annual heat demand, in kWh
- HP = price at which heat is sold, assumed to be £0.04/kWh
- Y = number of years of revenue assumed to be 10 years[130]
- C = estimate of the cost of installing heat pipe per m of a trench assumed to be £1000/m for this exercise

This methodology also provides an indication of the viability of connecting a heat load. If there are large gaps between circles, it suggests that connecting loads may not be viable. Conversely, if circles overlap, connecting them may be more viable.

13.3.1 Evaluation of District Heating Network Opportunities

The bringing together of various data layers described above informs the development of a 'Heat Opportunities Plan' shown in the E4 map. The development of the plan for B&NES Council allows for identifying clusters of sites with the potential to be technically feasible and economically viable for a heat network.

[130] In practice, a heat/electricity supply contract to an anchor load may last for 20 to 25 years, but the use of 10 years reflects the fact that the revenue over 25 years would roughly need to be twice the initial capital costs to cover the operation and maintenance costs for the network.

Policy Recommendation

Policy Reference: ES-PR-4 (Refer to Table 43 in Section 17)

It is recommended that applications for renewable electricity generation, or development that is energy intensive and likely to have a surplus of heat, within 1km of a site with potential for seasonal energy storage (e.g. abandoned mine workings) should consider utilising such a facility.

Policy Recommendation

Policy Reference: DH-PR-1 (Refer to Table 44 in Section 17)

It is recommended that development proposals for dwellings, employment or depots for hosting transport fleets located within 0.5km of an existing renewable heat resources or renewable electricity generating installations should consider utilising such resources for heating, hot water and/or process use transport fuel.

Policy Recommendation

Policy Reference: DH-PR-2 (Refer to Table 44 in Section 17)

It is recommended that proposals for development that will host heat intensive activities and are likely to generate excess heat (or power) should consider:

a. Potential to be located within 0.5km of a heat demand cluster identified in the Heat Opportunities Map or other identified heat use;
b. Enabling heat (power) off-take for supply for other / nearby uses and provide evidence of discussions with potential off-takers for the heat (or power).

Policy Recommendation

Policy Reference: DH-PR-3 (Refer to Table 44 in Section 17)

It is recommended that development proposals within 0.5km of an existing district heat network fed from a renewable (non-fossil fuel) source will be expected to connect where feasible and viable.

A higher resolution version of this map is contained in the accompanying document ‘Bath and North East Somerset RERAS – Maps’.

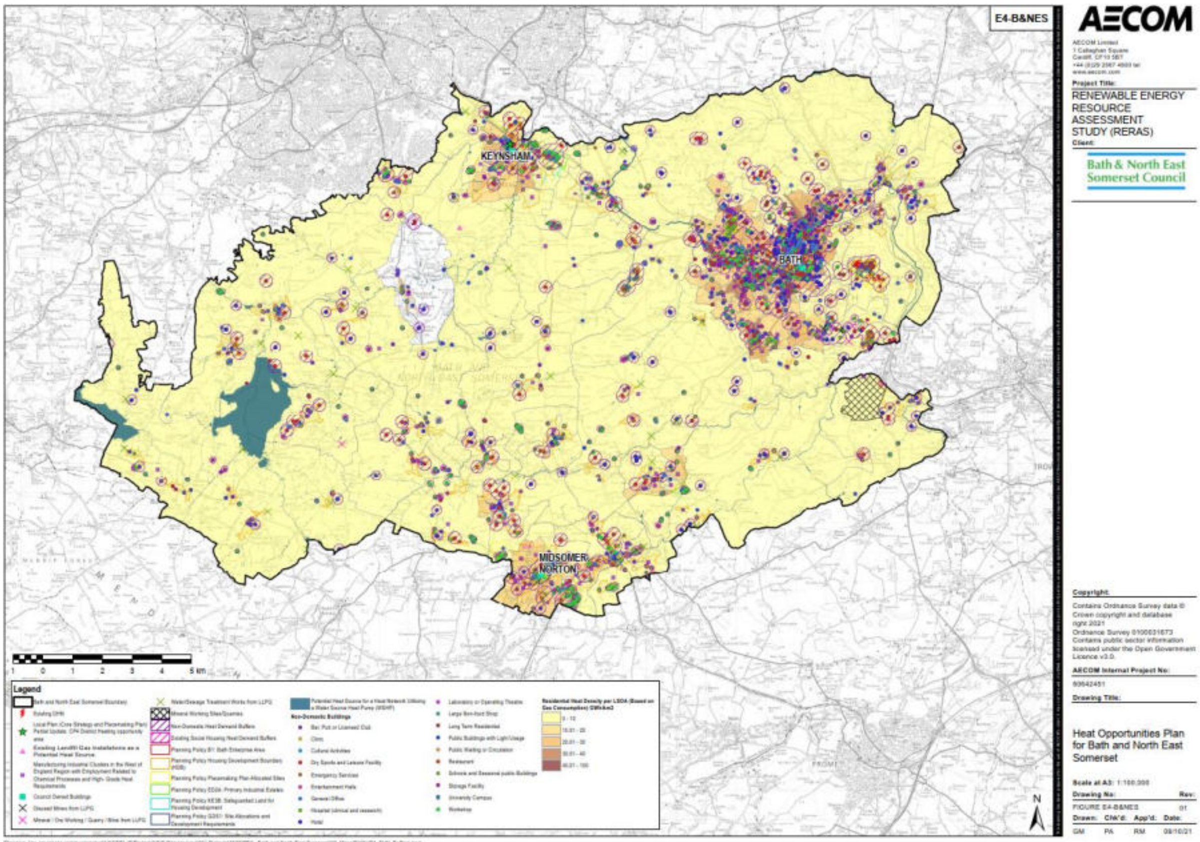


Figure 58: E4-B&NES: Heat Opportunities Map for Bath and North East Somerset

The map shows significant heat clusters and potential for heat networks in Bath, Keynsham, and Midsomer Norton. As explained earlier in this study, the results of this part of the assessment can be used to assist the Council in identifying or ranking potential development sites based on DHN potential. Therefore, this section describes the key factors considered when designing a network and area characteristics suitable for heat network development.

13.3.2 Heat Demand

As mentioned earlier, heat demands of the building are represented as circles with their size proportional to the size of the demand, and overlapping circles provide an indication of a potentially viable connection. The buildings are also colour coded based on the building use, and the council-owned buildings are flagged on the maps. Additionally, the E4 map illustrates the residential heat density and social housing heat demand in B&NES. When considering a potential strategic development site for a heat network, the Council can use the equation provided earlier in this section and the E4 map to do a very high-level assessment of the potential viability of the site. As an example, if the circle for a new site overlaps with heat circles from other existing buildings, it suggests that connecting the loads may be viable.

13.3.3 Route and Physical Barriers Consideration

The development of heat networks requires suitable routes to be identified to lay the pipework. The installation of pipes and associated equipment is expensive and disruptive, and therefore, the routing needs to be carefully considered to ensure the network is as efficient as possible so that the largest amount of heat possible is sold over the shortest length of pipework. Specific determining factors influencing the choice of network route include:

- The use of existing roads and pathways where public ownership enables development.
- The use of landscaped / pedestrian areas to reduce disruption to transport routes and allow lower cost installation.
- The use of minor roads where utility congestion may be less and where traffic disruption could be minimised.

- Aiming to find entrances to buildings which would allow pipework to be routed to existing plant rooms, based on information gathered, including site visits.
- Aiming to use minor roads where possible.
- Provision for future expansion, e.g. designing the network to facilitate expansion or connection to other networks.

The installation of heat network pipes may cause significant disruption on transport routes and involve additional time delays, costs and risks. In general, the network layout should avoid using busy routes to minimise disruption to traffic during construction works. Many major roads have grass verges that could accommodate DH pipework, although these may be planted with trees that will need to be avoided. In places where major roads are excavated to install DH pipework, the oversizing of these pipes should be considered to future-proof the network against future expansion. Such future-proofing should, for example, consider the expansion of the network to serve more buildings and the connection to alternative heat sources.

Similar to the roads, railway lines, canals and rivers can also present a physical barrier to the location of a network route, as it is challenging to install pipes across them. Existing crossing points and bridges can provide opportunities for the network to cross these barriers. Location of the barriers should be in proximity or within the heat cluster area since a connection is technically and economically challenging and can only be justified if significant heat loads exist across the barrier (e.g. river). Therefore, the following data layers are included on the maps

- Infrastructure (e.g. roads, railways etc.);
- Surface water (e.g. canals, rivers etc.).

13.3.4 Land Ownership

Similar to electricity or gas infrastructure, when heat network pipes are routed through private land, wayleave and/or access rights need to be agreed upon with the landowners. There is no authorised right of wayleave or easement for district heating infrastructure, unlike electricity or gas utilities providers. Whilst most such agreements are made voluntarily, where refused, a heat network developer is unable to apply for a compulsory right. As such, wherever possible, a network routes should follow public roads, minimising the need to negotiate and obtain permission from private landowners. GIS data of the maps heat network potential maps is provided to B&NES Council and can potentially be used to be viewed along with public-owned land data held by the Council.

13.3.5 Renewable or Low Carbon Energy Sources

As well as committed energy consumers, an energy network needs one or more sources of energy that offer the consumers an advantage over their business-as-usual energy supply arrangement. The energy source should also deliver environmental benefits; therefore, potential renewable or low carbon heat and, in some cases, electricity are included on the maps. When identifying suitable heat clusters or assessing future development sites for heat network potential, consideration should be given to the following sources that are included on the maps:

- Surface water that can potentially be used for a water source heat pump system;
- Manufacturing industrial clusters in the west of England region with employment-related to chemical processes and high-grade heat requirements. These sites can be investigated further for any available waste heat;
- Existing anaerobic digesters and landfill gas installations. These sites may provide opportunities for expanded connectivity;
- Wind and Solar PV SAs identified in this RERAS that can be utilised to supply renewable electricity to a heat pump system or generate hydrogen (maps E5 and E6 in the accompanying document ‘Bath and North East Somerset RERAS – maps’ show the location of these SAs in conjunction with district heating network opportunities within B&NES); and,
- Mineral working sites/quarries. The mines that are included on the E4 map are based on the available data in the LLPG or the Council’s policies for active mines.

However, when an underground mine is no longer in use, the pumps that were keeping them dry are often switched off. This results in the mine filling with water, which is heated and kept at a constant temperature throughout the year via geological processes. This water can be transferred through a pipe network and distributed through the district heat network using a heat exchanger[131]. Mine water heat is a low carbon heat source that could be considered for heat networks.

The Coal Authority provides an interactive map viewer that allows for viewing selected coal mining information graphically. The database includes abandoned mines locations as well as mine water temperature maps. It should be noted that even with the higher water temperature mines, this does not necessarily mean the resource is useable because the water's depth, sustainable energy yield, and recharge potentials should be investigated further. A link to the dataset is provided in the footnote[132].

Policy Recommendation

Policy Reference: DH-PR-4 (Refer to Table 44 in Section 17)

It is recommended that areas identified through the Local Plan for wind farms and solar PV farms are within 0.5km of an identified heat cluster, consideration is given to safeguarding these sites in order to provide electricity for powering heat pumps as part of a private wire / district heat network.

13.4 Summary and Conclusions

The high-level study undertaken allows for the identification of clusters of sites with the potential to be technically feasible and economically viable for a heat network. It also allows the Council to investigate future development sites for a heat network. However, the level of assessment is insufficient to propose targets for heat networks. However, it does indicate that there is potential for DHN schemes that require more in-depth analysis to identify which are financially viable. 17.4 provides further details regarding the support and funding schemes available for heat networks.

13.5 Next Steps

Once new development sites have been confirmed, the heat network map can be refined. The next steps for the Council in the development of heat networks in B&NES are:

- Identify appetite of anchor loads for the connection to a DHN
- Survey of potential anchor loads to confirm compatibility with a heat network and age of the existing heating plant
- Obtain current annual metre readings of anchor loads.
- Undertake a techno-economic viability assessment of potential clusters and network routes.
- Network locations should then be safeguarded, and the planning process steered towards the connection of new buildings to the network.

[131] Coal Authority – Geothermal energy from abandoned coal mines: https://www2.groundstability.com/geothermal-energy-from-abandoned-coal-mines/
[132] Coal Authority interactive map viewer; https://mapapps2.bgs.ac.uk/coalauthority/home.html

14. Projected Energy Consumption in Bath and North East Somerset in 2030

This section of the study considers the future energy consumption of B&NES. To provide recommendations to aid the Council with its 2030 Climate Emergency aim, the 2030 future energy consumption has been assessed. Future consumption has then been compared with the potential installed capacity of the renewable and low carbon technologies discussed in Sections 4 to 12 to establish that the requirement for net zero carbon is achievable. A series of steps were undertaken to complete this task, as follows:

Understand the Future Energy Scenarios and Distribution Future Energy Scenarios.

↓

Accelerating the 2050 Distribution Future Energy Scenarios to 2030 to align with the Council's aims

↓

Using this method to project the Building Integrated Renewables in 2030

↓

Using this method to project the Energy Consumption in 2030

14.1 Understanding the Future Energy Scenarios and the Distribution Future Energy Scenarios

14.1.1 Future Energy Scenarios

The National Grid Electricity Systems Operator's (ESO) produces Future Energy Scenarios (FES) annually[133], containing in-depth analysis of different future scenarios in the energy system within the UK. The FES is used as a fundamental part of annual network planning and operability analysis. A description of the three scenarios and further details regarding them are provided in Appendix P.

Based on AECOM's expertise, B&NES Council were advised to utilise the Consumer Transformation scenario in this study to maximise local solutions in achieving a net zero energy system.

The Consumer Transformation scenario assumes that net zero is met with measures that have a greater impact on consumers and is driven through consumer engagement. This scenario leads to considerable improvement to energy efficiencies and higher levels of renewable energy generation technologies integrated into homes.

Figure 59 shows the Consumer Transformation projected greenhouse gas emissions pathway for the UK.

[133] Future Energy Scenarios, National Grid ESO, July 2020; https://www.nationalgrideso.com/document/173821/download

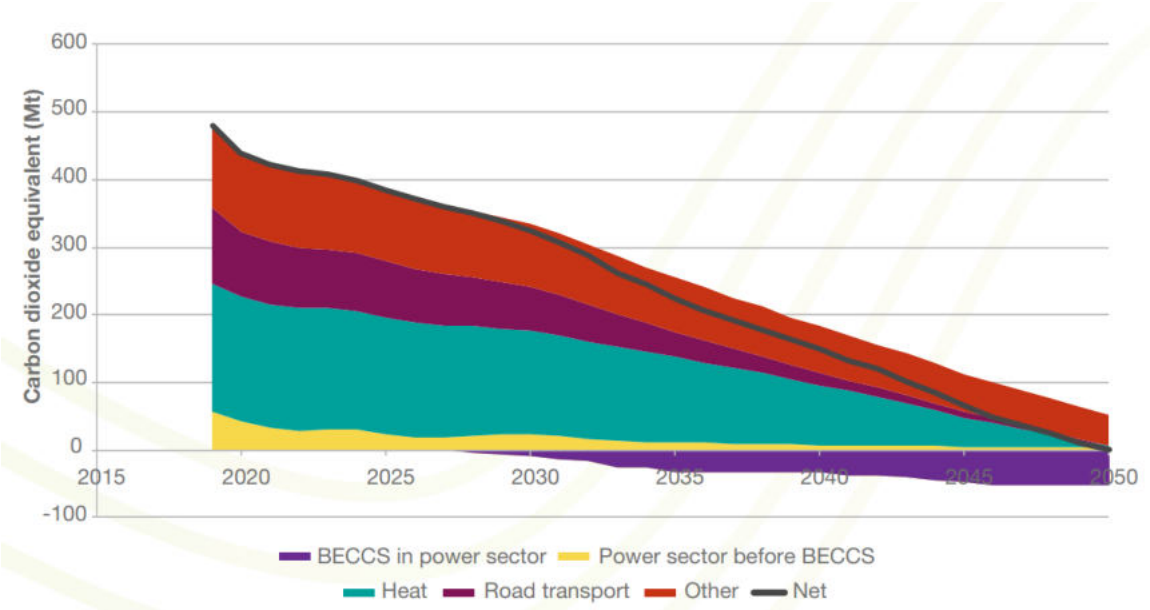


Figure 59: UK Total Net Greenhouse Gas Emissions (Consumer Transformation)[134]

The data shows the fundamental use of Bioenergy with Carbon Capture and Storage (BECCS) in achieving net zero emissions. BECCS is the combination of bioenergy with carbon capture transportation and permanent storage to capture any CO_2 released during combustion. This is both a technically complex and costly process. The FES assumes that the greenhouse gases released in each scenario will be mainly offset by using BECCS. The use of BECCS to offset the projected additional greenhouse gas emissions is included in the FES at a national level. For B&NES, given the significant potential for renewable electricity generation from wind and solar PV and the relatively small amount of generation from bioenergy, it is unlikely that there will be a requirement for BECCS. In subsequent reviews of the Local Plan, depending upon progress towards its net zero aim, B&NES. may wish to consider using BECCS to offset the residual emissions from the "Other" sector (Agriculture, Land Use and Land Use Change and Forestry (LULUCF), Waste, F-gases, Aviation and shipping) or remaining fossil fuel consumption locally.

Policy Recommendation

Policy Reference: BM-PR-2 (Refer to Table 45 in Section 17)

It is recommended that there be a presumption in favour of proposals for stand-alone electricity generation plant utilising biomass if the proposal utilises a BECCS system and proposals are incompliance with BM-PR-1a and 1b.

14.1.2 Distribution Future Energy Scenarios

Western Power Distribution (WPD) has used the National Grid ESO FES as a framework to make projections concerning changes in consumption, storage and distributed generation, including electrified transport and heat across the South West England; these are the Distribution Future Energy Scenarios (DFES). As in the FES, the DFES are compliant with the 2050 UK net zero target, excluding the 'Steady Progression' scenario.

Alongside providing projections for renewable energy generation and energy consumption, the DFES also provides projections on the heating systems, uptake of heat pumps, and the transport system's transformation.

[134] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download

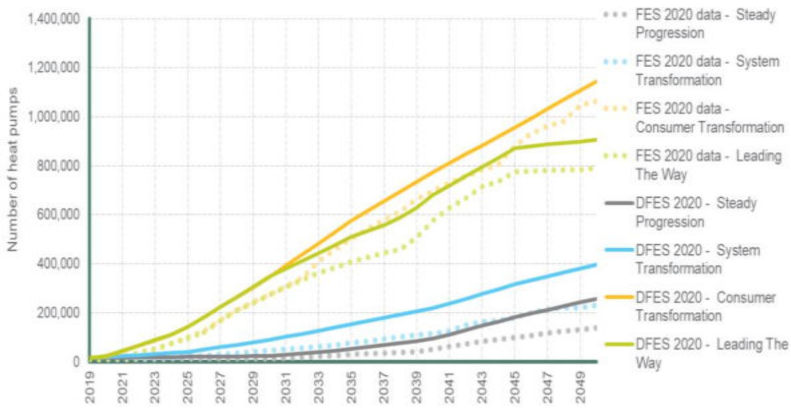
There will be an increase in the number of direct electric heating systems

Table 30: Domestic Electric Heating by Scenario in the South West[135]

Data summary for direct electric heating in South West licence area:

Number of households (1,000s)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	101	106	110	114	119	124	130
System Transformation	101	107	110	112	113	113	112
Consumer Transformation	101	107	109	110	110	108	107
Leading the Way	101	108	112	115	116	116	116

The baseline number of direct electric heating units (101,000) is based on analysis of domestic heating technology types from Energy Performance Certificate (EPC) data.



73% of homes will be served by a heat pump

Figure 60: Domestic Non-Hybrid Heat Pumps by Scenario in the South West[136]

Up to 270 times more electric vehicles

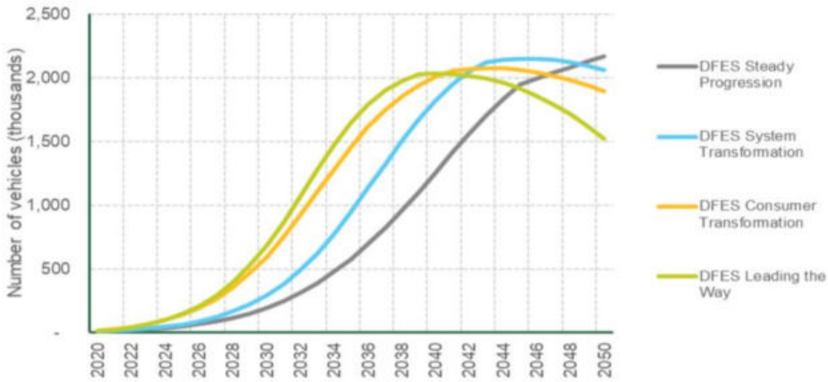


Figure 61: Battery Electric Vehicles by Scenario in the South West[137]

In Leading the Way, Consumer Transformation and System Transformation, the number of electric vehicles reduces from the late 2030s and mid 2040s respectively. This results from high levels of societal change resulting in high use of autonomous vehicles, public and active travel, which results in many homes opting to have fewer cars, or no car at all.

135 Distribution Future Energy Scenarios 2020, page 20, https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf
136 Distribution Future Energy Scenarios 2020, page 17, https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf
137 Distribution Future Energy Scenarios 2020, page 24, https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf

14.1.3 Guidance on Input to the Distribution Future Energy Scenarios

Local councils are consulted to provide input into the process of updating the WPD DFES once they have developed or updated their scenarios; this RERAS can be used to help with the process.

Regen's 2020 WPD DFES analysis and the RERAS use much of the same input data and methods to analyse the energy system. The DFES analysis may go deeper in terms of a geographic focus and granularity, but results can be aggregated up to a council level.

The main difference, however, is the starting point and the overall objective the analysis is looking to meet:

DFES provides a set of regional and sub-regional energy scenarios for the primary purpose of network planning, which are based on the National Grid ESO FES, other national or potentially devolved government scenarios. The DFES allows for a high degree of regional or devolved nation variation based on stakeholder input and supported by "bottom-up" evidence analysis but is still bounded within a national scenario framework and can be reconciled back to the national scenario. So, while the DFES should be strongly influenced and informed by stakeholder input, and regional evidence gathering, it does not claim to represent the full extent of local energy ambition and local objectives.	The RERAS starts from the basis of local energy objectives, not a national scenario. The RERAS, therefore, represents a much more local stakeholder view of the energy system, albeit with potentially strong input from energy networks.

The DFES starts from the basis of a national scenario that is modelled across one or multiple licence areas. However, a RERAS starts from local energy objectives and can be more detailed and consider stakeholder input more thoroughly. Therefore, the RERAS projections and forecasts could be quite different from DFES results and national scenarios and serve a different purpose: to create momentum and impetus behind a locally defined energy future, a net zero action plan, and economic growth. The RERAS could be used to inform a Local Area Energy Plan (LAEP), which is an evidence-based plan which can enable the transition to a net zero-carbon energy system[138]. The production of a LAEP could provide a stable base for effective local action to reduce carbon emissions and potentially define specific proposals for local energy networks.

Incorporating RERAS results back into the DFES process would allow the District Network Operators (DNOs) to analyse the results within their network planning processes and compare and present the results against the national scenarios.

Incorporating the RERAS outputs within the DFES analysis would require some practical steps, all of which are surmountable:

a) It would probably require the definition of a new (5th) DFES scenario as it would be difficult to reconcile the RERAS into one of the existing national scenarios;

b) DFESs are updated annually, whereas a RERAS or LAEP is likely to be completed less regularly. Some means of updating or maintaining the RERAS would be required if the process was to be repeated annually. This is because the DFES process, being undertaken for multiple licence areas at once, cannot always incorporate local energy objectives and stakeholder feedback;

c) It is unlikely that the RERAS would cover an entire DNO licence area at any given time, a methodology would be needed to extend to the remaining licence area, or the approach could be to use the RERAS or LAEP inputs for a part of the licence area only.

[138] https://www.cse.org.uk/projects/view/1369

14.2 Predicting 2030 Future Energy Consumption

The underlying scenario framework of the DFES and FES assumes a 2050 decarbonisation projection. This means that to ensure that the projections meet the Council's 2030 decarbonisation aim, the 2050 projections and data points in the DFES and FES must be accelerated for B&NES from 2050 to 2030.

This acceleration was modelled such that the 2050 projections have been condensed to 2030. Therefore, it is assumed that in addition to the technology uptake rates, underlying assumptions on consumer behaviour change, technology efficiencies, and energy efficiency rates have also been accelerated to meet local ambition. The only exclusion to this is the number of new dwellings. The number of new dwellings used within this assessment aligns with the value predicted within the DFES for 2030 (see Figure 62).

Figure 62: Homes Built Per Year in the South West[139]

Figure 63 shows the projection methodology process, the different colours represent different scenarios.

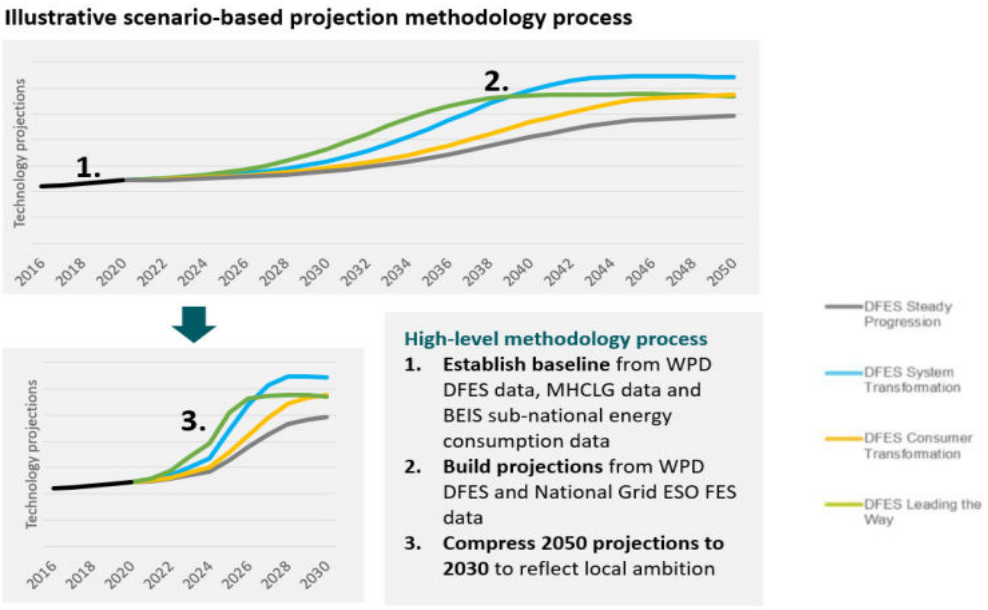


Figure 63: Illustrative Scenario Based Projection Methodology Process

139 DFES 2020 Results and Assumptions Report, Figure 6: https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf

14.3 Building Integrated Renewables Projection

14.3.1 Building Integrated Renewable

Any renewable energy generation technology that is integrated as part of a building (domestic or non-domestic) is called a ‘building integrated renewable’. As the transition to renewable energy increases in line with the Consumer Transformation Scenario, the number of building integrated renewables will increase and this requires consideration when projecting the future energy consumption. As building integrated renewables are de-centralised forms of energy generation, an increase in the installation of building integrated renewables will have an impact on the future energy consumption and therefore require consideration when projecting the future energy consumption.

14.3.1.1 Solar Thermal

Solar thermal systems use solar collectors, usually placed on the roof of a building, to preheat water for use in hot water applications in the building. A conventional boiler or immersion heater increase the temperature of the water, or to provide hot water when solar energy is unavailable. Figure 64 below shows a summary of such a system.

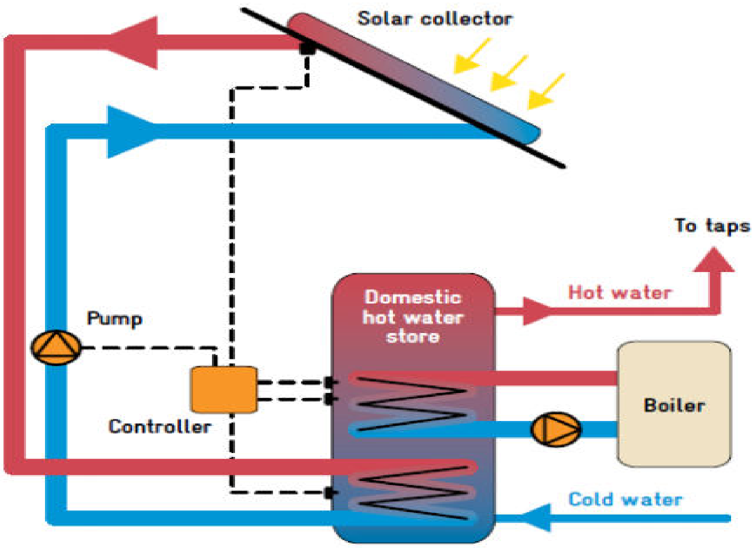


Figure 64: Systematic of a Solar Thermal System[140]

14.3.1.2 Heat Pumps

Heat pump systems absorb the solar heat energy stored in the ground, water bodies, or air into a fluid at low temperature. The fluid is then passed through a compressor to increase its temperature for heating purposes (e.g. space or water heating in buildings)[141]. Larger heat pumps can also be incorporated in district heating schemes.

Although the heat pumps extract renewable heat from the environment, they use electricity as fuel, which may or may not come from renewable sources. However, one of the significant advantages of heat pumps compared to other heat delivery systems is that the heat output is greater (typically 2 to 3 times) than the electricity input, making them an energy-efficient heating method[142].

[140] Solar Thermal Systems and Collectors, DBEIS https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879765/Solar_Thermal_TIL_-_April_2020.pdf
[141] https://energysavingtrust.org.uk/advice/air-source-heat-pumps/#:~:text=Air%2Dto%2Dwater%20heat%20pumps,your%20wet%20central%20heating%20system.&text=They%20will%20not%20provide%20you,Heat%20Incentive%20(RHI)%20scheme.
[142] https://energysavingtrust.org.uk/advice/air-source-heat-pumps/

14.3.1.3 Biomass Boiler or CHP

Biomass heating is an established and proven technology. The technology can be used to provide heat to buildings of all sizes, either through individual boilers or via district heating networks. Refer to section 8 for details of these systems.

14.3.2 Calculation Method

14.3.2.1 Baseline

The baseline of existing electrical energy projects was informed by Western Power Distribution's (WPD) Distribution Future Energy Scenarios (DFES) data. Non-electrical heating technologies were evaluated from two sources; Ministry of Housing, Communities & Local Government (MHCLG) Energy Performance Certificate (EPC) data and English Housing Survey data, which provided a spatial baseline of heating technologies.

14.3.2.2 Projection

Projections of building integrated renewables in the region are estimated primarily using existing WPD DFES projections. The DFES projects the uptake of generation, storage and demand technologies connecting to the distribution electricity network to 2050 using the national Future Energy Scenarios (FES) as a framework.

For more information on the DFES and FES, see Section 14.1 and Appendix P.

14.3.3 Building Integrated Renewable Energy Uptake in 2030

14.3.3.1 Domestic Thermal Technologies

A breakdown of projections of domestic renewable heating technologies in B&NES in baseline year and 2030 is provided in Table 31.

Table 31: Domestic Thermal Technologies Projections

Technology	Number of Installations in 2019	Number of Installations in 2030
Hybrid Heat Pumps – Dwellings	0	8,395
Heat Pumps Systems - Dwellings	135	58,047
Direct Electric Heating Systems - Dwellings	7,312	7,050[143]
Biofuel Systems - Dwellings[144]	0	720
Biomass Systems - Dwellings	144	246
Solar Thermal Systems - Dwellings	46	33
Estimated Number Fossil Fuelled Dwellings (Gas and Off-Gas)	71,101	0[145]
% of Fossil Fuelled Dwellings (Gas and Off-Gas)	90.4%	0%

It is projected that by 2030, there will be a significant shift towards electric heating, it should be noted that policy interventions at national and local scale would be required allow for this major shift.

[143] Direct electric heating could also have a role to play in heating homes of the future where heat demand is particularly low, for instance where a home is built to very high fabric standards, such as passivhaus.
[144] Biofuels such as biomethane are not considered as a separate renewable energy technology in this study, however DFES includes projection of installation for these systems which is incorporated in RERAS.
[145] The Consumer Transformation scenario projects that the residential heating demand in future will be met by mainly electricity, hydrogen and biofuels. See Appendix P for more details. These changes are likely to require interventions at a local and national level, such as policies and incentives to encourage consumers to choose energy-efficient and zero/low carbon heating technologies.

14.3.3.2 Non-Domestic Thermal Technologies

The FES data does not include projections of commercial and industrial thermal technologies. However, projections of total heat demand and the proportion of the heat that is supplied by electricity in these buildings is calculated.

Additionally, it was assumed that high-grade process heat requirements will be met by hydrogen in the commercial and industrial setting and therefore a projection of hydrogen electrolysis' portion of electricity consumption was calculated and shown in Section 12.

14.3.3.3 Buildings Mounted Renewable Electricity Generators

Table 32 includes details of projection of micro building-mounted wind turbines and rooftop solar PV panels in B&NES.

Table 32: Projection of Micro Building-Mounted Solar PV and Wind Installations

Technology	Installed Capacity in 2019 (MWe)	Indicative Number of Installations	Indicative Carbon Savings (2020 Grid Carbon Factor)	Installed Capacity (Including Existing) in 2030 (MWe)	Indicative Number of Installations	Indicative Carbon Savings (2020 Grid Carbon Factor)
Onshore Wind <6kW [146]	0.006	1[147]	1.3	0.088	15	19.5
PV- Commercial Rooftop (10kW - 1MW)	7	127[148]	1,553	46.71	849	10,360
10,360PV- Domestic Rooftop (<10kW)	7.32	1,464[149]	1,624	73.54	14,708	16,311

[146] Small Scale Building Integrated
[147] Assuming 6kW per installation
[148] Assuming 55kW per installation
[149] Assuming 5kW per installation

14.4 Energy Consumption Projections

14.4.1 Calculation Method

14.4.1.1 Baseline

The B&NES energy consumption baseline was informed by BEIS sub-national energy consumption statistics. This provided a sectoral energy baseline for different fuels for B&NES in the study and can be found in Section 3

14.4.1.2 Projection

Projections into the rate of change of energy consumption have been derived from National Grid ESO's Future Energy Scenarios. Therefore, the same scenario framework is used for both the technology projections and the energy consumption projections (see Figure 63).

The ESO FES incorporates the key assumptions necessary to model future energy consumption projections within a scenario framework for different future pathways. For example, the scenarios incorporate assumptions on heating, including home efficiency improvements, technology efficiency improvements, and changes in consumer behaviour. It should be noted that achieving these will require policy interventions at the local and, in some cases, national level.

For more information on the DFES and FES, see Section 14.1.

14.4.1.3 Industrial Process and Manufacturing Energy Consumption

Some energy consumption lies outside the scope of the National Grid ESO FES. In these cases, the Climate Change Committee's (CCC) Further Ambition scenario[150] projections on industry emissions are used. Relative to other sectors in the region, these emissions are relatively small.

14.4.1.4 2030 Decarbonisation Aim Adjustment

As with the technology projections, the energy consumption projections have also been condensed from 2050 to 2030. Therefore, this assumes that underlying assumptions on consumer behaviour change, technology efficiencies, and energy efficiency rates have also been accelerated to meet local ambition. Appendix R includes details of the key data sources used to calculate future energy consumption and building integrated renewable technologies projections.

[150] https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf

14.5 2030 Energy Consumption in Bath and North East Somerset

Projected energy consumption in B&NES in 2030 is provided in Table 33.

Table 33: Projected Energy Consumption (GWh) in B&NES in 2030

Fuel Type	Use	Details	2030 Energy Consumption (GWh)
Fossil Fuels and Renewables Other Than Electricity	Heating	Domestic Buildings Fossil Fuels and Renewables Energy Consumption for Heating	72.8
Electricity	Heating	Domestic Buildings Electricity Consumption for Heating (Includes Demand for Hydrogen Electrolysis)	295.2
Electricity	Non-Heating Electricity in Buildings	Domestic Buildings Non-Heating Electricity Consumption	159.6
Fossil Fuels and Renewables Other Than Electricity	Heating	Commercial and Industrial Buildings Fossil Fuels and Renewables Energy Consumption for Heating	54.1
Electricity	Heating	Commercial and Industrial Buildings Electricity Consumption for Heating (Includes Demand for Hydrogen Electrolysis)	90.6
Electricity	Non-Heating Electricity in Buildings	Commercial and Industrial Buildings Non-Heating Electricity Consumption	343.4
Fossil Fuels and Renewables Other Than Electricity	Transport Sector	Transport Sector Other Fuels Consumption	66.1
Electricity	Transport Sector	Transport Sector Electricity Consumption	177.3
Total Heat Demand (Including Electrical Heating Consumption)		512.8	
Total Electricity Consumption (Including Electrical Heating Consumption and Transport Sector Electricity Consumption)		1,066.2	
Total Transport Sector Energy Consumption		243.4	
Total Energy Consumption		**1,259.2**	

Based on the results, there will be a total energy consumption of 1,259.2GWh in 2030 in B&NES; of this, domestic buildings' energy consumption accounts for 527.7GWh, C&I sector 488.2GWh and transport sector 243.4Wh of the total consumption.

The total electricity consumption across B&NES is projected to be 1,066.2GWh in 2030, including 385.8GWh of electric heating and 177.3GWh for electric vehicles

The total heat consumption across B&NES is projected to be 512.8GWh. Of this, 385.8Wh will be met via electrical heating, and the remaining heat, which will be supplied by fuels other than electricity, is 126.9GWh.

To meet the additional heating demand, it is anticipated that fossil fuels may be required and thus will require offsetting in order to meet the net zero aim. The potential offsetting as a result of the use of these fossil fuels is outside the scope of the RERAS. The FES assumes that BECCS can be used as an offsetting method, see Section 14.1.1[151].

Figure 65 below illustrates the projected energy consumption across different sectors in B&NES in 2030.

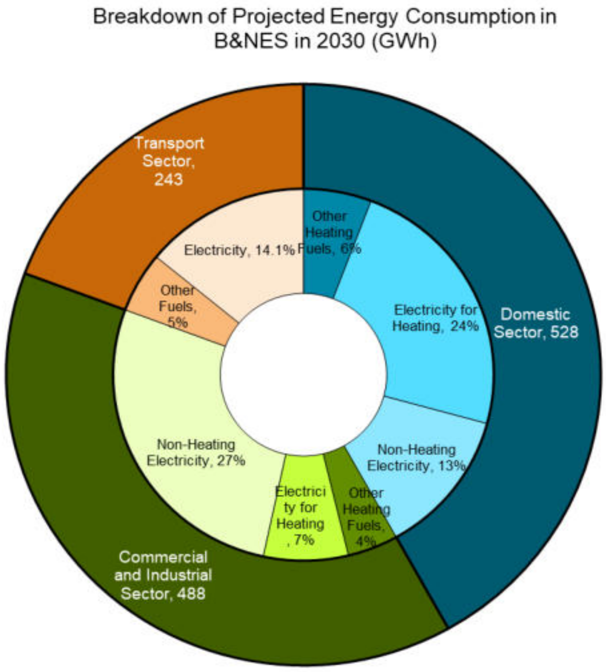


Figure 65: Breakdown of Projected Energy Consumption (GWh) in B&NES

Figure 66 below provides a comparison between the current and projected 2030 Energy.

[151] It should be noted that offsetting should be viewed as a last resort to meet additional heating demand and use of offsetting does not agree with Climate Emergency declarations.

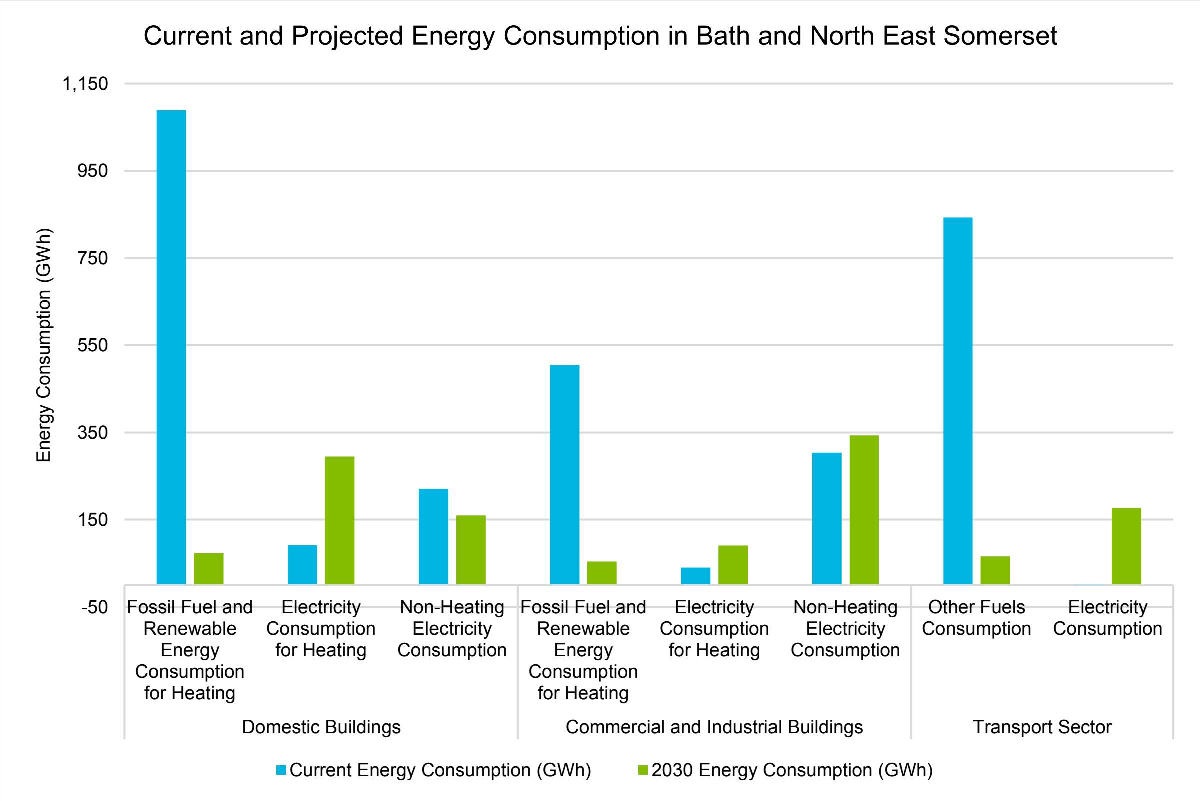


Figure 66: Comparison of Current and 2030 Projected Energy Consumption Bath and North East Somerset

For domestic buildings, the use of fossil fuels is projected to be reduced significantly in 2030, in fact figures and table in Appendix P only project a small amount of natural consumption in Industrial and Commercial sector only. Therefore, the green parts in this figure (for Fossil Fuel and Renewable Energy Consumption for Heating) are mainly for renewable energy. It should also be noted that under Consumer Transformation, heat pumps become the dominant heating technology hence the significant change in electricity for heating demand in comparison to moderate change in other renewables. The scenario assumes that the energy efficiency of buildings is improved through better insulation and by more energy efficient appliances. This reduces overall energy demand and will enhance the operation of heat pumps, when fitted. These major changes are likely to require policy interventions as national and local level by 2030.

The significant reduction in Transport energy demand relates to road transport and is due to a combination of electrification, automation and changing consumer behaviour[152].

Commercial and industrial buildings follow a similar pattern in relation to heat pumps as domestic buildings, it also includes implantation of energy efficiency measures, but it should be noted that some industrial processes will not be fully decarbonised as mentioned above.

[152] National Grid ESO Future Energy Scenarios, July 2020, page 44 “The energy efficiency of vehicles varies greatly at point of use” https://www.nationalgrideso.com/document/173821/download

15. Identifying the Contributions of Bath and North East Somerset

15.1 Introduction

The previous sections of this study comprise an assessment of the potential renewable energy resource across B&NES, converted into installed capacities for each of the technologies. In doing this exercise, assumptions have been made about the technologies that might be utilised to meet the projected consumption in 2030. This section looks to combine outputs of the resource assessment, technology assumptions and future demand projections to and provide some scenarios for B&NES to meet its renewable energy generation aims. In order to integrate these sections, a series of steps need to be followed:

Calculate the potential energy generation from the new opportunities identified

↓

Calculate the maximum potential of all renewables (includes existing generators)

↓

Compare the maximum potential renewable energy generation in 2030 with B&NES' 2030 energy consumption

↓

Use the above information to present some potential scenarios for renewable energy development for the Council to consider

15.1.1 Calculating Energy from Installed Capacity

The area-wide resource assessment results indicate the potential installed capacity for different technologies (in MW) that the available resource can support. A well-established and straightforward way of estimating how much energy the potential capacity might generate is to use capacity factors (as load factors).

These factors, which vary by technology, measure how much energy a generating station will typically produce in a year for any given installed capacity.

This reflects the fact that the installed capacity is a measure of the maximum amount of power or heat that a generating station can produce at any given moment. However, for reasons to do with either fuel availability, the need for maintenance downtime, or a heat-generating plant, a lack of heat demand at certain times of day or year, the capacity factor is always less than 1.

The annual energy output for each technology can be calculated by multiplying the installed capacity by its capacity factor and the number of hours in a year (8,760).

A summary of the different capacity factors for different technologies is given in Table 34 and Appendix Q includes sources of the data for each renewable technology capacity factor.

Table 34: Capacity Factors for Renewable and Low and Zero Carbon Technologies

Technology	Capacity Factor[153]
Onshore Wind	0.25
Biomass (Electricity)	0.75
Biomass (Heat)	0.40
Hydropower	0.29
Energy from Waste (Electricity)	0.90
Energy from Waste (Heat)	0.50
Landfill Gas (Electricity)	0.46
Landfill Gas (Heat)	0.30
Anaerobic Digestion Utilising including Food Waste, Animal Slurry, Poultry Litter, Sewage Sludge and Sewage Gas. (AD with CHP)	0.43
Anaerobic Digestion Utilising Food Waste, Animal Slurry, Poultry Litter, Sewage Sludge and Sewage Gas. (Heat)	0.5
Solar Farm	0.11
Domestic and Non-Domestic Renewable Electricity Technologies Such as Rooftop Solar PV (electricity)	0.10
Domestic and Non-Domestic Renewable Thermal Technologies (Thermal)	0.20

15.2 Maximum Theoretical Potential of New Renewable Energy Solutions

The maximum theoretical new potential renewable electrical and thermal installed capacity across B&NES, excluding that which is already installed, is calculated as circa 5,566MWe and circa 0.09MWt for 2030

The figures above exclude building integrated biomass and biofuel. DFES makes projections about how much biomass and biofuel will be used in B&NES in 2030. The figure assumed is lower than the identified available resource, so we have assumed that only the DFES amount is supplied from local biomass sources and is represented as a 'consumption' figure in Table 35 (as opposed to an installed capacity/ generation figure).

The maximum theoretical new potential renewable electrical and thermal generation across B&NES, excluding that which is already installed, was calculated as circa 5,607MWhe and circa 39.1MWht for 2030.

Electric heating installations are not included within this section as they are based on the DFES condensed projection and are therefore presented within the projected total electric consumption figures; see Section 14.4; which shows a 2030 energy consumption of 295.2GWh and 90.6GWh for domestic building electricity consumption and commercial and industrial building electricity consumption for heating respectively.

The total installed electrical capacity is dominated by potential solar and wind power with contributions from energy from waste, building integrated technologies and hydropower sites. These figures represent the theoretical maximum potential resource.

Total potential heating technologies across B&NES in 2030 will be dominated by electric heating (whether this is in the form of direct electric, heat pumps and/or hydrogen generated by electrolysis (mainly in the C&I sector). It should be noted that, due to hydrogen being an up-and-coming technology, it will be challenging to introduce the necessary infrastructure for large scale deployment by 2030 as it will be to retrofit the majority of homes with heat pumps and replace the majority of fossil fuelled vehicles with electric versions. It could be, due to the compressed timescales of B&NES'

[153] Refer to Appendix Q for sources of the data.

delivery aims, that the nature of the Council's decarbonisation is different to DFES projections e.g. hydrogen consumption is replaced by different electrically fed solutions or other low energy carbon carriers such as biogas.

Table 35 shows that there will be additional potential from other renewable heating technologies such as Energy from Waste (EfW). The figures shown in the table use the DFES projections for building integrated systems and the resource identified within this study for wind and solar PV developments[154].

Table 35: Maximum Potential Renewable Energy Resource and Generation in B&NES in 2030 (Excluding Existing Installations and Heat Delivered via Electric Heating Systems)

Resource	Potential Installed Capacity (Excluding Existing)		Potential Maximum Delivered Energy GWh	
	Electricity (MWe)	Thermal (MWt)	Electricity (GWhe)	Thermal (GWht)
Hydropower	0.403	-	1.01	-
Wind (500kW, 1.0MW and 2.5MW Turbines) [155]	180.01	-	391.8	-
Solar PV Farms	5,279.60	-	5,120.87	-
Projected Building Integrated Wind (<6kW) Turbines in 2030	0.08	-	0.07	-
Projected PV-Commercial Rooftop (10kW - 1MW) in 2030	39.71	-	34.79	-
Projected PV-Domestic Rooftop (<10kW) in 2030	66.22	-	58.01	-
Projected biomass consumption by building integrated biomass boilers in 2030 (domestic)	-	-	-	5.956
Projected biofuel consumption by building integrated biofuel boiler in 2030 (domestic)	-	-	-	32.9
Projected heat delivered by solar thermal in 2030 (domestic)	-	0.09	-	0.16
Total	**5,566.02**	**0.09**	**5,606.55**	**39.01**

15.3 Bath and North East Somerset Maximum Potential Renewable Energy Generation and 2030 Energy Consumption

Table 36 shows the theoretical maximum potential renewable electrical and thermal generation across B&NES, including that which is already installed[156]. The electric heating installations are not included in this section as they are considered in total electricity consumption figures.

[154] In this RERAS, 41.29GWht of biomass resource has been identified (see Section 8) however, the above figures only contain uptake based on the DFES and therefore these have not been included in the table.

[155] The potential from 1.0MW and 2.5MW search areas cannot be added together as some of the areas overlap. The maximum capacity in this table is taken from 1.0MW search areas plus and additional non-overlapping 2.5MW search areas.

[156] In this RERAS, 41.29GWht of biomass resource has been identified (see Section 8) however, the above figures only contain uptake based on the DFES and therefore these have not been included in the table.

Table 36: Maximum Potential Renewable Energy Generation in Bath and North East Somerset in 2030 (Excluding Heat Delivered via Electric Heating Systems)

Resource	Existing Installed Capacity		Maximum Installed Capacity from New Installations		Potential Maximum Delivered Energy GWh	
	Electricity (MWe)	Thermal (MWt)	Electricity (MWe)	Thermal (MWt)	Electricity (GWhe)	Thermal (GWht)
Energy from Waste	0.06	0.11	0.00	0.00	0.45	0.25
Hydropower	0.162		0.403	-	1.41	
Landfill Gas	1.60		0.00	0.00	6.48	
Large Scale Wind[157]	0.105		180.01	-	392.03	
Solar PV Farms	5.87		5,279.60	-	5,126.56	
Other (including, food waste, animal slurry, poultry litter and sewage sludge. AD with CHP and biomass)	5.11	8.68	0.00	0.00	25.15	34.44
Projected Building Integrated Wind (<6kW) Turbines	0.001		0.08		0.08	
Projected PV-Commercial Rooftop (10kW - 1MW)	7.0		39.71		45.31	
Projected PV-Domestic Rooftop (<10kW)	7.30		66.22		71.33	
Projected biomass consumption by building integrated biomass boilers in 2030 (domestic)						5.95
Projected biofuel consumption by building integrated biofuel boiler in 2030 (domestic)						32.90
Projected heat delivered by solar thermal in 2030 (domestic)				0.09		0.16
Non-domestic renewable thermal technologies other than heat pumps[158]		4.8				8.33
Total					**5,668.8**	**82.03**

The total potential electrical capacity is dominated by potential solar and wind power with contributions from energy from waste, building integrated technologies, biomass, anaerobic digestion plants and hydropower sites. These figures represent a theoretical maximum potential resource.

The data shows that the theoretical maximum potential renewable electricity generation in B&NES in 2030 is circa 5,668.8GWh. Therefore, there would be more than enough resource to meet the 1,066 GWh projected electricity consumption in 2030 (see Section14.4).

[157] The potential from 1.0MW and 2.5MW Search Areas cannot be added together as some of the areas overlap. The maximum capacity in this table is taken from 1.0MW Search Areas plus and additional non-overlapping 2.5MW Search Areas.
[158] It has been assumed the majority of new renewable heat installations in non-domestic buildings will be of electric heating. High-grade heat requirements will be met by hydrogen in the C&I setting and therefore hydrogen electrolysis's portion of electricity demand is also calculated and included.

The total 2030 electricity consumption includes electrical heating (including heat pumps), transport sector electricity consumption, electricity consumption for uses other than heating, and electricity consumption for hydrogen electrolysis.

As the potential renewable electricity generation in B&NES is considerably higher than required to meet the projected 2030 consumption of 1,066GWh, there is flexibility for the Council to apply other constraints and other considerations to refine the SAs through the Local Plan process. Data regarding potential additional constraints and their impact upon theoretical maximum potential renewable energy generation can be found in Appendix G and Appendix J.

The theoretical maximum potential from renewable heating technologies is projected to be 82.03GWh in 2030. Therefore, it is concluded that there will only be enough resource to meet 64.6% of the projected 127GWh heat consumption (see Section14.4) by fuels other than electricity.

The renewable heating technologies include biomass (energy crops and wood fuel) anaerobic digestion with CHP (food waste, animal slurry, poultry litter and sewage sludge) and solar thermal.

The maximum potential for renewable energy resource is presented in this section however a 100% uptake of the potential installed capacity identified through the study particularly for solar PV and wind is extremely ambitious and unlikely to be achievable. It would also be highly undesirable for such a large proportion of B&NES to be developed for energy generation. Moreover, there is insufficient demand and infrastructure to take the power that would be generated by such an approach and hence the majority of the developments would become unviable as projects. Appendix U includes further details regarding this option.

15.4 Scenarios for a Carbon Neutral B&NES in 2030

This RERAS has utilised the Distribution Future Energy Scenarios (DFES) and Future Energy Scenarios (FES), accelerated from 2050 to 2030, to project the electricity and heat consumption in B&NES in 2030. For more information on the FES and DFES; see Section 14.1 and for guidance on incorporating RERAS results into the DFES process, see Section 14.1.3.

Policy Recommendation

Policy Reference: SC-PR-1 (Refer to Table 40 in Section 17)

It is recommended the three NZC calculations are presented as scenarios, for information only.

Policy Recommendation

Policy Reference: SC-PR-2 (Refer to Table 40 in Section 17)

It is recommended that B&NESC aims to maximise the potential for the generation and supply of renewable and low and zero carbon electricity and heat.

At the moment, the decarbonisation scenarios presented reflect, as accurately as possible, the evidence gathered i.e. the future demand for electricity will increase significantly and the only resource and technologies likely to be able to meet the demand in 2030 is larger scale wind farms and solar PV farms. This study reveals the key policy considerations, how much local generation is acceptable and where to locate it. The evidence and recommendations presented here inform those considerations including for public consultation and community engagement at a later stage through the Local Plan process. Community engagement is considered in Section 16 and recommendations for policy provided in Section 17. We have presented three decarbonisation scenarios below to inform the discussion and how each of the scenarios relate to net zero carbon in B&NES in 2030.

In all three of the scenarios, it was assumed that the assumptions set out for 2050 in DFES Consumer Transformation scenario are met in 2030, this includes the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated renewables and the transformation of the transport systems (e.g. electric vehicle uptake). These projections are likely to require policy interventions at the local and national levels to be met.

1. **Meet the DFES defined efficiency and renewable energy contribution only**

   In this scenario, it is assumed that the Consumer Transformation 2050 projections (see Appendix P) set out in the DFES for B&NES are met in 2030. The energy generation produced by renewables is equivalent to B&NES' share of grid renewable electricity in 2050 to meet zero carbon. This scenario results in B&NES greening its share of the grid electricity by 2030. Once other areas 'catch-up' in 2050 as per DFES, B&NES electricity consumption will become net zero. This scenario includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated and standalone renewables (e.g. solar PV and wind farms) and the transformation of the transport systems (e.g. electric vehicles uptake). This scenario and the following two scenarios are likely to require policy interventions at the local and national levels.

   This scenario means that B&NES would only 'green' the proportion of the grid identified by the DFES.

2. **Meet the equivalent of 33% of the demand in B&NES by 2030 and set out a pathway and targets to ensure the equivalent of 100% of the demand is met by 2050**

   This scenario acts as a steppingstone between scenarios 1 and 3 and assumes that 33% of the electricity demand in B&NES in 2030 will be met by installing additional wind and solar developments in some of the Search Areas identified in this study. As there are certain assumptions outlined in the DFES (such as uptake of heat pumps and electric vehicles) that have been condensed to 2030 in this study, this option provides insurance if these are not met as a higher proportion of the demand will be met by renewables in comparison to the scenario one projection. Therefore, this scenario also includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated renewables and the transformation of the transport systems (e.g. electric vehicles uptake).

   The renewable energy generation can then be assessed every 10 years, and the aim increased to ensure the equivalent of 66% of B&NES' demand can be met by 2040 and 100% by 2050. By 2030, this approach also meets the equivalent of the proportion of the grid identified in the DFES as B&NES contribution to UK zero carbon in 2050.

3. **Meet the 2030 consumption in B&NES from generation located within B&NES the**

   This scenario assumes that the 2030 electricity demand in B&NES will be met by installing additional wind and solar developments in some of the Search Areas identified in this study. The demand could be met through a varying combination of wind development and solar development, promoted through Local Plan policies and strategy. This scenario also includes the assumptions set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency upgrades in buildings, installation of building integrated renewables and the transformation of the transport systems (e.g. electric vehicles uptake).

The technology aims and combinations can be finalised through public consultation and community engagement at a later stage. Community Engagement is considered in Section 16 and recommendations for policy provided in Section 17. Once the aims for B&NES are finalised, these can be fed into future iterations of DFES, to achieve progressively better alignment.

Below, in Figure 67 is a bar chart that provides a visual representation of the renewable electricity generation in 2030 for each scenario as well as B&NES' electricity consumption in 2030.

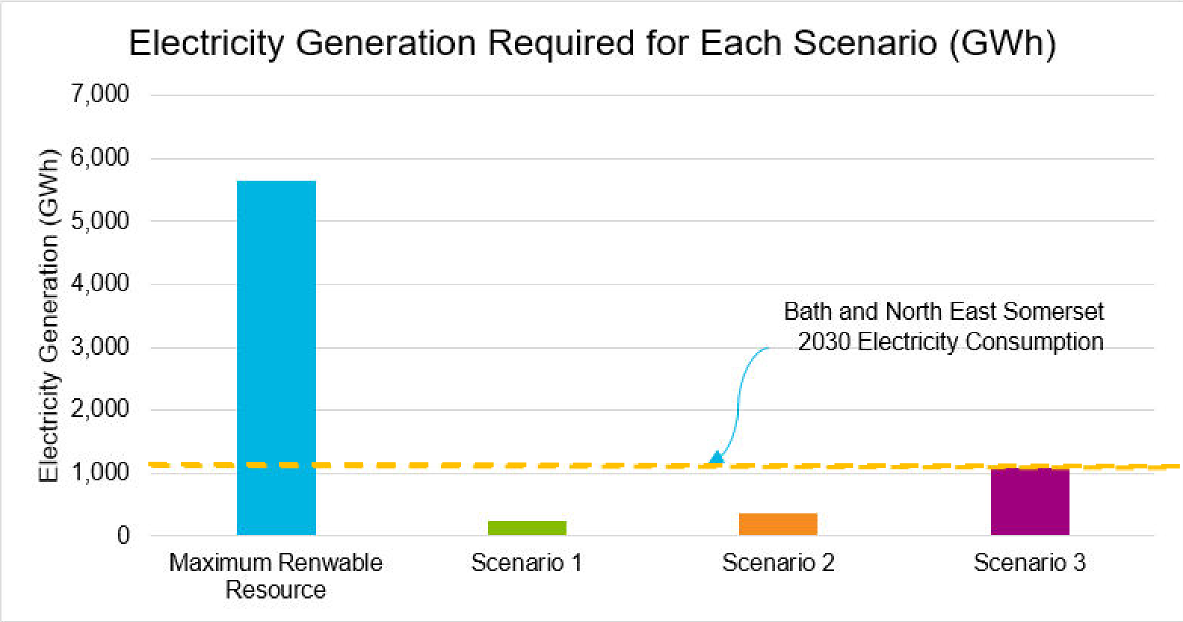


Figure 67: Comparison of Energy Generation Required for Each Scenario

The three scenarios are explained in further detail below.

Scenario 1 - Meeting the Distribution Future Energy Scenario Projection by 2030

In this scenario, it is assumed that the Consumer Transformation 2050 projections (see Appendix P) set out in the DFES for B&NES are met in 2030. The energy generation produced by renewables is equivalent to B&NES' share of grid renewable electricity in 2050 to meet zero carbon. This scenario results in B&NES greening its share of the grid electricity by 2030. Once other areas 'catch-up' in 2050, as per DFES, B&NES electricity consumption will become net zero. This scenario includes the assumption set out in the DFES Consumer Transformation scenario, including the number of heat pumps installed and changes to the heating systems, energy efficiency in buildings, installation of buildings integrated and standalone renewables (e.g. solar PV and wind farms) and the transformation of the transport systems (e.g. electric vehicles uptake). These projections are likely to require policy interventions at the local and national levels to be met. This scenario results in B&NES greening its share of the grid electricity in 2030, but it should be noted that although B&NES' proportion of the grid will be green by 2030, the rest of the UK will not have achieved greening their proportion of the grid yet. The breakdown of the DFES projections can be found in Appendix T.

Scenario 1 assumes that the majority of homes are primarily heated by heat pumps (circa 73% of homes in the South West of England as per the DFES), and there will be an overall decrease in the number of dwellings with direct electric heating in B&NES.

Scenario 1 assumes that there will be circa 270 times more electric vehicles than in 2020 in the South West of England, as per the DFES[159].

The DFES requires approximately five new 5MW wind developments and two new 50MW ground mounted solar developments in B&NES to meet the large sale wind and solar projections.

Meeting the DFES projection in 2030 would generate enough renewable electricity to cover 20.3% of B&NES' 2030 Consumption.

This scenario means that B&NES would only 'green' the proportion of the grid identified by the DFES.

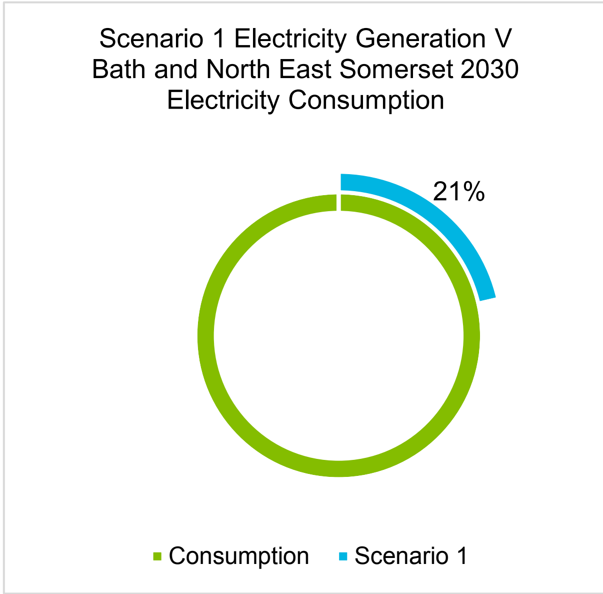


Figure 68: Electricity Generation Comparison of Scenario 1 and Bath and North East Somerset's 2030 Consumption

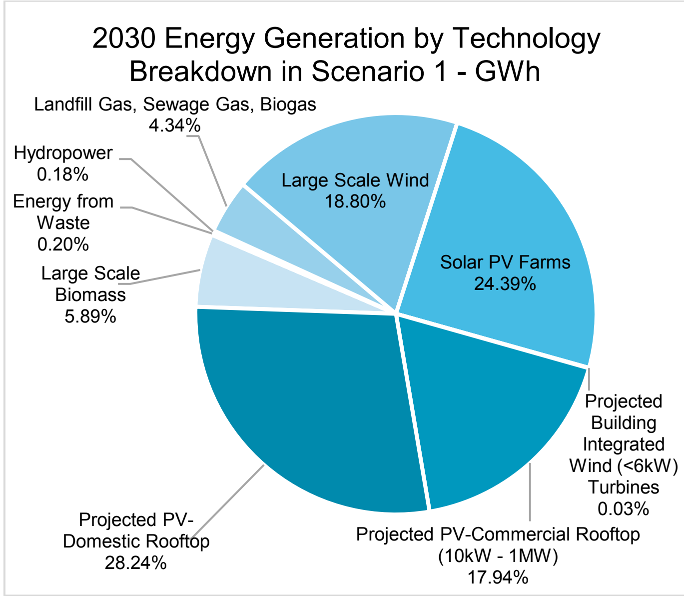


Figure 69: 2030 Energy Generation by Technology Breakdown in Scenario 1 - GWh

Figure 70: Pictogram of Number of Additional 50MW Solar Farms and 5MW Wind Farms Required in Scenario 1[160]

Table 37: DFES Technology Projection Breakdown (See Appendix T for More Details)

Technology	2050 DFES Projection	2030 Projection for Bath and North East Somerset	Total Generation Required to meet 2030 DFES Projection (MWh/annum)	Additional Capacity required to meet DFES (MWe)	Additional Generation required to meet DFES (MWh)
Onshore Wind	22.22	22.22	42,878	22.12	42,786
Ground Mounted Solar	57.4	57.4	55,642	51.50	49,952
Building Integrated Wind	0.088	0.088	76.97	0.088	71.71
Building Integrated Solar - Rooftop	91.2	73.54 [161]	105,341	66.22	58,006
Landfill Gas, Sewage Gas, Biogas	2.52	2.52	9,889	-2.16	-8,506
Hydropower	0.162	0.162	404.4	0	0
Large Scale Biomass	2.032	2.03	13,439	0	0
Waste Incineration (EfW)	0.057	0.057	445.9	0	0

[159] 7,000 EVs in baseline year and 1,894,000 EVs in 2030 in the South West licence area in Consumer Transformation scenario. https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf
[160] Each solar panel icon is equivalent to one 50MW solar farm. Each wind turbine icon is equivalent to one 5MW wind farm.

[161] The building integrated solar 2030 figure is lower than the DFES 2050 projection as number of new dwellings used within this assessment aligns with the value predicted within the DFES for 2030 not 2050.

Scenario 2 – Meet 33% of Bath and north East Somerset's Consumption by 2030

This scenario acts as a stepping-stone between scenarios 1 and 3.

It is still assumed that the DFES projections for B&NES, accelerated to 2030 for this study, would be installed and the additional generation would be covered through the wind and solar Search Areas identified in this study. However, as specific projections outlined in the DFES (such as transport transformation and heating systems uptake) have been condensed to 2030 in this study, this option provides insurance if these are not met.

A 100% uptake of the available wind installations (1.0MW and 2.5MW SAs) was assumed, with the additional required generation being met by the solar PV farms. This combination is not mandatory, and a different ratio of wind farms to solar PV farms could be used to meet the required generation.

In this scenario, a pathway can be produced, which includes a series of renewable energy generation aims that can be assessed and updated on a 10-year basis to ensure B&NES can achieve net zero carbon by 2050. The suggested pathway is as follows:

2030
33% of the demand is met by renewable energy generation in B&NES

2040
66% of the demand is met by renewable energy generation in B&NES

2050
100% of the demand is met by renewable energy generation in B&NES

Scenario 2 assumes that the majority of homes are primarily heated by heat pumps (circa 73% of homes in the South West of England as per the DFES), and there will be an overall decrease in the number of dwellings with direct electric heating in B&NES.

Scenario 2 assumes that there will be circa 270 times more electric vehicles than in 2020 in the South West of England, as per the DFES[162].

Scenario 2 would require three new 50MW solar farms and nine new 5MW wind farms in B&NES.*

*Assuming a take up of 100% of the wind resource (1.0MW and 2.5MW SAs) identified in this study, and meeting the rest with solar PV

This scenario requires consideration by the Council and communities, industry and other stakeholders as to the appropriate renewable energy generation mix. This could include decisions relating to the planning balance and potential additional constraints within B&NES.

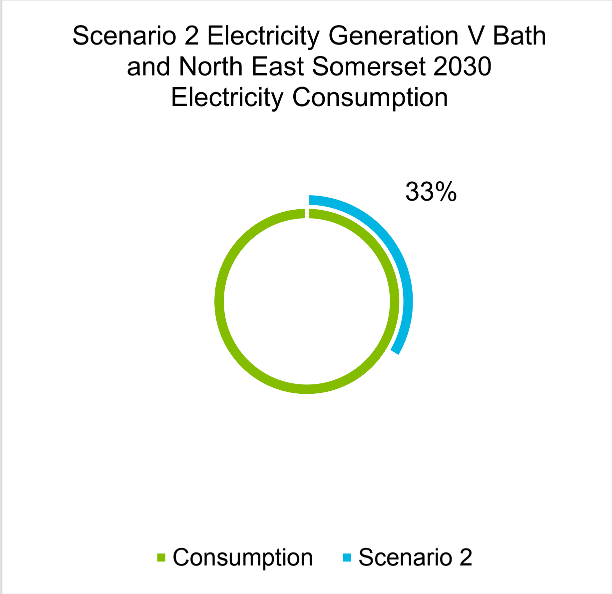


Figure 71: Electricity Generation Comparison of Scenario 2 and Bath and North East Somerset's 2030 Consumption

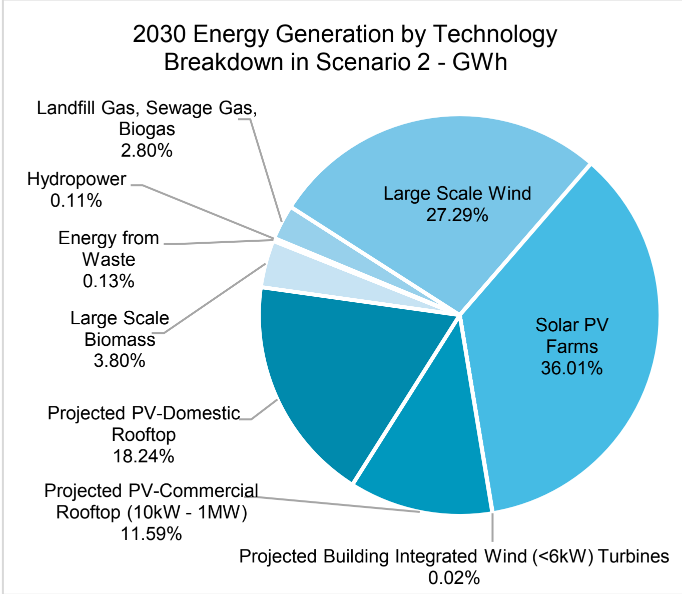


Figure 72: 2030 Energy Generation by Technology Breakdown in Scenario 2 - GWh

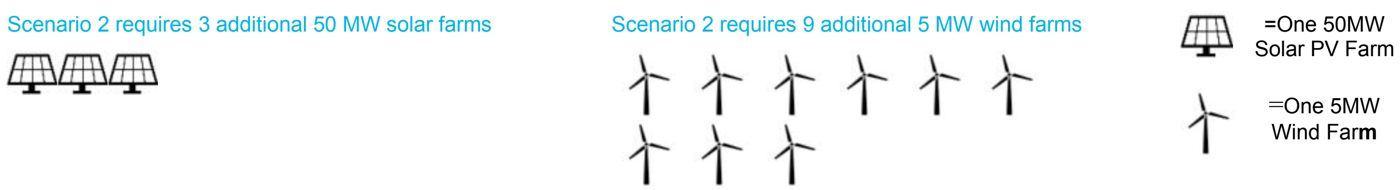


Figure 73: Pictogram of Number of Additional 50MW Solar Farms and 5MW Wind Farms Required in Scenario 2[163]

Table 38: Electricity Generation Potential from New Wind and Solar Farms in Scenario 2[164]

	Wind Farms				Solar			
	Assumed Up-take %	**Installed Capacity (MW)**	**Projected Electricity Generation from Wind (GWh)**	**Estimated Number of New Wind Farms to be Built until 2030****	**Assumed Up-take %**	**New Installed Capacity (MW)**	**Projected Electricity Generation from Solar PV (GWh)**	**Estimated Number of New Solar PV Farms to be Built Until 2030*****
Total New Potential based an assumed up-take	100%	44	96.4	9	3%	132	127.2	3

**Assuming 5MW per site (eq 0.625 km²)

*** Assuming 50MW per site (eq 1.2 km²)

162 7,000 EVs in baseline year and 1,894,000 EVs in 2030 in the South West licence area in Consumer Transformation scenario. https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf

163 Each solar panel icon is equivalent to one 50MW solar farm. Each wind turbine icon is equivalent to one 5MW wind farm.

164 It is still assumed that the DFES projections for other technologies, accelerated to 2030 for this study, would be installed (see Appendix T).

Scenario 3 – Meeting Bath and North East Somerset's 2030 Electricity Consumption

This scenario provides enough renewable energy generation to meet the 2030 electricity consumption.

It is still assumed that the DFES projections for B&NES, accelerated to 2030 for this study, would be installed (see Appendix T) and the additional generation would be covered through the wind and solar Search Areas identified in this study.

As the wind Search Areas were more finite than the solar PV Search Areas, and wind turbines have a higher space efficiency for the same energy generation and are generally more efficient, it was assumed a 100% uptake of the available wind installations (1.0MW and 2.5MW SAs), with the additional required generation being met by the solar PV farms. This combination is not mandatory and a different ratio of wind farms to solar PV farms could be used to meet the electricity consumption.

It should be noted that the lack of grid connection opportunities may affect the ability of B&NES to meet the 2030 aim under this scenario; therefore, more investment in the grid would be required to support a greater number of renewables than is currently assumed to be needed from DFES.

Scenario 3 assumes that the majority of homes are primarily heated by heat pumps (circa 73% of homes in the South West of England as per the DFES), and there will be an overall decrease in the number of dwellings with direct electric heating in B&NES.

Scenario 3 assumes that there will be circa 270 times more electric vehicles than in 2020, in the South West, as per the DFES[165].

Scenario 3 would require eighteen new 50MW solar farms and nine new 5MW wind farms in B&NES.*

*Assuming a take up of 100% of the wind resource (1.0MW and 2.5MW SAs) identified in this study, and meeting the rest with solar PV

This scenario requires consideration by the Council and communities, industry, and other stakeholders as to the appropriate renewable energy generation mix. This could include decisions relating to the planning balance and potential additional constraints within B&NES.

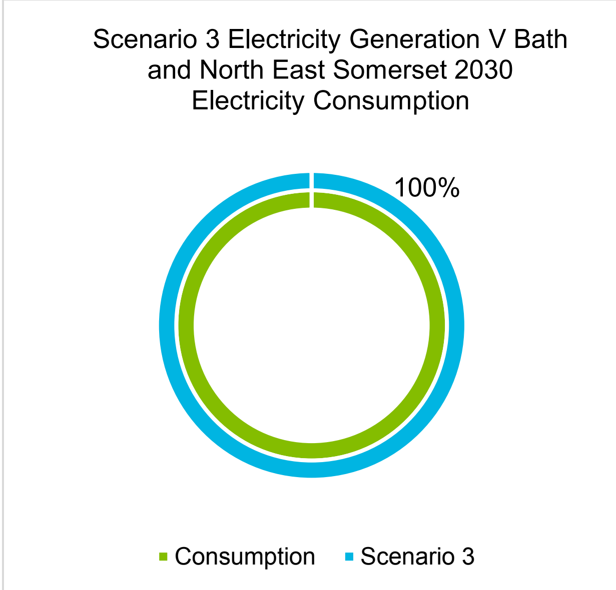


Figure 74: Electricity Generation Comparison of Scenario 3 and Bath and North East Somerset's 2030 Consumption

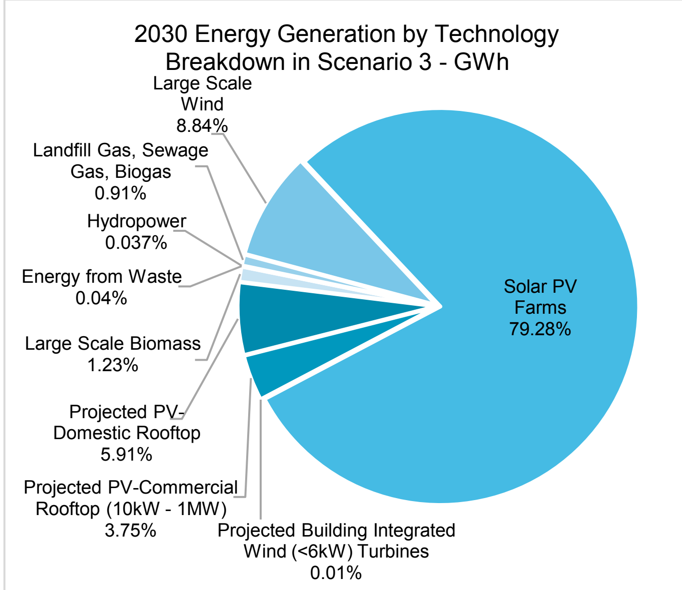


Figure 75: 2030 Energy Generation by Technology Breakdown in Scenario 3 - GWh

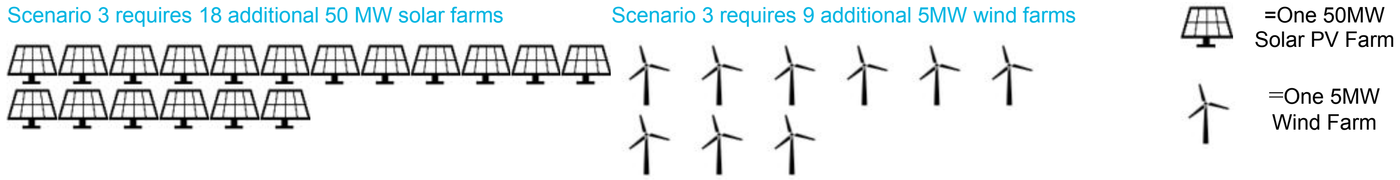


Figure 76: Pictogram of Number of Additional 50MW Solar Farms and 5MW Wind Farms Required in Scenario 3[166]

Table 39: Electricity Generation Potential from New Wind and Solar Farms in Scenario 3[167]

	Wind Farms				Solar PV			
	Assumed Up-take %	Installed Capacity (MW)	Projected Electricity Generation from Wind (GWh)	Estimated Number of New Wind Farms to be Built until 2030**	Assumed Up-take %	New Installed Capacity (MW)	Projected Electricity Generation from Solar PV (GWh)	Estimated Number of New Solar PV Farms to be Built Until 2030***
Total New Potential based an assumed up-take	100%	44	96.4	9	17%	898	864.9	18

1. **Assuming 5MW per site (eq 0.625 km²)

*** Assuming 50MW per site (eq 1.2 km²)

[165] 7,000 EVs in baseline year and 1,894,000 EVs in 2030 in the South West licence area in Consumer Transformation scenario. https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf

[166] Each solar panel icon is equivalent to one 50MW solar farm. Each wind turbine icon is equivalent to one 5MW wind farm.
[167] It is still assumed that the DFES projections for other technologies, accelerated to 2030 for this study, would be installed (see Appendix T).

16. Advice on Community Engagement

16.1 Community Engagement

Community engagement is essential to ensure the foundations of a long-lasting positive relationship between the community and those involved in developing renewable and low carbon energy proposals. Disregarding the importance of community engagement can lead to negative impacts on the community's economic, environmental or social situation[168]. The Community Engagement Guidance from the Department of Energy and Climate Change (DECC)[169] states that effective engagement can ensure that a development proposal:

- reflects an accurate understanding and appreciation of local interests and concerns;
- provides a better and more timely consideration of the material benefits and impacts of the proposal, which is reflected in the decision-making process; and
- ensures that, if the proposal goes ahead, local people have the opportunity to shape how the development is actually realised and build an ongoing relationship with the developer

All parties involved in renewable and low carbon energy developments, developers, local authorities and communities, should follow the principles of best practice:

Timely

A clear timetable in which engagement opportunities are identified should be created by all parties. Should this change, every effort should be made to communicate this to everyone.

The engagement opportunities should commence early in the process, where it is easy and cost-effective to make changes and so that adequate time is allowed for consideration and response to these changes. Feedback is essential to aid the understanding of how the information collected throughout the engagement process is used.

Transparent

All parties should be clear about the interests and people they are representing. Accessible and understandable information should be provided to enable easy engagement with the process. Fixed aspects of the development and community benefits should be made clear and explanations provided, alongside highlighting areas that are 'up for debate.'

Constructive

All engagement should be undertaken in a positive manner, creating and strengthening relationships built on mutual trust. All communication should be a two-way process and actions to adopt links with parties who can advise and support the use of suitable engagement links.

Inclusive

Understanding of the whole range of local opinions about the proposed developments should be sought. Exploration into understanding the potential barriers to those actively participating should be undertaken to ensure that there is an equal opportunity for everyone to be heard. A variety of engagement methods will ensure that there is a chance to get involved in a way that is suited to everyone's needs. These practices should be reviewed, and gaps identified and improved upon that will help widen the process and ensure views from across the spectrum of the community are heard.

[168] Code of Practice for Wind Energy Development in Ireland, Guidelines for Community Engagement, http://www.derryaddwindfarm.ie/wp-content/uploads/sites/6/2017/06/Code-of-Practice-community-engagment.pdf

[169] Community Engagement for Onshore Wind Developments: Best Practice Guidance for England, DECC, October 2014, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/364244/FINAL_-_Community_engagement_guidance_-06-10-14.pdf

Fair and Evidence Based

All parties should acknowledge and respects the rights of all those who are involved in the process to express their views. Robust, factual information and evidence should form the basis of engagement. Participants should have the opportunity to take an active part in the development proposals and understand how their opinions and input affect the development proposal. Changes made to the development should be done based on the wider community view and not a forthright minority.

Unconditional

It should be made clear that any engagement, at any stage of the development, does not imply support for the development, nor that approval by the local planning authority has a higher chance of being achieved.

After the completion of this RERAS, a community engagement process should begin. The term 'community' encompasses a variety of people, including communities of place and communities of interest. It is, therefore, essential to ensure that the information within the RERAS is delivered to the community in an accessible and engaging manner.

When considering the term 'local community' in the community engagement process, it is difficult to define the geographical extent of 'local', however, it is essential to ensure that the local community has backed the development proposal, as per footnote 54 in the National Planning Policy Framework[170]. For renewable and low carbon development, the local community may include[171]:

- Proximity to the development;
- Visual impact from the development (the nearest residents may have less of a view of the wind farm than those living further away but with more direct sightlines);
- Level of disruption and nuisance caused by construction activity and traffic;
- How the location is used for work or recreation by the wider community; and
- Noise impact from the development.

The best option to engage with the community would be through public consultation, in which the mapping process is explained to the community, showing each mapping layer and the constraints applied at each step. Through this consultation, clear aims and timeframes can be conveyed to the community and a space can be made for questions and concerns to be raised. This will help improve the understanding of the method taken to define the local SAs and the aims of the council and its importance. An improved understanding of the necessity of renewable and low carbon energy developments and the methodology behind the identification process is likely to result in a minimised pushback from the local community. Through this process, community groups with specific interests in a particular site may come forward and express their interest to get involved in renewable or low carbon energy development.

[170] National Planning Policy Framework, Ministry of Housing, Communities & Local Government, July 2021; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

[171] Delivering Community Benefits from Wind Energy Developments: A Toolkit, Centre for Sustainable Energy, July 2009, https://www.cse.org.uk/downloads/reports-and-publications/community-energy/renewables/Delivering%20community%20benefits%20from%20wind%20energy%20-%20a%20tookit.pdf

16.2 Community Energy Projects

Community energy projects help to involve the local community and invite local leadership, control and local engagement; they can be fully owned/ controlled by the community or through a partnership with commercial or public sector parties. Community energy projects can include community-owned renewable electricity installations such as solar PV panels, wind turbines or hydroelectric generation.

There is a wide variety of funding opportunities and support for community energy schemes, including the Community Energy Guidance provided by the UK Government[172] and the Community Energy England website[173]. See item 4 in Section 17.5 for details of further work that might be considered by B&NES Council in relation to community energy projects.

[172] Community Energy Guidance, UK Government, 2015; https://www.gov.uk/guidance/community-energy
[173] https://communityenergyengland.org/pages/funding-opportunities-2

17. Planning Policy Approach

17.1 What is this section about?

The purpose of the planning system is to contribute to the achievement of sustainable development through economic, social and environmental objectives. The Council is currently preparing its Local Plan and, as part of this, developing new policies to encourage increased levels of renewable energy generation. Achieving this ambition is critical in the context of the Council's recent Climate Emergency Declaration, which has resulted in an aim of a net zero B&NES by 2030.

This RERAS provides the evidence to inform the Council's new Local Plan policies for renewable energy and associated infrastructure and contains recommendations for consideration regarding potential policy approaches with regard to:

- Net zero carbon scenarios;
- Search Areas for wind farms and solar PV farms;
- Increased energy storage;
- Encouraging the development of and connection to heat networks;
- Development of other renewable energy resources e.g. biomass, etc.

This section of the study contains policy recommendations. The recommendations are set out by renewable energy type, each with their own table containing references to the relevant evidence as well as the supporting rationale and references to the National Planning Policy Framework (NPPF).

The NPPF (2021) sets out the framework within which Local Plans (including those relating to renewable energy development) should be prepared. The key requirements of NPPF, as related to this RERAS are summarised as follows (numbers relate to NPPF paragraphs[174]):

> *152. The planning system should help to contribute to radical reductions in greenhouse gas emissions……[and]… support renewable and low carbon energy and associated infrastructure.*
>
> *155. To help increase the use and supply of renewable and low carbon energy and heat, plans should:*
>
>> *a) maximise the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);*
>>
>> *b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and*
>>
>> *c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.*
>
> *156. Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in Local Plans or other strategic policies that are being taken forward through neighbourhood planning.*
>
> *157. In determining planning applications, local planning authorities should expect new development to comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable.*
>
> *158. When determining planning applications for renewable and low carbon development, local planning authorities should approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale*

[174] https://www.gov.uk/guidance/national-planning-policy-framework

projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

References to the NPPF are woven into the text within the tables, to show how the RERAS responds to the requirements.

Prior to setting out the evidence and policy recommendations, some clarifications are provided on the scope and status of these proposals.

17.2 Scope of the Policy Recommendations

17.2.1 Nationally Significant Infrastructure Projects (NSIP)

Renewable energy applications in B&NES may exceed 50MW. It should be noted that applications for onshore wind and energy from biomass and/or waste >50MW have a different consenting regime in England. Established by the Planning Act (2008), Nationally Significant Infrastructure Projects (NSIP) bypass the normal local planning requirements. Since 2012, powers have been held by the Planning Inspectorate to receive, examine and approve applications by way of Development Consent Order (DCO). The Planning Act 2008 defines and establishes a process for examining NSIPs, with the need for such schemes established in National Policy Statements (NPS). The purpose of the NSIP process is to weigh the local impacts of schemes against the national need for such infrastructure.

The NPS concerned with impacts and other matters which are specific to biomass, energy from waste (EfW) and onshore wind energy is EN-3[175]. EN-3 contains useful information about the factors that influence site selection by developers for renewable energy generating stations, as well as background information on the criteria considered by the Infrastructure Planning Committee (IPC) when considering applications. Whilst pertaining to specific, larger installations, EN-3[175] is relevant in part for smaller installations as well as technologies not addressed. As such, it is useful reference material for the Council.

17.2.2 Broader Net Zero Agenda

Reflecting the wider scope of the zero-carbon agenda, there are likely to be a number of overlaps between this RERAS and other evidence being gathered by B&NES Council. Whilst the use of DFES scenarios means that energy used in or generated for use in individual buildings as well as transport fuel are included in developing baselines and future energy projections, policy recommendations are not provided for these items.

In this study, policy recommendations are provided in relation to Search Areas (SAs) for wind farms, solar PV farms as well as for other renewable energy resources and larger stand-alone technologies with associated infrastructure to encourage the production, generation, storage and supply of renewable energy and fuel.

A major challenge for B&NES in becoming net zero by 2030 is to deliver on the DFES projections related to the mass uptake of heat pumps for heating buildings and electric vehicles. Achieving the DFES projections in itself will require broader policy interventions, many of which are likely to be beyond the scope of the Local Plan (For example, existing buildings will need to switch their heating systems from gas to renewable/ low carbon sources). Each of the scenarios presented in this RERAS for setting renewable energy generation aims assume realisation of the DFES projections.

[175] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

17.2.3 Exclusions

No assessment of site-specific access has been undertaken through the RERAS. Instead, assumptions have been made about location and system sizes (without knowing actual detail of proposals). Conversely, it is worth noting that, in some cases large infrastructure can be, for example, air-lifted into place, and it is possible for new access roads to be funded, depending on project-specific economics. AECOM recommends that project developers provide early indications of access plans to the Council when bringing forward proposals for renewable energy projects.

17.3 Recommended Policy Approaches

The tables below utilise a referencing system using the following protocol:

- Table Names e.g. Scenarios (SC);
- Table headings e.g. whether the item is evidence (EV), a policy recommendation (PR) or the rationale for the recommendation (RA);
- Each policy recommendation has a number, starting with one and ascending e.g. SC-PR-1, AS-PR-2, etc. These references can also be tracked back to the relevant section of the RERAS;
- Each policy recommendation may have a number of evidence items linked to it, hence evidence is assigned 1a, 1b, etc. There may also be a number of reasons for making a policy recommendation, hence the rationale is also labelled 1a, 1b, etc.

Due to space constraints, abbreviations are used in the below tables. To aid the reader, the key abbreviations are as follows:

- **EV:** Evidence
- **PR**: Policy Recommendation
- **RA** : Rationale
- **NZC:** Net Zero Carbon
- **B&NESC:** Bath and North East Somerset Council
- **SAs:** Search Areas
- **WF**: Wind Farms
- **SF**: Solar PV Farms
- **ES**: Energy Storage
- **DH**: District Heating Networks
- **BM**: Biomass
- **SC**: Scenario
- **PPG**: Planning Policy Guidance

Table 40: Recommended Policy Approaches Relating to Scenarios for NZC (SC)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **SC-EV-1a:** Details of the three NZC scenarios can be found in Section 15; and • **SC-EV-1b:** See Section 16, for guidance in relation to community advice.	• **SC-PR-1-:** It is recommended the three NZC calculations are presented as scenarios, for information only.	• **SC-RA-1a:** There is no agreed method for calculating zero carbon at a local authority area level, so NZC claims may be challenged; • **SC-RA-1b:** The Council needs to consult and engage with local people, businesses, industries etc. A discussion about which scenario to aim for (including potential consideration of other scenarios) could be done through engagement on the Local Plan or as part of a wider climate emergency carbon neutral plan; • **SC-RA-1c:** Given the challenges to achieving NZC aims and the complexity surrounding the energy system that is constantly evolving, it is considered preferable to retain some flexibility in terms of defining carbon neutral and specifying how much RE generation should be targeted. Therefore, it is not considered useful to set a specific, rigid aim/ maximum target for renewable energy generation; and • **SC-RA-1d**: NPPF emphasises the need to maximise the potential for development (NPPF para155a). Any perceived restriction placed upon the use of the available resource for renewable energy generation may be viewed as unnecessarily limiting. Therefore, if the numbers used in developing the three NZC scenarios are to be presented as aims in the Local Plan, it is recommended that it be made clear that these are minimum values rather than a cap (refer to Section 14.3.3 and Section 15).

• **SC-EV-2a:** Details of the identified renewable resources in B&NES are provided in Section 4 to Section 10, and a summary of the findings is provided in Section 15; • **SC-EV-2b:** Energy storage is discussed in Section 11 of the report; and • **SC-EV-2c:** Heat opportunities mapping results are included in Section 13. Map E4 shows significant heat clusters and potential for heat networks in Bath, Keynsham, and Midsomer Norton.	• **SC-PR-2:** It is recommended that the Council aims to maximise the potential for the generation and supply of renewable and low zero carbon electricity and heat.	• **SC-RA-2a:** NPPF emphasises to help increase the use and supply of renewable and low carbon energy and heat, Local Plans should provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts (NPPF, para 155a).

Table 41: Recommended Policy Approaches Relating to Wind Farms (WF)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **WF-EV-1a:** PPG states that there are no hard and fast rules about how suitable areas for renewable energy should be identified; • **WF-EV-1b:** W7 (Figure 31) map presents locations of wind resource SAs across B&NES; • **WF-EV-1c:** It should be noted that some of the 1.0Mw and 2.5MW SAs overlap as presented in W7 map (Figure 31); and • **WF-EV-1d:** A list of the primary constraints applied in identifying the SAs can be found in Section 4.2.1 and Appendix H, along with details of any buffers or separation distance assumptions.	• **WF-PR-1:** It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints.	• **WF-RA-1a:** NPPF (2021) (para155) states that "to *help increase the use and supply of renewable energy, plans should b) consider identifying suitable areas for renewable and low carbon energy sources"; and* • **WF-RA-1b:** NPPF (2021) (para158) states that when determining planning applications for renewable and low carbon development, local planning authorities should: b) approve the application if its impacts are (or can be made) acceptable. The Council has considered which constraints would be acceptable and applied these accordingly in the identification of SAs. For Wind and Solar PV developments, the Council in collaboration with WECA, identified certain designations and land uses that were constrained out of the resource assessment process on environmental, technical and safety grounds.
• **WF-EV-2a:** See Table 13 and Table 14 in Section 4.2.2 for details of the 1MW and	• **WF-PR-2:** It is recommended that proposals for wind turbines of the appropriate number and size (to make the	• **WF-RA-2a:** SAs have been identified but the shape and extent of each are produced using three different wind turbine specifications.

2.5MW turbine SAs and total associated maximum installed capacities for each; and • **WF-EV-2b:** It is assumed that 500kW SAs can accommodate at least a single 500kW turbine;	most efficient use of the resource/ land) benefit from a presumption in favour of wind development when located within the areas identified for that use through the Local Plan.	Where proposals involve turbines within the sizes modelled in the RERAS, it can be assumed that proposals are in compliance with all the primary constraints identified. An example for assessment is: a. For proposals for turbines up to 500kW capacity, utilise the 500kW SA maps for assessment; b. For proposals for turbines up to 1MW capacity, utilise the 1MW SA maps, etc.
• **WF-EV-3a:** WF-EV-1a applies. • **WF-EV-3b:** WF-EV-1b applies; • **WF-EV-3c:** The applicant will need to supply the specification of the proposed turbines to understand the noise and topple distance details. Assumptions about noise and topple distances can be found in Table 11 on page 61**;** • **WF-EV-3d:** WF-EV-1d applies. • **WF-EV-3e:** Maps relevant for 2.5MW turbines only can be found in the accompanying document 'Bath and North East Somerset RERAS – maps'; and • **WF-EV-3f:** WF-EV-1f applies.	• **WF-PR-3:** It is recommended that proposals for wind turbines >2.5MW within the areas identified through the Local Plan will benefit from a presumption in favour of wind development, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple distances) and consideration of other site specific issues and constraints.	• **WF-RA-3a:** WF-RA-1a applies; • **WF-RA-3b:** Where proposals do not align with the scheme sizes or technical proposals (e.g. for the calculation of topple distances and noise buffers, etc.) as set out in the RERAS, then the guidance and data supported GIS should be utilised by B&NES to test whether proposals remain compliant; • **WF-RA-3c:** Because turbines >2.5MW have not been modelled, the precise shape and extent of SAs are unknown. However, as long as the development proposed is within an identified SA (suggest for 2.5MW turbines), additional checks can be undertaken to ensure compliance, e.g. in relation to topple distances noise and particularly the primary constraints listed in Section 4.2.1; • **WF-RA-3d:** WF-RA-1c applies; and • **WF-RA-3e:** It should be noted that while PPG advises that set-back distances for safety are inflexible, where building/land owners indicate that they wish to do so, advice/ guidelines on siting wind turbines (in relation to noise, flicker and topple distance) can be waived, providing it is evidenced that doing so doesn't impact on applying those parameters elsewhere. In such instances, these parameters should pose no

		obstacle to granting planning permission, subject to other policy requirements being met
• **WF-EV-4a:** WF-EV-1a applies; • **WF-EV-4b:** Each stage of the mapping process can be found in Appendix G. These maps show where items such as wind resource and land slivers, etc have been identified and may provide an indication where proposals for smaller turbines may be brought forward; • **WF-EV-4c:** A list of the primary and other constraints applied in identifying the SAs and providing supporting information can be found in tables Appendix H & Appendix I; and • **WF-EV-4d:** NPPF (2021)(para156) states that local planning authorities should support community-led initiatives for renewable energy, including developments outside areas identified in Local Plans or other strategic policies that are being taken forward through neighbourhood planning.	• **WF-PR-4:** It is recommended that proposals for wind turbines outside of areas identified as suitable for wind development through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.	• **WF-RA-4a:** WF-RA-1a applies; • **WF-RA-4b:** Where proposals involve turbines located outside of SAs it can be assumed, on the basis of the RERAS modelling, that each turbine will be <500kW installed capacity (though there could potentially be proposals containing multiple smaller turbines e.g. 2 x 350kW, etc); • **WF-RA-4c:** WF-RA-1c applies; and • **WF-RA-4d:** Because no modelling has been undertaken in relation to these sites, applications will need to provide evidence of the mitigation of all potential constraints to the satisfaction of the Council.
• **WF-EV-5a**: See Table 13 and Table 14 in Section 4.2.2 (page 67) for details of the 1MW and 2.5MW turbine SAs and total associated maximum installed capacities for each; • **WF-EV-5b**: WF-EV-1d applies; and • **WF-EV-5c**: It should be noted that some of the 1.0Mw and 2.5MW SAs overlap as presented in W7 map.	• **WF-PR-5**: It is recommended that the SAs identified through the RERAS for 1MW and 2.5MW turbines are further refined and safeguarded through the Local Plan process.	• **WF-RA-5a**: Larger wind farms are likely to be the most economic solutions for generating renewable electricity; and • **WF-RA-5b**: There is relatively little area suitable for potential wind energy generation (when compared with potential area for solar PV) and suitable sites for significant wind energy generation outside of the identified SAs are unlikely to be found.

• **WF-EV-6a**: The recommended exclusion zones can be found in Map W15 in Appendix G and in the accompanying document 'Bath and North East Somerset RERAS – maps'; and • **WF-EV-6b**: Assumptions about technologies and associated noise and topple distance buffers can be found in Table 11 on page 61. It should be noted that exclusion zones are only modelled for turbines up to 2.5MW. Proposals for turbines >2.5MW may be prevented where proposed development is sited relatively close to a SA.	• **WF-PR-6**: It is recommended that policy measures (e.g. safeguarding) are put in place to ensure that the areas identified for wind development through the Local Plan are not sterilised by non-wind development.	• **WF-RA-6a**: As part of a safeguarding policy, the Council could also consider use of a mechanism to ensure that the sterilisation of opportunities for wind development is prevented; • **WF-RA-6b**: This recommendation assumes it is decided to safeguard the larger Wind Search Areas; and • **WF-RA-6c**: The recommended safeguarding zones are based on modelled topple distances.
• **WF-EV-7a**: See Table 13 and Table 14 in Section 4.2.2 (page 67) for details of the 1MW and 2.5MW turbine SAs and total associated maximum installed capacities for each; • **WF-EV-7b**: W7 map (Figure 31) presents locations of the above SAs across B&NES; and • **WF-EV-7c**: It should be noted that some of the 1.0Mw and 2.5MW SAs overlap as presented in W7 map(Figure 31).	• **WF-PR-7**: It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity, subject to compliance with noise, topple-distance, site specific constraints, and other policy considerations should be looked upon favourably.	• **WF-RA-7a**: Larger wind farms are likely to be the most economic solutions for generating renewable electricity; and • **WF-RA-7b**: There is relatively little area suitable for potential wind energy generation (when compared with potential area for solar PV) and suitable sites for significant wind energy generation outside of the identified SAs are unlikely to be found.
• **WF-EV-8a**: Constraints maps include sites of existing and consented wind farms (see Section 4 and W2 map (Figure 30); and • **WF-EV-8b**: See Appendix E for details of the sites and installed capacities of existing wind farms in B&NES.	• **WF-PR-8**: It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity will, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple-distances), site specific constraints, and other policy considerations should be looked upon favourably.	• **WF-RA-8a**: Technology development is moving at pace (with larger turbines becoming available). Existing wind farm sites provide a relatively straight-forward and significant opportunity for increasing generation capacity.

Table 42: Recommended Policy Approaches Relating to Solar PV Farms (SF)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **SF-EV-1&2a:** See Map S7 (Figure 36) in Section 5 and in the accompanying document 'Bath and North East Somerset RERAS – maps' for the locations of the solar PV farm SAs; • SF-EV-1b: A list of other constraints and information related to assumptions about buffers distances, etc can be found in Appendix L and Map S8 in the accompanying document 'Bath and North East Somerset RERAS – maps'. • **SF-EV-1&2c:** Analysis of solar PV farm SAs in relation to grid connection points with capacity can be found in Map S15 in Section 6 on page 81; • **SF-EV-1&2d:** Analysis of solar PV farm SAs in relation to landscape character and sensitivity in relation to solar PV farm SAs can be found in Maps S16 in Section 7 on page 86 and in the accompanying document 'Bath and North East Somerset RERAS – maps'; • **SF-EV-1&2e:** Analysis of solar PV farm SAs in relation to demand for heat can be found in Map E6 in the accompanying document 'Bath and North East Somerset RERAS – maps' (Also see Section 13.3.5 in this report); and • **SF-EV-1&2f:** Other sensitivity testing in relation to solar PV farm SAs can be found in Maps S9 to S14 in Appendix J and the accompanying document 'Bath and North East Somerset RERAS – maps'.	• **SF-PR-1-**: It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints. As part of this a strategy approach which takes account of clustering and the potential need to manage cumulative impact should be considered. • **SF-PR-2-:** It is recommended that proposals for solar PV farms within the areas identified for that use through the Local Plan benefit from a presumption in favour of solar development.	• **SF-RA-1&2a:** there are extensive areas that are potentially suitable for solar PV development so, while we do not recommend that it is necessary to safeguard sites for wind, the Council may wish to consider setting a strategy to prioritise specific areas for such development; and • **SF-RA-1&2b:** The shape and extent of the SAs provided in this RERAS are produced through a process of removing areas that are subject to primary constraints. This allows developers and planning officers to assume certain constraints are not present in SAs.

• **SF-RV-3a:** SF-EV-1a applies; • **SF-EV-3b:** A list of the constraints applied in identifying the SAs can be found in Appendix K, along with details of any buffers or separation distance assumptions; and • **SF-EV-3c:** SF-EV 1c to 1f apply.	• **SF-PR-3:** It is recommended that proposals for solar development outside of areas identified as suitable for that use through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.	• **SF-RA-3a:** SAs have been identified for the potential location of solar PV farms that are at least 5MW installed capacity. In theory, proposals for solar PV farms of less than 5MW may well come forward in non SAs although these are unlikely to be cost-effective.
• **SF-EV-4a:** See Map S2 in the accompanying document 'Bath and North East Somerset RERAS – maps' for the location of existing solar PV farms across B&NES; • **SF-EV-4c:** See Appendix E for details of the installed capacities of the existing solar PV farms in B&NES; • **SF-EV-4d:** SF-EV-1b applies; and • **SF-EV-4e:** SF-EV-2b applies.	• **SF-PR-4:** It is recommended that proposals for re-powering of solar PV farms at end-of-life to an equal or increased capacity, subject to compliance with primary constraints, site specific constraints, and other policy considerations should be looked upon favourably.	• **SF-RA-4a**: The extents of existing solar PV farms have been included within RERAS mapping. Any proposed extension of the size / moving of the PV farm boundaries will require checking that proposals comply with relevant policy and constraints.

Table 43: Recommended Policy Approaches Relating to Energy Storage (ES)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **ES-EV-1a:** Energy storage is discussed in Section 11 of the report; • **ES-EV-1b:** Details of the wind farm SAs of >1MW, including potential installed capacities can be found in Table 13 and Table 14 in Section 4.2.2 (page 67) • **ES-EV-1c:** Locations of the wind farm SAs can be found in Map W7 (Figure 31) in section 4.2.2 on page 66; • **ES-EV-1d:** Details of the solar PV farm SAs, including potential installed capacities can be found in Section 5.2.2 and Map S7 (Figure 36).	• **ES-PR-1:** It is recommended that policy encourages applicants promoting schemes for renewable electricity generation of >1MW, regardless of technology, to consider including storage as part of their proposal. This could include some form of energy storage (green hydrogen production, seasonal or battery storage), private wire supply or evidence as to why this is not feasible or viable.	• **ES-RA01a:** EN-3[176] lists grid connection as a consideration that can affect the siting of renewable technologies; • **ES-RA-1b:** Increasingly there are constraints placed on renewable electricity generation due to the inability to export at certain times. Where storage and/or private wire supply is feasible and viable, opportunities for storage should be considered to maximise the renewable energy resource and investment; • **ES-RA-1c:** Distances to suitable grid connections in rural areas are often greater (more costly), with lower starting network

[176] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

• **ES-EV-1e**: Locations of the solar PV farm SAs can be found in Map S6 and Map S7 in Appendix J and the accompanying document 'Bath and North East Somerset RERAS – maps'; • **ES-EV-1f:** Wind SAs and solar PV farm SAs have been prioritised using the WPD grid connection analysis. Maps W16 and S15 in Section 6 on page 81 show results of the assessment; • **ES-EV-1g**: This general policy recommendation for storage should be read in conjunction with ES-PR-2 (Hydrogen, see Section 12) and Table 44 (recommended policy approaches relating to district heating network) below which also provides a storage function (also see Section 13); and • **ES-EV-1h:** Details of existing heat demands and potential locations for heat networks, as well as locations for potential seasonal storage opportunities (e.g. abandoned mines) can be found in Section 13.3.5 and Map E4 on page 121.	*It should be noted that WPD maps show only a snapshot in time and are subject to rapid change.* The grid capacities maps are useful for all technologies that generate electricity.	capacities and coupled with a lack of demand for power from existing development; and • **ES-RA-1d:** Battery storage will usually be sited, either next to renewable electricity development or at the site where the electricity is consumed. The physical space and other requirements for such storage will need to be considered as part of the application process.
• **ES-EV-2a:** Maps H1 and H2 in Section 12.5 on page 113 present the wind SAs and the solar PV farm SAs respectively in relation to their location in relation to industrial clusters with potential for green hydrogen production / use; and • **ES-EV-2b:** ES-EV 1a-e apply.	• **ES-PR-2:** It is recommended that applications for renewable electricity generation of >1MW located within 1km of an industrial cluster identified as having potential for hydrogen production consider utilising outputs (via private wire) for such purposes. *The Council may wish to undertake further analysis of existing sites that may employ hydrogen and discuss with stakeholders prior to implementing a policy.*	• **ES-RA-2a:** Energy storage will play an increasingly important role in UK decarbonisation and therefore opportunities should be maximised; • **ES-RA-2b:** Hydrogen could provide a low carbon energy source for difficult to "decarbonise" sectors, such as heavy transport, aviation and various industrial processes, and could also play an important role in system balancing as a multi-vector fuel (a fuel that can be produced or consumed across different energy sectors), using very low-cost electricity during times of over-supply

		to convert, store and transport renewable energy for applications across the energy system; and • **ES-RA-2c:** 1km is an arbitrary figure. The less infrastructure required, the more likely the project is to be viable, but this figure cannot be known without further analysis.
• **ES-EV-3a:** ES-EV-2a applies.	• **ES-PR-3:** Building on ES-PR-2, it is recommended that applications for new industrial development that may have a use for green hydrogen should be guided towards locations near/in 'hydrogen clusters' wherever practical. *See items 2 and 3 in Section 17.5 for details of further work that might be considered by the Council in relation to 'hydrogen clusters'.*	• **ES-RA-3a**: ES-RA-2a to 2c apply.
• **ES-EV-4a:** The location of abandoned mines with potential use for seasonal storage as well as other potential storage opportunities (e.g. potential for heat networks) can be found in Section 13.3.5 and Map E4 on page 121.	• **ES-PR-4:** It is recommended that applications for renewable electricity generation, or development that is energy intensive and likely to have a surplus of heat, within 1km of a site with potential for seasonal energy storage (e.g. abandoned mine workings) should consider utilising such a facility.	• **ES-RA-4a:** 1km is an arbitrary figure. The less infrastructure required, the more likely the project is to be viable, but this figure cannot be known without further analysis.

Table 44: Recommended Policy Approaches Relating to District Heating Networks (DH)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **DH-EV-1a:** The RERAS Heat Opportunities Map E4 and Sites of Existing Renewable Energy Map R1 shows the locations of existing renewable electricity and heat generating resources; and • **DH-EV-1b**: Appendix E identifies a list of what is meant by 'existing renewable heat resource and electricity generating installation.	• **DH-PR-1:** It is recommended that development proposals for dwellings, employment or depots for hosting transport fleets located within 0.5km of an existing renewable heat resources or renewable electricity generating installations should consider utilising such resources for heating, hot water and/or process use transport fuel.	• **DH-RA-1a:** The policy is intended to prompt investigation of identifying existing renewables in close proximity to an intended development. This in turn should prompt consideration of how energy might be brought to site (i.e. via a heat network, private wire electricity or for gas or liquid fuels, physical delivery). • **DH-RA-1b:** The proposed 0.5km is arbitrary. The length (and therefore cost) of infrastructure relative to the value of energy sales will establish viability (so a relatively short distance is suggested) – this cannot be known without knowing locations and nature of off-takers. It may be decided by the Council that further evidence is warranted; and • **DH-RA-1c:** Heat networks should be considered for 2 main reasons: a. as a means of decarbonising heating in existing buildings, for example where it is not viable or feasible to improve the energy efficiency of the buildings to a level where heat pumps are economically viable. b. Where it is the most practical means of delivering very low carbon/renewable heat in new build taking account of available heat resource (e.g. sewage, mine workings etc) and reject heat from cooling.
• **DH-EV-2a:** Heat opportunities mapping results are included in Section 13. Map E4 shows significant heat clusters and potential	• **DH-PR-2:** It is recommended that proposals for development that will host heat intensive activities and are likely to generate excess heat (or power) should consider:	• **DH-RA-2a:** Consideration of electricity supply is included within the heat network section as, with the move to heat pumps for the provision of space heating and/or domestic hot water, electricity will become

for heat networks in Bath, Keynsham, and Midsomer Norton; • **DH-EV-2b**: The most heat intensive industries are cement, ceramics, iron and steel, glassmaking, chemicals, refineries, paper and pulp, and food and drink which are likely to create a surplus of heat (or power). For more details on the potential for recovering and using surplus heat from industry refer to the following report. A Report for DECC, The potential for recovering and using surplus heat from industry[177]; and • **DH-EV-2c:** Section 8 includes the assessment's findings in relation to resource biomass and Table 26 on page 100 details energy from wastes resource potential such as sewage sludge. It should be noted that this policy relates to any future proposals such as EfW plants, wastewater treatment plants (WWT), etc.	a. Potential to be located within 0.5km of a heat demand cluster identified in the Heat Opportunities Map or other identified heat use; b. Enabling heat (power) off-take for supply for other / nearby uses and provide evidence of discussions with potential off-takers for the heat (or power).	the predominant source of energy for such uses. and • **DH-RA-2b:** Increasingly, low temperature heat networks are being considered, driven by heat pumps supplied with renewable electricity.
• **DH-EV-3a:** E4 map in Section 13.3.1 on page 121 shows the location of the existing heat network at University of Bath. The network utilises a natural gas CHP system; and • **DH-EV-3b:** No existing heat network that utilises a renewable source has been identified in B&NES.	• **DH-PR-3:** It is recommended that development proposals within 0.5km of an existing district heat network fed from a renewable (non-fossil fuel) source will be expected to connect where feasible and viable.	• **DH-RA-3a:** 'Renewable' is purposely highlighted. In the UK there are numerous existing heat networks that are fed from gas CHP engines: whilst efficient, recent changes to carbon factors means that they will cost carbon against a counterfactual of gas boilers into the future. It is important for heat network pipes and associated infrastructure to be installed. This being the case, any Council policy might still wish to include connection to CHP networks. The energy centres attached to such networks can be changed to renewable energy sources in the future in order that decarbonisation can happen.

[177] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/294900/element_energy_et_al_potential_for_recovering_and_using_surplus_heat_from_industry.pdf

		• **DH-RA-3b:** The proposed 0.5km is arbitrary. The length (and therefore cost) of infrastructure relative to the value of energy sales will establish viability (so a relatively short distance is suggested) – this cannot be known without knowing locations and nature of off-takers. It may be decided by the Council that further evidence is warranted; and • **DH-RA-3c**: It should be noted that if the requirement remains for renewables there would be no existing heat networks to which development could connect.
• **DH-EV-4a:** Section 13 of this report presents the results if the heat mapping assessment. Additionally, see E4 to E6 maps in the accompanying document 'Bath and North East Somerset RERAS – maps'. E5 and E6 maps shows locations of the SAs in relation to the identified heat cluster. Section 13 includes details of the methodology employed to prepare these maps and the mapping GIS layers have been supplied to the Council.	• **DH-PR-4:** It is recommended that areas identified through the Local Plan for wind farms and solar PV farms are within 0.5km of an identified heat cluster, consideration is given to safeguarding these sites in order to provide electricity for powering heat pumps as part of a private wire / district heat network.	• **DH-RA-4a** It is difficult to retrofit buildings to be NZC. Of then the roofs have not been designed to be able to host enough solar PV panels to supply heating and power needs. It is therefore sensible, where there is potential for a larger source of renewable electric, that they be fully utilised to decarbonise urban areas.

Table 45: Recommended Policy Approaches Relating to Biomass (BM)

Evidence (EV)	Policy Recommendation (PR)	Rationale (RA)
• **BM-EV-1a:** Biomass resource has been assessed in Section 8 of this study. • **BM-EV-1b:** Energy crops (e.g. miscanthus, short-rotation coppice, etc.) and wood fuel resources were considered, and the results are included in Sections 8.2 and 8.3. • **BM-EV-1c:** Map B2 in the accompanying document 'Bath and North East Somerset RERAS – maps' illustrates the constraints	• **BM-PR-1:** It is recommended that proposals utilising biomass are looked upon favourably where: a. a whole life carbon benefit can be evidenced; and b. the development should be located away from urban areas (and preferably in areas off the gas grid).	• **BM-RA-1a:** Biomass is perhaps the most complex of fuels to evaluate in terms of ensuring that the resource is used to its biggest advantage. There remains some disagreement about the real carbon benefit of utilising biomass as fuel. Emissions relating to the harvesting, processing and transportation of biomass should be accounted for when calculating benefit and understanding replacement-planting;

that are associated with restrictions to harvesting energy crops.

- **BM-EV-1d:** Map B3 in the accompanying document 'Bath and North East Somerset RERAS – maps' shows areas of land that could be planted with energy crops after application of the constraints listed in Appendix N;
- **BM-EV-1e:** Refer to the following sources for locations off the national gas grid network in B&NES;
    a. Areas and types of properties off the gas grid[178]
    b. LSOA estimates of properties not connected to the gas network[179]
- **BM-EV-1f:** Heat Opportunities Map E4 in the accompanying document 'Bath and North East Somerset RERAS – maps' shows the locations of urban areas and heat demand clusters in B&NES.

- **BM-RA-1b**: Whilst the Environment Agency has a strict permitting regime for flue arrangements for biomass plant, there remain concerns about the use of biomass related to impact upon air quality in urban areas;
- **BM-RA-1c:** The RERAS evidence reveals limited opportunity for biomass resource in B&NES and, whilst the source of the biomass is unknown, that plant is already in operation locally that utilises a large part of the projected resource for generating electricity;**BM-RA-1d:** Applications may be received for plant utilising biomass that is sourced outside of B&NES. The policy recommendations seek to take account of local and non-local sourcing;
- **BM-RA-1e:** The Council should note that the policy recommendation effectively excludes biomass from feeding into district heating schemes as these are likely only to be developed in urban areas of high heat demand density; and
- **BM-RA-1f:** when thinking about local supply of biomass, transportation of the fuel is a fraction of the carbon saving hence spatial relationship between resource and place of generation/consumption is not as significant as for other energy resources.

[178] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/267375/off_gas_grid.pdf
[179] https://www.gov.uk/government/statistics/lsoa-estimates-of-households-not-connected-to-the-gas-network

- **BM-EV-2a:** The Consumer Transformation scenario from National Grid (refer to Section 14 and Appendix P) assumes of bioenergy is used in power sector with Carbon Capture and Storage (BECCS) in achieving net zero emissions. BECCS is the combination of bioenergy with carbon capture and storage to capture any CO2 released during combustion, and the FES assumes that the greenhouse gases released in the scenario will be mainly offset by using BECCS.

- **BM-PR-2:** It is recommended that there be a presumption in favour of proposals for stand-alone electricity generation plant utilising biomass if the proposal utilises a BECCS system and proposals are incompliance with BM-PR-1a and 1b.

- **BM-RA-2a:** The FES assumes that the greenhouse gases released in each scenario will be mainly offset by using BECCS. The use of BECCS to offset the projected additional greenhouse gas emissions is included in the FES at a national level; and
- **BM-RA-2b:** Because we are guiding to employ biomass in rural locations, this effectively excludes biomass feeding heat networks (as networks are likely to be in locations with high heat demand density). However, DH-PR-1 and DH-PR 2b to 2d continue to apply.

17.4 General policy recommendations

The development of major renewables sites offers opportunities for nature recovery, the development of natural climate solutions and enhancing (biodiversity (to a net gain)). Policy should reflect this as a requirement and key locations with opportunity identified when detailed criteria-based policies are formulated.

Moreover, for all renewable energy applications, circular economy principles should be applied to all projects, to ensure best use of materials at end of life, as well as full or enhanced restoration of land.

17.5 Further work

This section contains suggestions where further work might be considered by B&NES Council, as follows:

1. Policy recommendations in relation to District Heating Networks have been provided in the relevant table {*District Heating Networks (DH))* above. In the absence of more detailed analysis, those recommendations have utilised arbitrary distances between generators and demand. Further detailed feasibility studies could be undertaken to identify indicative schemes and better establish economic viability. Such analysis would enable more detailed and targeted policies to be formulated and implemented.
2. It is recommended (see ES-PR-1 above) that policy encourages applicants promoting schemes for renewable electricity generation of >1MW, regardless of technology, to consider including storage as part of their proposal. This could include for some form of energy storage (green hydrogen production, seasonal or battery storage), private wire supply or evidence as to why this is not feasible or viable. Prior to implementing any policy for storage, B&NES Council may wish to consider further a strategy for clustering renewable electricity projects in rural areas, in order to reduce grid connection costs and/or to consider outlets/uses for the power. Part of such a study should also include approach to managing cumulative impact in rural areas.
3. It is recommended (see ES-PR-2 above) that applications for renewable electricity generation of >1MW, located within 1km of an industrial cluster identified as having potential for hydrogen production consider utilising outputs (via private wire) for such purposes. B&NES Council may wish to undertake further analysis of the hydrogen clusters identified in this study and discuss with stakeholders prior to implementing any policy.
4. In relation to renewable and low carbon developments, the Council could offer to facilitate expert services for potential developments, such as site assessments, and to form partnerships with community groups. These partnerships might act as an incentive to other community groups looking to get involved.

Appendix A : Nuclear Fusion

Nuclear fusion is the production of energy through two small atoms combining to form one larger atom. During this process, mass is lost, and energy is gained. This energy is released in the form of a fast-moving particle called a neutron. The kinetic energy of the neutron is converted into heat. This heat is used to produce steam, which is used to power turbines and alternators and, in turn, produce electricity, see Figure 77[180]. Fusion has a significant potential to be a long-term energy source that is environmentally responsible (with no carbon emissions). Traditional nuclear fission power plants have the disadvantage of generating unstable nuclei; some of these are radioactive for millions of years. nuclear fusion on the other hand does not create any long-lived radioactive nuclear waste.

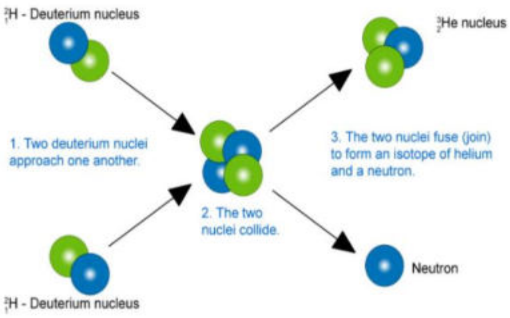


Figure 77: Nuclear Fusion Diagram[180]

Energy production by nuclear fusion is not yet commercially available; however, the UK Government's Ten Point Plan for a Green Industrial Revolution[181] outlines ambitions to be the first country in the world to commercialise fusion energy technology. The plan outlines the aim to build the world's first commercially viable fusion power plant in the UK by 2040.

Western Gateway has submitted a bid proposing that a technology park and power plant be located at two former nuclear power station sites in Oldbury and Berkeley[182]. The bid correlates with the Ten Point Plan for a Green Industrial Revolution with an expected operational date of 2040. The UK Atomic Energy Authority (UKAEA) will assess the nominated sites and produce a shortlist of three selected sites for submission to the secretary of state for business energy and industrial strategy.

[180] http://resources.hwb.wales.gov.uk/VTC/2008-09/science/irf08_48/Images/Nuclear-fusion.jpg
[181] The Ten Point Plan for a Green Industrial Revolution, HM Government, November 2020; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf
[182] https://www.insidermedia.com/news/south-west/land-nominated-for-fusion-power

Appendix B : Marine Renewable Technologies

There are many forms of marine energy generation; however, the two forms of marine energy that are relevant to this study and mentioned in the South West Marine Plan[183]due to their significant resources are:

- Tidal Energy – Tidal energy uses the natural rise and fall of the sea tides and currents to generate energy. There are three main methods to get tidal energy. Tidal streams, where a turbine is situated in a tidal stream. Barrages, where water flows over the top of a barrage or through turbines within the barrage. Moreover, tidal lagoons, where a barrier partially encloses a body of ocean. The turbine rotates as the lagoon fills and drains.
- Offshore Wind Energy – Offshore wind energy is the installation of wind turbines offshore. Offshore wind energy provides the advantage over onshore wind energy due to the lack of obstacles resulting in reduced wind speed; this means that more of the wind can be harnessed. The CCC report "Reducing UK emissions June 2020" states that offshore wind is now the fastest growing form of electricity generation in the UK[184]

The marine licensing system for tidal power in the United Kingdom is complex. In general, consent from the Marine Management Organisation (MMO) is required to construct, extend, or operate any offshore generating stations with a capacity between 1 and 100MW (Section 66 of the Marine and Coastal Access Act 2009[185]; Section 36 of the Electricity Act 1989[186]). Safety zone consents may also be required (Section 95 of the Energy Act 2004[187]).

Stations that would generate more than 100MW are classified as Nationally Significant Infrastructure Projects (NSIPs) and require a Development Consent Order (DCO) granted by the Secretary of State. The local planning authority for each region permits onshore planning and the Department for Business, Energy and Industrial Strategy (DBEIS) regulates the decommissioning of projects under Energy Act 2004.

The development of hydrokinetic turbines for river arrays means that energy can now be generated relatively efficiently with minimal impacts to the shape and behaviour of river channels, opening up the possibility for more sustainable energy production in large rivers with active sediment transport. However, such installations are likely to be small-scale (5-50kW), non-economic when compared with other renewables and the calculation of theoretically installed capacity complex, hence the exclusion of projections within this RERAS. It should be noted that large scale marine renewable technologies (e.g. tidal stream devices, tidal range barriers and lagoons, and wave energy conversion devices) are excluded from this assessment as decisions about such development are outside of the Council's jurisdiction.

[183]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857299/DRAFT_SW_Marine_Plan.pdf
[184] https://d423d1558e1d71897434.b-cdn.net/wp-content/uploads/2020/06/Reducing-UK-emissions-Progress-Report-to-Parliament-Committee-on-Cli..-002-1.pdf
[185]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/490998/Marine_and_Coastal_Access_Act_2009__Energy_Bill_2015-16_Keeling_Schedule_.pdf
[186]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/490992/Electricity_Act_1989__Energy_Bill_2015-16_Keeling_Schedule_.pdf
[187]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/490993/Energy_Act_2004__Energy_Bill_2015-16_Keeling_Schedule_.pdf

Appendix C : Policy Context and Drivers for Renewable Energy

C.1 Introduction

The following section sets out the key policies, regulations and incentive schemes relating to renewable energy targets, carbon emissions and waste internationally, nationally, regionally and across Bath and North East Somerset.

C.2 International policy context

The Kyoto Protocol (1998)

The Kyoto Protocol is an international treaty with the goal of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[188]

The Paris Agreement (2016)

The Paris Agreement entered into force on the 4th of November 2016. Under the UN negotiations and alongside over 190 other countries, the UK drafted the Paris Agreement to tackle climate change. The agreement sets out a global framework to limit the effects of climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. The Agreement additionally sets a target for net zero global emissions in the second half of this century. The UK Government has ratified the agreement.

C.3 National Policy

Climate Change Act (2008)

The Climate Change Act sets a legally binding target to reduce UK carbon emissions. The policy has recently been amended[189] to change the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline, with this increasing from an 80% target to a 100% target. This target means that it is now UK law to produce net zero carbon by the year 2050.

The Climate Change Act also established the Climate Change Committee (CCC), an independent statutory body, to advise the UK Government and the Devolved Administrations on setting and meeting carbon budgets and other related matters.

National Planning Policy Framework

The National Planning Policy Framework (NPPF) is the overarching planning guidance in England, it sets out the Government's planning policies for England and guidance on how these should be applied[190].

The National Planning Policy Framework states that: "The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."

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[188] Kyoto Protocol to the United Nations Framework Convention on Climate Change, United Nations, 1998; https://unfccc.int/resource/docs/convkp/kpeng.pdf
[189] The Climate Change Act 2008 (2050 Target Amendment) Order 2019 No. 1056, BEIS, 2019; https://www.legislation.gov.uk/ukdsi/2019/9780111187654
[190] National Planning Policy Framework, Ministry of Housing, Communities & Local Government, July 2021; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

Additionally, the NPPF confirms that, in order to help increase the use and supply of renewable and low carbon energy and heat, “plans should:

a. *provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);*

b. *consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and*

c. identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for collocating potential heat customers and suppliers.”

(Section 14. Paragraph 151)

The NPPF also requires local planning authorities (LPAs) to support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in Local Plans or other strategic policies that are being taken forward through neighbourhood planning. It also confirms that “when determining planning applications for renewable and low carbon development, local planning authorities should:

a. not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

b. approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial-scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.”

(Section 14. Paragraph 154)

The Framework illustrates the importance of Local Plans in delivering development that has the backing of local communities; therefore, LPAs should consider the local potential for renewable and low carbon energy generation when preparing Local Plans[191].

Some of the other key paragraphs from the NPPF relating to energy and climate change are set out below for completeness.

- Plans should take a proactive approach to mitigate and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure.

(Section 14. Paragraph 149)

- New development should be planned for in ways that:

a. avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

b. can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government’s policy for national technical standards.

[191] https://www.gov.uk/guidance/renewable-and-low-carbon-energy#:~:text=The%20National%20Planning%20Policy%20Framework,planning%20concerns%20of%20local%20communities.

(Section 14. Paragraph 150)

- In determining planning applications, local planning authorities should expect new development to:
  a. comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
  b. take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

(Section 14. Paragraph 153)

UK National Energy and Climate Plan (NECP)

The NECP is the framework by which European Union Member States are required to set out their integrated climate and energy objectives, targets, policies and measures, covering the 5 dimensions of the Energy Union for the period 2021 to 2030. Following the exit of the UK from the EU, the UK was subject to EU legislation during the Brexit transition and so the UK NECP was submitted shortly before the end of 2020.

UK Industrial Strategy (2017)

The Industrial Strategy, published in November 2017, emphasises the need for clean growth in order to boost economic prosperity within the UK. Some of the stated aims of the Industrial Strategy relevant to energy use in the built environment include:

- Increasing the delivery of new homes;
- Decarbonising the heat supply; and
- Lowering emissions from the transport sector.

There is a particularly strong emphasis on supporting electric vehicle uptake, through investment in charging infrastructure and by extending the plug-in car grant. The Strategy also states that, ‘After the Grenfell Review, we will update Building Regulations to mandate that all new residential developments must contain the enabling cabling for charge-points in the homes’ (p. 145).

Resources and Waste Strategy, 2018

The Resources and Waste Strategy[192], updated in 2018 sets out how England will preserve material resources by minimising waste, promoting resource efficiency and moving towards a circular economy. This strategy plans to encourage the reduction and increased management of waste through policies to support reuse, repair and remanufacture activities and by tackling waste crime.

Waste Management Plan for England, 2021

The Waste Management Plan for England[193], updated in 2021 sets out the Government’s ambition to work towards a more sustainable and efficient approach to resource use and management. The plan aims to deliver England’s waste ambitions through:

- the delivery of sustainable development and resource efficiency, including provision of modern infrastructure, local employment opportunities and wider climate change benefits;
- ensuring waste management is considered alongside other spatial planning concerns;
- providing a framework in which communities and businesses are engaged with and take more responsibility for their own waste;

[192] Department for Environment, Food & Rural Affairs. *Resources and Waste Strategy: at a glance.* Available at: https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england/resources-and-waste-strategy-at-a-glance

[193] Department for Environment, Food & Rural Affairs. *Waste Management Plan for England*. January 2021. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955897/waste-management-plan-for-england-2021.pdf

- helping to sustainably secure the re-use, recovery or disposal of waste; and
- ensuring new developments complement sustainable waste management.

National Planning Policy for Waste, 2014

The National Planning Policy for Waste[194] (NPPW) sets out detailed waste planning policies for England and should be read in conjunction with the NPPF, Waste Management Plan for England and the National Policy for Wastewater and Hazardous Waste.

The NPPW focuses on the implementation of waste policies across England's local authorities through the demand, suitability and ability to monitor waste management facilities.

Clean Growth Strategy (CGS) (2017)

A strategy that sets out the UK Government's ambitious policies and proposals, through to 2032 and beyond for decarbonising all sectors of the UK economy[195],

The 'power' sector is considered in the CGS policy with an ambition of close to zero emissions by 2050. The strategy considers a potential pathway of growing low carbon sources such as renewables and nuclear to over 80% of electricity generation and phasing out unabated coal power by 2032. The document contains a number of policies and proposals regarding the following topics.

- Growing low carbon sources of electricity
- Delivering smarter, more efficient energy
- Keeping energy costs down for businesses and households
- Government innovation investment

In addition to the power sector, commercial and industrial (C&I) and domestic buildings sectors are also considered within the Framework.

A key proposal regarding C&I buildings in the document is phasing out of the installation of high carbon forms of fossil fuel heating in new and existing businesses off the gas grid during the 2020s, starting with the new build. It also considers supporting the recycling of heat produced in industrial processes, to reduce business energy bills and benefit local communities.

Additionally, rolling out of low carbon heating is anticipated for UK homes through:

- building and extending heat networks across the country,
- phasing out the installation of high carbon fossil fuel heating in new and existing homes currently off the gas grid during the 2020s, starting with new homes
- Investing in low carbon heating by reforming the Renewable Heat Incentive

25 Year Environment Plan (2018)

The plan was published in 2018 and it builds on the proposals and policies outlined in the CGS and aims to improve the environment within a generation and to leave it in a better state than we found it. It details how the government will work with communities and businesses to do this[196].

The document confirms that the UK Government will work towards eliminating all avoidable waste by 2050 and all avoidable plastic waste by the end of 2042[197] as well as committing to the following action points:

[194] Department for Communities and Local Government. *National Planning Policy for Waste.* October 2014. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf
[195] The Clean Growth Strategy, HM Government, October 2017; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
[196] A Green Future: Our 25 Year Plan to Improve the Environment, HM Government, 2018; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf
[197] Avoidable means what is Technically, Environmentally and Economically Practicable.

- Exploring different infrastructure options for managing residual waste beyond electricity, including the production of biofuels for transport and emerging innovative technologies;
- Looking at ways to increase the use of heat produced at waste facilities through better connections to heat networks. The facilities will become more efficient and emit less carbon dioxide;
- Investigating ways to cut carbon dioxide emissions from EfW facilities by managing the amount of plastics in the residual waste stream. This will be linked with any opportunities to recycle more plastics or reduce the amount used.

Among other relevant proposals in this document is a commitment to support extra woodland creation and incentivise more landowners and farmers to plant trees on their land, including agroforestry and bio-energy production.

The UK Heat Strategy (2013).

The UK Heat Strategy laid out a strategic framework for the transition to a low carbon heat supply.

The strategy highlighted the importance of improving the energy efficiency of buildings and incentivised local authorities to enable the development and expansion of heat networks, for instance, by setting up the Heat Network Development Unit (HNDU)[198].

Building Regulations in England (Part L and Part F)

The Building Regulations set the minimum standards for building performance and must be met for a building to be approved for construction. Part L of the Building Regulations focuses on the conservation of heat and power and sets specific requirements for the fabric performance, building services efficiency, overheating and CO_2 emissions and Part F contains guidance on the building ventilation. The Building Regulations are currently being updated and are undergoing a two-part consultation for the Future Homes Standard, including proposed options to increase the energy efficiency requirements for new homes in 2021. The Future Homes Standard will require new build homes to be future-proofed with low carbon heating and world-leading levels of energy efficiency; it will be introduced by 2025[199]. Government responses for part one of the consultation were released in January 2021. The second stage of the consultation ran until 13th April 2021 and the feedback is currently being analysed.

The Government's responses to the first stage of the consultation are set out below:

- From 2025, the Future Homes Standard will deliver homes that are zero-carbon ready
- Acknowledgement that there is a need to clarify the Local Planning Authorities' roles in setting energy efficient requirements for new homes that go beyond the minimum standards set out through the Building Regulations
- In 2020, an interim uplift in Part L standards would be introduced that delivered a meaningful reduction in carbon emissions and provided a stepping stone to the Future Homes Standard (this is ongoing)
- A revised package of performance metrics that will ensure a fabric first approach is at the heart of all new homes alongside low carbon heating systems that have been settled upon. Fabric Energy Efficiency Standard will be one of four performance metrics that achieves this balance
- A comprehensive package of measures to improve compliance, reduce the performance gap and provide more information to energy assessors, building control and homeowners was put forward
- More stringent transitional arrangements to ensure as many homes as possible are being built to new energy efficiency standards would be introduced.

[198] The Future of Heating: Meeting the Challenge, DECC, March 2013; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/190149/16_04-DECC-The_Future_of_Heating_Accessible-10.pdf

[199] Ministry of Housing, Communities & Local Government. *The Future Homes Standard: changes to Part L and Part F of the Building Regulations for new dwellings.* January 2021. https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings

The second stage of the two-part consultation was completed on 13th April 2021 and the feedback from this is being analysed.[200]

C.4 Financial Incentive Schemes

Below is a brief overview of some of the key financial incentive schemes for low and zero carbon energy in the UK.

Renewable Heat Incentive (RHI)

The RHI scheme is a government environmental programme to support renewable heat delivered to homes or non-domestic buildings. RHI provides incentives for consumers to install renewable heating in place of fossil fuels. It is open to homeowners and landlords, commercial, industrial, public, not-for-profit and community generators of renewable heat. The domestic RHI scheme has been recently extended to March 2022 but the government announced that non-domestic RHI closed to new applications on 31 March 2021[201].

The government is currently consulting on a Clean Heat Grant scheme to follow on from the RHI building on the Clean Growth Strategy. The consultation document confirms through this new scheme households and small non-domestic buildings will receive support to enable the installation of heat pumps and, in limited circumstances, biomass, to provide space and water heating[202].

Energy Company Obligation (ECO)

The 2011 Energy Bill, which made provision for the Green Deal, also provided for an Energy Company Obligation (ECO). The scheme has been updated several times with the latest update in 2018, known as ECO3 which runs from 2018 to 2022[203]. Under the scheme energy companies are obligated to promote and support carbon emissions reductions to customers and certain householders in receipt of benefits are eligible to apply for a grant to contribute to the measures.

Smart Export Guarantee (SEG)

The SEG was introduced in Great Britain on 1 January 2020 and it is available to technologies up to a capacity of 5MW, including:

- Solar photovoltaic
- Hydro
- Micro-combined heat and power (with an electrical capacity of 50kW or less)
- Onshore wind
- Anaerobic digestion[204]

The scheme requires licensed electricity suppliers to offer at least one export tariff which must always be above zero and make payment to small-scale low-carbon generators for electricity exported to the National Grid[205].

Heat Networks Delivery Unit (HNDU)

The HNDU was set up in 2013 and it provides grant funding and guidance to local authorities in England and Wales for heat network project development[206].

[200] https://www.gov.uk/government/consultations/the-future-buildings-standard
[201] https://www.gov.uk/government/publications/changes-to-the-renewable-heat-incentive-rhi-schemes
[202] Future Support for Low Carbon Heat, Department for Business, Energy & Industrial Strategy, July 2020
[203] Energy Company Obligations ECO3: 2018 – 2022, Department of Business, Energy & Industrial Strategy, October 2018
[204] https://www.gov.uk/government/consultations/the-future-for-small-scale-low-carbon-generation
[205] https://www.ofgem.gov.uk/environmental-programmes/smart-export-guarantee-seg/about-smart-export-guarantee-seg
[206] https://www.gov.uk/guidance/heat-networks-delivery-unit

Heat Networks Investment Project (HNIP) funding

The GHNF is a capital grant funding programme which is intended to help new and existing heat networks to move to low and zero carbon technologies. Its objectives are to:

- achieve carbon savings and decreases in carbon intensity of heat supplied
- increase the total amount of low-carbon heat utilisation in heat networks (both retrofitted and new heat networks)
- help prepare the market for future low-carbon regulation and ensure compliance with existing regulations (such as the Heat Network (Metering and Billing) Regulations, Heat Network Market Framework and the Future Homes Standard)[207]

C.5 Ten Point Plan for a Green Industrial Revolution

The Ten Point Plan[208], publicised in November 2020, details how the UK intends to kick-start a green industrial revolution. Following the economic collapse induced by the coronavirus pandemic, a green industrial revolution, which aims to create and support 250,000 jobs by investing in clean technologies such as wind, carbon capture and low carbon hydrogen and improving the sustainability of national infrastructure such as public transport and new and existing buildings, is emerging. The ten points included in the plan are as follows:

1. Advancing Offshore Wind;
2. Driving the Growth of Low Carbon Hydrogen;
3. Delivering New and Advanced Nuclear Power;
4. Accelerating the Shift to Zero-Emission Vehicles;
5. Green Public Transport, Cycling and Walking;
6. Jet Zero and Green Ships;
7. Greener Buildings;
8. Investing in Carbon Capture, Usage and Storage;
9. Protecting Out Natural Environment; and,
10. Green Finance and Innovation.

Offshore Wind Sector Deal (March 2020)

Point 1 of the Ten Point Plan highlights the funding and attention that will be placed into advancing offshore wind. The Offshore Wind Sector Deal[209] accentuates the partnership between the Government and the offshore wind sector. The deal includes the details of the investments into the sector, including the plans to provide funding to allow for 40GW (increased from the 30GW set out in the original deal[210]) of offshore wind electricity generation, as mentioned within the Ten Point Plan. This development would result in offshore wind producing enough electricity to power every home in the country by 2030.

Although this is a significant investment into renewable energy generation, the 40GW produced by the offshore wind installations mentioned within the Ten Point Plan and the Offshore Wind Sector Deal will only produce enough electricity to meet the demand for the residential sector only. Other forms of renewable generation are still imperative at a local level in order to meet the demands for sectors such as commercial and transport sectors.

[207] https://www.gov.uk/government/consultations/green-heat-network-fund-proposals-for-the-scheme-design
[208] The Ten Point Plan for Green Industrial Revolution, HM Government, November 2020; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf
[209] https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal
[210] https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy

C.6 Emerging National Policy

Addressing climate change is an issue that is now at the forefront of public and government consciousness. In order to address the issue, new, fast-changing policies are emerging to ensure targets can be met. The most recent announcement from the UK Government, April 2021, set commitments projecting that the UK could cut carbon emissions by 78% by 2035, as per the sixth Carbon Budget.

Environment Bill 2020

Following on from the UK's 25 Year Environment Plan, the Environment Bill[211] has been produced to help deliver actions set out in the plan. The Environment Bill aims to manage the impact of human activity by creating a more sustainable and resilient economy.

Included in the bill is a UK Environmental Protections Policy which will allow for greater transparency regarding future environmental legislation following the UK's departure from the European Union. In addition, the bill focusses on resource and waste management, air quality, water management, green spaces and chemical regulations.

White Paper: Energy

The Energy White Paper 'Powering out Net Zero Future'[212] provides further clarity on the Ten Point Plan and highlights the long-term strategy for the wider energy system that transforms energy, supports green recovery and creates a fair deal for consumers, consistent with the target for net zero emissions by 2050.

There are 6 sections within the report:

- Consumers – Commitment to making the right reforms that will protect the interests of consumers and create opportunities to reduce bills and carbon emissions
- Power – Electricity is the key enabler for the transition away from fossil fuels and decarbonising the economy cost-effectively by 2050
- Energy Systems - To deliver energy reliably, while ensuring fair and affordable costs and accelerating our transition to clean energy, we need to create investment opportunities across the UK to enable a smarter, more flexible energy system, which harnesses the power of competition and innovation to the full.
- Buildings - Delivering our net zero target means largely eliminating emissions from domestic and commercial buildings by 2050
- Industrial Energy - By 2050, emissions from industry will need to fall by around 90% from today's levels
- Oil and Gas – Delivering the net zero target by 2050 means transforming the oil and gas sector in the UK

Several specific commitments are made under each section of the Energy White Paper, with the key commitments as follows:

Transforming Energy

Building a cleaner, greener future for our country, our people and our planet, by measures including:

- Targeting 40GW of offshore wind by 2030, including 1GW floating wind, alongside the expansion of other low-cost renewables technologies.
- Supporting the deployment of CCUS in four industrial clusters including at least one power CCUS project, to be operational by 2030 and putting in place the commercial frameworks required to help stimulate the market to deliver a future pipeline of CCUS projects.

[211] https://www.gov.uk/government/publications/environment-bill-2020/30-january-2020-environment-bill-2020-policy-statement#environmental-governance

[212] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf

- Establishing a new UK Emissions Trading System that aligned to our net zero target, giving industry the certainty, they need to invest in low-carbon technologies.
- Aiming to bring at least one largescale nuclear project to the point of Final Investment Decision by the end of this Parliament, subject to clear value for money and all relevant approvals.
- Consulting on whether it is appropriate to end gas grid connections to new homes being built from 2025, in favour of clean energy alternatives.
- Growing the installation of electric heat pumps, from 30,000 per year to 600,000 per year by 2028.
- Building world-leading digital infrastructure for our energy system based on the vision set out by the independent Energy Data Taskforce, publishing the UK's first Energy Data Strategy in spring 2021, in partnership with Ofgem.

Support a Green Recovery

Growing our economy, supporting thousands of green jobs across the country in new green industries and creating new export opportunities, by measures including:

- Increasing the ambition in our Industrial Clusters Mission four-fold, aiming to deliver four low-carbon clusters by 2030 and at least one fully net zero cluster by 2040.
- Investing £1 billion up to 2025 to facilitate the deployment of CCUS in two industrial clusters by the mid2020s, and a further two clusters by 2030, supporting our ambition to capture 10MtCO2 per year by the end of the decade.
- Working with industry, aiming to develop 5GW of low-carbon hydrogen production capacity by 2030.

Creating a Fair Deal for Consumers

Protecting the fuel poor, providing opportunities to save money on bills, giving us warmer, more comfortable homes and balancing investment against bill impacts, by measures including:

- Creating the framework to introduce opt-in switching, consulting by March 2021 on how it should be designed, tested and incrementally scaled up.
- Considering how the current auto-renewal and roll-over tariff arrangements could be reformed to facilitate greater competition, consulting by March 2021 on how opt-out switching could be tested as part of any future reforms.
- Assessing what market framework changes may be required to facilitate the development and uptake of innovative tariffs and products that work for consumers and contribute to net zero, engaging with industry and consumer groups throughout 2021 before a formal consultation.
- Ensuring the retail market regulatory framework adequately covers the wider market, consulting by spring 2021 on regulating third parties such as energy brokers and price comparison websites.
- Establishing the Future Homes Standard which will ensure that all newbuild homes are zero carbon ready.
- Consulting on regulatory measures to improve the energy performance of homes, and are consulting how mortgage lenders could support homeowners in making these improvements.
- Requiring that all rented non-domestic buildings will be Energy Performance Certificate (EPC) Band B by 2030, barring lawful exceptions.
- Extending the Energy Company Obligation to 2026 and expanding the Warm Home Discount to £475 million per year from 2022 to 2025/2026.

There is no target for a specific energy generation mix for 2050 within the Energy White Paper, but investments will be made into areas of innovative technology, such as advanced nuclear and clean hydrogen, which will help to commercialise these new technologies and reduce the overall technology costs, alongside the offshore wind sector.

White Paper: Planning for the Future

The Planning for the Future White Paper consultation was published by the UK Government in August 2020. The proposal aims to reform the planning system, creating an efficient and modernised planning process that focuses on design and sustainability, improving developer contributions to infrastructure and ensuring land is available for development. The proposals in the paper would apply to England only.

The published document was open for consultation, for 12 weeks from 6th August 2020, closing on 29th October 2020.

The role of Local Plans will be simplified, to focus on the identification of land under three categories:

- Growth Areas; suitable for development, and outline approval for development would be automatic.
- Renewal Areas; suitable for some additional development.
- Protected Areas; where development is restricted.

General development management policies will be set out nationally, with the Local Plans providing clear local rules, design codes and area-specific requirements.

The White Paper aims to support efforts to tackle climate change and maximise environmental benefits. It aims to do this by ensuring the National Planning Policy Framework (NPPF) targets the areas where a new planning system will most effectively address climate change mitigation and adaption, whilst driving environmental enhancements. The proposal also intends to facilitate improvements in buildings' energy efficiency standards to help target the net zero carbon by 2050 commitment.

The national policies will be set out within the NPPF, with the LA focusing on the locations, standards and design codes. LAs should start to consider the location of the three categories. Rather than general policies, clear and precise rules about these locations should be considered, and specific design codes created. Local Plans will become more visual and map-based, built upon the standards and rules produced.

With the planning white paper still aiming to support the fight against climate change, this RERAS will still feed into the local developments, making it essential regardless of the planning system's changes.

The planning white paper included proposals for consultation. The feedback following the consultation is still being analysed, meaning that the paper still requires governmental approval, and thus the formal writing of legislation. There is no indication on whether the proposals raised within the paper will come forward or what form these proposals will take. There is currently no timescale provided for when the consultation responses will be released.

Suppose the proposals within the paper are initiated. In that case, the Planning for Future White Paper will require the four councils in the West of England to update Local Plans to align with the government’s streamlined approach to policy setting, complete plans within 30 months; and, appoint a chief officer for design and placemaking. This digitisation and streamlining of planning applications will accelerate the delivery of new home whilst maintaining a focus on climate change.

C.7 West of England Planning Policy Context

The West of England Climate Emergency Action Plan (2020)

The West of England Climate Emergency Action Plan[213] confirms the regional goal for the West of England to be net zero carbon in 2030. The plan focuses on 5 challenge areas:

1. Low Carbon Transport System
2. Low Carbon Business
3. Renewable Energy
4. Low Carbon Buildings and Places
5. Green Environment.

The plan seeks to take in integrated approach to the 5 challenge areas to deliver low carbon improvements to the economy and travel within the region. The plan also includes a framework for the discussion on additional powers, funding and regulator changes required with the Government to accelerate the changes towards a zero-carbon future.

An update and report on the progress against these 5 challengers will be produced annually, ensuring that action evolve in line with lessons learnt and national changes.

The West of England Joint Waste Core Strategy

The Joint Waste Core Strategy (JWCS) sets out the strategic spatial planning policy for the provision of waste management infrastructure across the plan area. The joint strategy covers four council areas of Bath and North East Somerset, Bristol, North Somerset and South Gloucestershire and it applies to all waste, with the exception of most radioactive waste the policy for which is dealt with at a national level[214].

The document states the strategic objectives of the plan as:

"To move the management of waste up the waste hierarchy by increasing waste minimisation, recycling and composting then recovering further value from any remaining waste, and only looking to landfill for the disposal of pre-treated waste."

Moreover, the strategy confirms that proposals incorporating CHP or electricity generation will help national policy objectives and should be encouraged as such in the JWCS stating:

- "Energy recovery is placed beneath materials recovery in the waste hierarchy. However, it has a beneficial role to play and this is recognised in national policy in terms of both sustainable waste management and provision of a decentralised, renewable and/or low carbon energy source."
- "In accordance with national policy, the JWCS acknowledges the considerable potential for the production of heat from renewable sources and particularly opportunities for facilities that produce heat and electricity, such as energy from waste."

Policy 1: Waste Prevention

The JWCS seeks to encourage sustainable development in terms of a wise use of resources such as water, minerals, land and energy. Waste Prevention will be promoted by 5 target aims:

1. Authorities to work in partnership with businesses and the development industry to raise awareness and to provide information and advice;

[213] West of England Climate Emergency Action Plan, WECA, September 2020; https://westofengland-ca.moderngov.co.uk/documents/s2200/CE%20Action%20Plan.pdf
[214] West of England Joint Waste Core Strategy, WEP, March 2011; https://www.westofengland.org/media/211552/4.%20jwcs%20adoption%20document%20mar%202011.pdf

2. Raise public awareness on purchasing and lifestyle decisions;
3. Work in partnership with other LA and public bodies to ensure waste prevention is addressed in all contracts for works and services;
4. Ensure the provision of information, appropriate to the planning application, on the following matters: type and volume of waste; on-site waste recycling facilities; minimisation of raw material use; actively reduce, reuse and recycle waste throughout the construction phase; minimise transportation distance if waste disposed of elsewhere; ensure maximum diversion of waste from landfill once site is operational.
5. The Partnership Authorities leading by example.

Policy 2: Non-residual Waste Treatment Facilities

To comply with the draft RSS, approximately 800,000 Tons of additional recycling and composting capacity are required across the South West by 2020. An improved network of household waste recycling centres (HWRC) will be required across the South West to meet recycling and diversion targets.

Planning permissions for non-residual waste treatment facilities involving recycling, storage, transfer, materials recovery and processing (excluding open windrow composting) will be granted, subject to development management policies:

- Land that is allocated in a Local Plan or development plan document for industrial or storage purposes or has planning permission for such use.
- Previously developed land.
- Existing or proposed waste management sites, subject in the case of landfill and landraising sites or other temporary facilities.

Policy 3: Open Windrow Composting

Open windrow composting involves raw materials being arranged outdoors in piles (windrows) on a hard, impermeable surface, which is then mixed and turned regularly for aeration.

Planning permissions for open windrow composting, with sufficient distance, from any sensitive receptor will be granted, subject to development management policy:

- Existing or proposed waste management sites, subject in the case of landfill and landraising sites or other temporary facilities.
- Sites in the countryside which constitute previously developed land, or redundant agricultural and forestry buildings and their curtilages for proposals for the composting of waste.
- Sites in agricultural use proposing composting of waste for use within that agricultural unit.

Policy 4: Recycling, Storage and Transfer of Construction, Demolition and Excavation Waste at Mineral Sites

This policy aims to increase the use of secondary and recycled material as substitutes for virgin minerals and consequently reduce the amount of construction, demolition, and excavation waste disposed of to landfill.

Planning permissions for development involving recycling, storage and transfer of construction, demolition and excavation waste at mineral sites subject to development management policies, will be granted provided that the proposed development is for a temporary period commensurate with the operational life of the mineral site.

Policy 5 & 6: Residual Waste Treatment Facilities

Planning permissions for developments involving the treatment of residual wastes where it supports the delivery of the Spatial Strategy will be granted, subject to development management policies:

- 11 discrete sites across the region

- The facilities proposed will be required to contribute to the delivery of the Spatial Strategy.
- Indicative requirements for the South residual waste treatment are:
  - Zone A – ~390,000 TPA
  - Zone B – ~100,000 TPA
  - Zone C – ~150,000 TPA
  - Zone D – ~60,000 TPA
  - Zone E – ~100,000 TPA
- Monitoring will be undertaken to ensure the Spatial Strategy is delivered.

Policy 6 denotes the level of energy recovery expected to be achieved and the market(s) for that energy.

- Materials recovery facilities will be permitted provided that the value of the material and a market demand is presented.
- Energy recovery facilities will be permitted provided: the waste to be treated cannot practically and reasonably be reused, recycled or processed to recover materials; and that energy is recovered, and a market is presented for that energy.

Policy 8 & 9: Landfill, Landraise, Engineering or Other Operations

A key aim of the JWCS is to ensure that as much waste as possible is diverted away from landfill. To ensure resource use is maximised, all new landfill sites should either provide initial pre-treatment of wastes or be restricted to accept only those wastes that have been pre-treated.

In meeting the sub-region's landfill need, priority will be given to Brownfield land over Greenfield land. Planning permissions will be granted for waste disposal by landfilling, landraising or engineering or other operations, subject to development management policy, provided that:

- Waste that cannot practicably and reasonably be reused, recycled or processed (to recover materials; to produce compost, soil conditioner or inert residues; or to recover energy),
- Proposed developments must minimise waste necessary to deliver the B&NES' needs.
- Proposed developments must not prejudice the satisfactory restoration of mineral working sites in the locality, having regard to the supply and availability of appropriate waste materials for their restoration.
- Proposals are not within major aquifers, source protection zones, European sites of nature conservation or the appropriate buffer; except where it can be demonstrated that the relevant legislative requirements can be met.

In granting planning permission for landfilling or landraising developments, or engineering or other operations, conditions may be imposed limiting both the types and quantities of waste to be deposited in order to conserve capacity for waste that cannot be reused, recycled or processed.

Proposals for landfilling and landraising development, and engineering or other operations, should:

- Incorporate finished levels that are compatible with the surrounding area and any likely settlement.
- Include proposals for aftercare and secure long-term management of the restored site.
- Make provision for landfill gas to be recovered for use as an energy source.
- Make provision, where practical, for appropriate habitat creation for biodiversity benefit.

Policy 11 – Planning Designations

Planning permission will not be granted for waste-related developments which would endanger, or have a significant adverse impact on the following:

- RAMSAR Sites
- Special areas of conservation (SACs), candidate SACs, Special Protection Areas (SPAs) and potential SPAs;
- World Heritage Sites;
- Areas of Outstanding Natural Beauty (AONBs);
- The best and most versatile agricultural land;
- Scheduled Ancient Monuments (SAMs) or Sites of Archaeological Importance;
- National nature reserves (NNRs) or Sites of special scientific interest (SSSIs;
- Ancient semi-natural woodlands;
- Listed Buildings, Registered Parks, Gardens and Battlefields;
- Conservation Areas and sites of Nature Conservation Importance;
- Local Nature Reserves and non-statutory nature reserves;
- Areas of Historic Landscape Value;
- Regionally Important Geological Sites (RIGS)
- Groundwater Source Protection Zones;
- Areas in Flood Zone 3b or where the level of flood risk is considered unsuitable;
- Biodiversity Action Plan habitat and species
- Green Belt, except where very special circumstances are justified.

When assessing each development proposal consideration will be made into whether any significant adverse impact identified could be controlled to acceptable levels.

Policy 13 – Safeguarding Operational and Allocated Sites for Waste Management Facilities

Operational waste sites are safeguarded, except where alternative suitable facilities are to be provided as part of an authority approved strategy.

West of England Local Industrial Strategy (2019)[215]

The West of England's Local Industrial Strategy, published in July 2019, conveys the importance of minimising the impact on the environment when implementing the region's four main priorities: cross-sectoral innovation; inclusive growth; addressing the productivity challenge; and delivering innovation in infrastructure delivery.

To ensure the region is active in minimising environmental impact, the strategy confirms that the West of England will embed innovation in tackling major infrastructure challenges, and thus are committed to tackling climate change by contributing to the Clean Growth Grand Challenge mission.

C.8 Bath & North East Somerset Local Policy

Bath and North East Somerset Climate and Ecological Emergency Action Plan

In March 2019, B&NES Council declared a Climate Emergency and committed to achieving carbon neutrality by 2030, 20 years ahead of the national target. To enable meeting this target, B&NES requires:

- Energy efficiency improvement of the majority of existing buildings (domestic and non-domestic) and zero carbon new build;
- A major shift to mass transport, walking and cycling to reduce transport emissions;

[215] West of England Local Industrial Strategy, HM Government, July 2019

- A rapid and large-scale increase in local renewable energy generation.

Climate change is a priority in B&NES' existing Local Plan which covers 2011 to 2029, comprising a series of separate Development Plan Documents: The Core Strategy (adopted July 2014) and Placemaking Plan (adopted July 2017)[216]; Joint Waste Core Strategy (JWCS) (adopted March 2011); and, a series of 18No. Neighbourhood Plans[217] in varying stages of completion.

The Council has launched a partial update of the Local Plan due to a need to update particular policies, where circumstances have changed since the Core Strategy was adopted in 2014, particularly the Council's declaration of a Climate and Ecological Emergency.

The policy reviews below focus only on policy areas related to sustainable development, waste management and a response to climate change.

B&NES Climate Emergency Study 2019

Following the Climate Emergency declaration, a study was conducted to assess how the district and the Council might achieve the 2030 net zero target. This study used a national desk-based methodology, the SCATTER tool to assess the potential of a range of measures. The figures below were produced by scaling down national estimates of renewable energy deployment resource to a district level so are very high-level, however give an indication of the scale of installation needed if B&NES was to do its share of national decarbonisation (excerpt Table 3 from p6 here https://democracy.bathnes.gov.uk/documents/s58689/Appendix%20-%20Synthesis%20of%20Evidence.pdf). This provides a useful comparator for the analysis in this report.

Core Strategy and Placemaking Plan Existing Renewable Energy Policy

The Core Strategy and Placemaking Plan puts in place a strategic planning framework, guiding development within B&NES until 2029. There are many policies with the document, with existing policies aiming to encourage renewable energy development, where appropriate. There policies are based on the outputs from the Camco Bath and North East Somerset Renewable Energy and Planning Research[218] and the Regen South West Renewable Resource Assessment[219].

Policy CP3: Renewable Energy

Policy CP3 aims to increase to level of renewable energy generation in B&NES. The current targets are provided in Table 46.

Table 46: Renewable Electricity and Heat Generation Targets by 2029

Generation Type	Capacity (MW)
Electricity	110 MW_e
Thermal	165 MW_t

Source: B&NES Core Strategy

The above targets will be monitored and adjusted as technologies and initiatives improve. B&NES Council are responsible for determining applications for onshore renewable energy schemes of up to 50 MW generation capacity.

Policy SCR1: On-site Renewable Energy Requirement

In order to support the delivery of Policy CP3, it is expected that major developments (above a threshold of 1,000m^2 or 10No. dwellings, excluding industrial B2 and B8 uses) will provide renewable

[216] Bath & North East Somerset Council. *Core Strategy & Placemaking Plan.* Available at: <https://beta.bathnes.gov.uk/sites/default/files/2020-02/cs_pmp_vol_1_district-wide_compressed.pdf>
[217] Bath & North East Somerset Council. *View Current Neighbourhood Plans.* Available at: <https://beta.bathnes.gov.uk/view-current-neighbourhood-plans>
[218] https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/Evidence-Base/Sustainability/renewable_energy_and_planning_research_-_november_2010.pdf
[219] http://regensw.s3.amazonaws.com/south_west_renewable_energy_resource_assessment_methodological_report_november_2010_3ab46cc2726f0a25.pdf

energy on-site to reduce anticipated (regulated) carbon dioxide emissions in buildings by at least 10%.

The Energy Act (2008) continues to facilitate on-site renewable energy targets provided that the technical potential and financial viability have been demonstrated to have been adequately considered and tested.

Policy SCR2: Roof-mounted / Building-integrated Scale Solar PV

Roof-mounted solar photovoltaic (PV) panels are regularly permitted developments. However, where planning permission is required, solar arrays should be designed to complement the aesthetic of the host building. Consideration of character should inform design choices in line with Policy SCR2.

Where planning permission is required for roof-mounted/building-integrated solar PV, the following matters should be addressed:

- The use of monochrome, nonreflective photovoltaic materials to complement the existing roof material
- The facilitation of a regular, rhythmic pattern for multiple arrays wherever possible

In all development, particularly new build dwellings which incorporate solar energy, the photovoltaic materials should be considered as part of the overall scheme design.

Policy SCR3: Ground-mounted Solar Arrays

In addition to considerations discussed in Policy CP3, planning applications for ground-mounted solar arrays which follow best practice (e.g. BRE National Solar Centre guidance and the Solar Trade Association best practice commitments, or successor guidance) and should achieve as many of the following factors as possible:

- Proposals are focused on non-agricultural land or land of lower agricultural quality
- Proposals are sensitive to nationally and locally protected landscapes and nature conservation areas and take opportunities to enhance the ecological value of the land. To this end, the application should be supported by a Biodiversity Management Plan, which reflects the BRE National Solar Centre "Biodiversity Guidance for Solar Developments" (or successor guidance).
- Proposals seek to minimise visual impact where possible and maintain appropriate screening throughout the lifetime of the project (managed through a land management and/or ecology plan)
- Engagement at a pre-application stage with the community takes place
- Proposals are supportive of land diversification and continued agricultural use, biodiversity measures and supporting the provision of multi-functional Green Infrastructure e.g. permissive paths and wildlife corridors
- Proposals are used as an educational opportunity where appropriate
- Land is returned to its former use at the end of a project

In all cases proposals will be expected to be consistent with the relevant design, heritage and landscape policies.

Policy SCR4: Community Renewable Energy Schemes

Policy SCR4 aims to support the delivery of community renewable energy schemes and thus, the broader community involvement that result. This is in line with the approach set out in the Government's Community Energy Strategy.

The positive benefits of community energy schemes will be a material consideration in assessing renewable energy development proposals.

The preference is for schemes that are led by and directly meet the needs of local communities, in line with the hierarchy and project attributes below:

- Projects partially or fully owned by a local community group or social enterprise.
- Local community members have a governance stake in the project or organisation e.g. with voting rights.
- In the case of renewable energy proposals within the Green Belt, where community benefits are proposed to meet the "very special circumstances" test, the following criteria will be considered:
  - The contribution to achieving the targets set out in Policy CP3 of the Core Strategy to increase the level of renewable electricity and heat generation in the district;
  - The contribution that will be made to local and national renewable energy and carbon reduction targets;
  - Social and economic benefits. For example, local job creation opportunities; raising the quality of life in rural areas through diversification of agricultural land and generating an alternative income for farmers;
  - The temporary nature of the renewable energy development and the ability to restore land to its original condition at the end of the project's life;
  - Contributions to improving the biodiversity, public amenity and soils in the vicinity of the scheme.

In all cases schemes will only be permitted if there is no unacceptable impact on the significance of a designated and non- designated heritage asset.

Policy CP4: District Heating

Policy CP4 aims to provide a basis for Development Management to support the principle of combined heat and power (CHP) and/or combined cooling, heat and power (CCHP) and district heating.

Areas within B&NES will be identified as either "district heating priority areas" or "district heating opportunity areas". Bath Central, Bath Riverside and Keynsham High Street will be expected to incorporate infrastructure for district heating, and will be expected to connect to existing systems where and when this is available, unless demonstrated that this would render development unviable.

Adopted Neighborhood Plans

A total of 9No. neighbourhood plans have been adopted as part of B&NES Council's LP; each applicable policy is discussed below. Draft neighbourhood plans have been produced for Stanton Drew and Freshford Village Hall Community Right to Build Order. A total of 7No. communities within B&NES have proposed neighbourhood plans; the communities with proposed neighbourhood plans are as follows: Bathampton, Batheaston, High Littleton and Hallatrow, Keynsham, Midsomer Norton, Paulton and Timsbury.

Many of the neighborhood plans have provisions to conserve and protect the landscape to improve energy performance and adapt to climate change, with a focus on flooding impacts, which require individual site decisions within the respective areas. These plans also contain policies specifically to encourage renewable energy, these are listed below.

Chew Valley Area – Policy HDE6a. Sustainability – Renewable Energy

Development proposals for renewable energy installations must not be detrimental to their landscape setting, and their design must demonstrate sensitivity to the local environment.

Claverton – Policy E2a

Support will be given to non-residential developments which: incorporate sustainable and natural building materials; seek to maximise energy efficiency; and, provide renewable energy generation

Clutton – Policy CNP5. Sustainability by Design
All new dwellings and commercial developments should where appropriate be laid out to maximise solar energy gain.

Englishcombe – Climate Change 2. Renewable energy.

This policy supports proposals that aim to incorporate renewable energy generation as part of the development; and, supports the development proposals for renewable energy generation structures that are accompanied by a full impact assessment of the potential effect on bats and other European species and where any impacts are satisfactory mitigated.

Englishcombe – Climate Change 3. Energy Efficiency.

This policy supports development proposals that seeks to maximise energy efficiency.

Westfield – Policy 3. Housing Design

Each new development application must demonstrate the following: high quality design, reflecting the identity of Westfield; sympathy to local heritage assets; variety of garden sizes and landscaping features; and, energy efficient design and climatic resilience into the design in the following ways.

- New build development will be required to achieve a 19% reduction in CO2 emissions from a baseline of Part L compliance.
- Extensions and change of use: Applicants will be expected to install simple, cost effective energy efficiency measures to be carried out on the existing building if possible and practical.
- Electric vehicle charging and cycle parking: Developments must ensure: 20% of new parking spaces provide an electrical charging point or are future-proofed to provide a charging point with installations of appropriate wiring; and, new build developments must provide one cycle storage space for studio and one-bedroom flats, two cycle storage spaces for all other residential unit sizes. Storage must be under cover, secure and accessible, as set out in the requirements for the Home Quality Mark standard.

Appendix D : Clean Growth Strategy – Power Sector Policies and Proposals

The UK published the Clean Growth Strategy in October 2017. The Clean Growth Strategy sets out the policies and proposals, for decarbonising all sectors of the UK economy[220]. The power sector policies and proposals are discussed below.

Growing Low Carbon Sources of Electricity

1. The Government confirm the Government's intention to phase out unabated coal generation by 2025, and will shortly publish the Government's detailed response to the consultation.
2. The Government are delivering new nuclear capacity through the final investment decision on Hinkley Point C and will progress discussions with developers to secure a competitive price for future projects in the pipeline.
3. The Government will work with industry as they develop an ambitious Sector Deal for offshore wind. Provided costs continue to fall, this could result in 10 gigawatts of new capacity built in the 2020s, with the potential to support high-value jobs and a sustainable UK industry exporting goods and services around the world. The Government will also consider whether there could be opportunities for additional offshore wind deployment in the 2020s, if this is cost-effective and deliverable. This would mean up to £557 million for further Pot 2 Contract for Difference auctions, with the next one planned for spring 2019. The Government will work with the Crown Estate and the Crown Estate (Scotland) to understand the potential for deployment of offshore wind in the late 2020s and beyond and it is our current intention that wind projects on the remote islands of Scotland that directly benefit local communities will be eligible for the next Pot 2 auction, subject to obtaining State aid approval.
4. The Government want to see more people investing in solar without government support and is currently considering options for our approach to small scale low carbon generation beyond 2019. More nascent technologies such as wave, tidal stream and tidal range, could also have a role in the long-term decarbonisation of the UK, but they will need to demonstrate how they can compete with other forms of generation.
5. The Government remain committed to carbon pricing to help reduce emissions in the power sector. Further details on carbon prices for the 2020s will be set out in the autumn 2017 Budget.

Delivering Smarter, More Efficient Energy

6. The Government will ensure that every household is offered a smart meter by their energy supplier by the end of 2020, and expect energy suppliers to make every effort to provide smart meters to all their customers.
7. The Government, Ofgem and industry will implement the 29 actions set out in the Smart Systems and Flexibility Plan published on 24 July. These will enable technologies such as energy storage and demand-side response to compete effectively within the energy market, help integrate more low carbon generation such as solar into our energy system, and deliver secure, smart appliances and smart tariffs to allow consumers to benefit from using energy at times when it is cheaper. Innovations and other steps to increase flexibility could unlock up to £40 billion in energy cost savings up to 2050.
8. The Government will continue to work with Ofgem and the National Grid to create a more independent system operator which will help to keep household bills low through greater competition, coordination and innovation across the system.
9. The Government will work with Ofgem to ensure the necessary regulatory and market arrangements evolve to support the development of a clean, smart and flexible energy system as outlined in their strategy for regulating the future energy system.

[220] https://www.gov.uk/government/publications/clean-growth-strategy

10. The Government will work to ensure significant private investment in new electricity interconnectors, which will help keep prices low for consumers, ensure a more secure grid and help integrate clean generation. Project assessments indicate the potential for at least 9.5 gigawatts more interconnection by the early-to-mid 2020s, in addition to the 4 gigawatts today and the 4.4 gigawatts under construction.
11. Ofgem's price control regime will enable up to £26 billion of investment in upgrading and operating our electricity distribution networks from 2015-23 and will work closely with the industry to capitalise on the opportunities for smart integration of electric vehicles into the electricity system.
12. The Government confirmed that when an installer installs solar panels with a battery in residential accommodation, this can attract a reduced VAT rate of 5 per cent if the installation conditions are met. The Government will keep the tax treatment of technologies such as solar, storage and heat networks under review.

Keeping Energy Costs Down for Businesses and Households

13. The Government has commissioned an independent review into the cost of energy led by Professor Dieter Helm CBE which will recommend ways to deliver the Government's carbon targets and ensure the security of supply at minimum cost to both industry and domestic consumers. Once Ministers have had the opportunity to consider the Helm review's proposals, the Clean Growth Strategy will incorporate its recommendations into our further policy development as appropriate.
14. The Government are publishing a draft bill to require Ofgem to impose a cap on standard variable and default tariffs across the whole market.
15. The existing Levy Control Framework will be replaced by a new set of controls beyond 2020/21. These will be set out later this year.
16. The Government are evaluating the results of the Electricity Demand Reduction Pilot, which has offered organisations £5.4 million of funding for projects that could reduce bills and improve security of supply through making energy savings at peak times.

Government Innovation Investment

- The Government expects to invest around £900 million of public funds between 2015 and 2021 in research and innovation in the power sector.
- Power and smart systems: Ensuring that the power system is smart and resilient to new demands and new sources of supply will be important for energy security, cost and industrial opportunities. The Government, in partnership with the Research Councils and Innovate UK, expects to invest around £265 million in research, development and deployment in this area which will help to reduce the cost of electricity storage, advance innovative demand response technologies and develop new ways of balancing the grid, for example using EVs.
- Nuclear: The Government needs to bring down nuclear power costs while maintaining safety by investing in innovation that will help plants to be built to time and budget. In partnership with the Research Councils and Innovate UK, the Government expects to invest around £460 million to support work in areas including future nuclear fuels, new nuclear manufacturing techniques, recycling and reprocessing, and advanced reactor design. The Government has asked the Nuclear Innovation and Research Office (NIRO) to convene a new advisory Board, building on the success of the Nuclear Innovation and Research Advisory Board (NIRAB). The Board will provide independent expertise and advice to support and inform the Government's Nuclear Innovation Programme. The Government is also announcing that it will invest £7 million to further develop the capability and capacity of the nuclear regulators to support the development of advanced technologies. The industry is developing a potential nuclear sector deal as part of the Government's Industrial Strategy, co-ordinated around the objective of achieving cost reductions.
- Renewables: The UK already has a world-leading offshore wind sector and is well placed to benefit from further investment in renewables innovation to accelerate cost reduction. The Government, in partnership with the Research Councils and Innovate UK, expects to invest

around £177 million to further reduce the cost of renewables, including innovation in offshore wind turbine blade technology and foundations. New innovation opportunities are likely to arise in a number of areas, including floating offshore wind platforms, and advanced solar PV technologies.

- Carbon capture, usage and storage: CCUS could reduce the cost of meeting our 2050 target by supporting emissions reductions in industry, power, heating and transport. Our new approach to CCUS is set out in the Business chapter.
- Ofgem is making available to GB electricity network companies up to £525 million of regulated expenditure between 2016 and 2021. The goal is to support smarter, flexible networks, from enabling the integration of clean generation through to customer-focussed energy efficiency measures. This builds on previous network company innovation which delivered 4.5 – 6.5 times more benefits for consumers than it cost.

Appendix E : Existing Low and Zero Carbon Energy Technologies

Site Name	Technology	Location (X-coordinate):	Location (y-coordinate):	Site Postcode	Capacity (MW)	Status	Data Source
Unknown	Anaerobic digestion	358047.481	157813.228	BS40 6HP	0.25	Operational	Regen
Queen Charlton Quarry Renewable Energy Facility - food waste	Anaerobic Digestion	363,395	165,868	BS31 2TN	2.2	Consented	REPD
Fosseway Environment Park	Anaerobic Digestion	372,395	161,189	BA2 8PD	1.00	Consented	Regen/ REPD
Farthingham	Hydropower			BA2 7UD	0.05499	Operational	REGO
Queen Charlton Recycling Centre	Landfill Gas	363,728	165,914	BS31 8TN	1.60	Operational	Regen
Ridings Farm Endurance	Onshore Wind	365,142	159,301	BA2 0HH	0.0795	Operational	REGO/ Regen, Built and Granted Applications
Unknown	Onshore wind	373,151	168,748	BA1 9DT	0.02	Operational	Regen, Built and Granted Applications
Chelwood Solar Farm	Photovoltaic	364,184	161,166	BS39 4NR	5	Operational	Built and Granted Applications
Hunstrete (Wilmington Farm)	Photovoltaic	365,003	161,514	BA2 9AD	2.3	Operational	REPD, Built and Granted Applications
Clutton Hill Farm Estate	Photovoltaic	51°23'5.69"N	2°29'3.48"W		0.0912	Operational	REGO
Dickies	Photovoltaic - Roof Mounted			BA3 4XD	0.24	Operational	REGO
HCL Fasteners	Photovoltaic - Roof Mounted			BA3 4BS	0.111	Operational	REGO
Keynsham Civic Centre Offices PV	Photovoltaic - Roof Mounted	365,523	168,461		0.194	Operational	REGO
NPK Church Farm	Photovoltaic - Roof Mounted			BA2 9HT	0.13136	Operational	REGO

Operations Centre Office Solar PV	Photovoltaic - Roof Mounted			BA2 7WW	0.2462	Operational	REGO
Stowey Farm Cowhouse	Photovoltaic - Roof Mounted	51°19'59.17"N	2°34'35.15"W		0.2	Operational	REGO
TPM UK Ltd	Photovoltaic - Roof Mounted			BS39 6UU	0.133	Operational	REGO
Wessex Water Services Ltd	Sewage gas	372,054	162,321	BA1 3AU	0.63	Operational	Regen

Appendix F : Existing Renewable Electricity Generated in Bath and North East Somerset

Technology	Capacity Factor	Installed Capacity (MW)	Energy Generated (MWhe)
Micro and Small Wind Power	0.10	0.11	97
Wind Farms	0.25	0.00	0
Biomass Energy Crop	0.75	2.03	13,439
Energy from Waste	0.90	0.06	446
Hydropower	0.29	0.16	404
Landfill Gas	0.46	1.60	6,484
Solar PV Farms	0.11	5.87	5,691
Rooftop Solar PV	0.10	14.33	12,550
Other including food waste, animal slurry, poultry litter, sewage sludge and sewage gas. (AD with CHP)	0.43	3.08	11711
Domestic and Non-Domestic Renewable Electricity Technologies Such as Rooftop Solar PV (Electricity)	0.10	0.00	0
Total		27.23	50,822

Appendix G : Wind Energy Resource Methodology

G.1 Introduction

This section of the RERAS focuses on the identification of resource and potential generation from larger scale wind turbines across B&NES. For this study, the potential for installing wind turbines of 2.5 MW, 1 MW, and 500kW sizes were assessed, and primary constraints associated with wind energy development are considered. For an assessment of the potential for smaller scale turbines, it is suggested to refer to the existing B&NES Renewable Energy and Planning Research study[221].

In relation to wind energy, this RERAS is primarily concerned with the spatial identification of potential wind farm developments larger than 5MW total capacity[222], which was considered the minimum size of a wind farm that could be financially viable without additional incentives[223].

Commercial-scale wind farms seek to install turbines at as large a scale as possible; however, it should be noted that any project (regardless of size) might be of interest to developers and community groups. Therefore, in the interest of completeness, additional suitable areas for installing smaller scale turbines (500kW) are included in the assessment. In this study, when assessing a 500kW wind turbine's resources, overlaps with areas suitable for larger turbines were prioritised to the larger turbines. It should be noted, that there is a strong community energy resource within B&NES, 40% of the renewable energy capacity within B&NES is in community ownership[224].

G.2 Mapping

The wind resource potential in B&NES was determined through a series of steps in which the primary constraints associated with wind development have been considered. The datasets corresponding to these constraints are overlaid in GIS maps in stages to produce the final Search Areas shown in this RERAS. This assessment considers a combination of primary constraints comprising those that exclude certain places from being considered as potentially suitable as areas of search for locating wind farms (e.g. international nature conservation designations), as well as other constraints that require further consideration through the Local Plan process (e.g. Areas of Outstanding Natural Beauty (AONB)). For the purposes of this study, these are shown for 'information only' purposes. Each of these different type of constraints, and the stages at which the data layers were applied in the GIS mapping process, was discussed and agree with the Council.

Maps have been produced to illustrate each stage of the process of identifying primary constraints and opportunities.

The flowchart shown in Figure 78 shows the process steps and the output maps at each mapping stage. More detail on each of the steps is provided in this section.

[221] https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/Evidence-Base/Sustainability/renewable_energy_and_planning_research_-_november_2010.pdf
[222] Each 2.5MW and 1.0MW Search Area can locate a minimum of 5MW wind farm containing 2.5MW or 1.0MW turbines respectively whereas the 500kW Search Areas can accommodate at least a single 500kW turbine
[223] 5MW is the cut-off point for eligibility of a wind farm to receive subsidies in the Feed-In Tariff (FIT) scheme.
[224] B&NEs Council

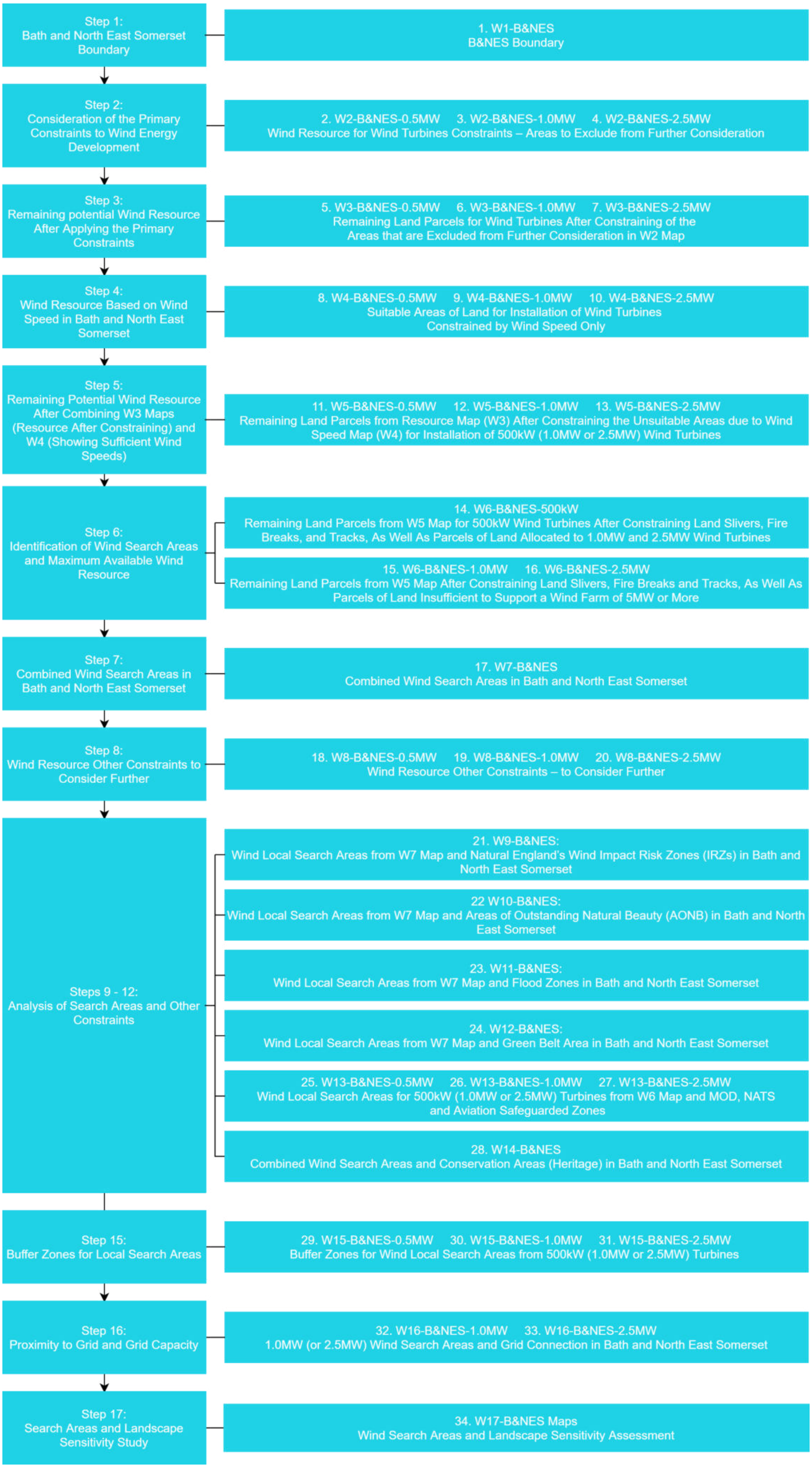


Figure 78: Flowchart of Wind Energy Resource Mapping Process

The different turbine sizes result in varying cut off wind speeds, noise buffers, tip heights and topple distances, and therefore, each of the turbine sizes investigated has been individually mapped. Table 47 below presents the specifications of the wind turbines that were considered in this study.

Table 47: Wind Turbines Specifications Used Within This Study

Turbine Size (Rated Output)	Dimensions	Wind Speed Cut Off	Wind Turbine Density	Approx. Distance Between Turbines	Noise Buffer[225]	Topple Distance+10 % Buffer (Tip Height Plus 10%)
2.5 MW	Tip Height[226]: 135 m Rotor Diameter: 100 m Hub Height: 85 m	A lower limit of 5m/s measured at 45m above ground level (agl)	9 MW/km^2	595 m	600 m	148.5 m
1 MW	Tip Height[195]: 100 m Rotor Diameter: 55 m Hub Height: 60-80 m	A lower limit of 6m/s measured at 45m above ground level (agl)	8 MW/km^2	399 m	500 m	110 m
500 kW	Tip Height[195]: 70 m Rotor Diameter: 45 m Hub Height: 40-60 m	A lower limit of 6m/s measured at 45m above ground level (agl)	One turbine to be sited on each identified area	One turbine to be sited on each identified area	400 m	77 m

Throughout this study, reference is made to titles and reference numbers to correspond with maps. Screenshots of these maps are included throughout this section Where maps have been produced for the 500kW, 1MW and 2.5MW separately, maps for the 1MW turbines have been included. Higher-resolution maps and the additional 500Kw and 2.5MW turbine maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[225] The noise buffers are based on SQW Energy Renewable and Low-Carbon Energy Capacity Methodology – Methodology for the English Regions.
[226] Height to blade tip at the highest point.

Step1: Bath and North East Somerset Boundary

Map Reference and Title:

1. W1-B&NES: Bath and North East Somerset Boundary

This map shows the B&NES boundary. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

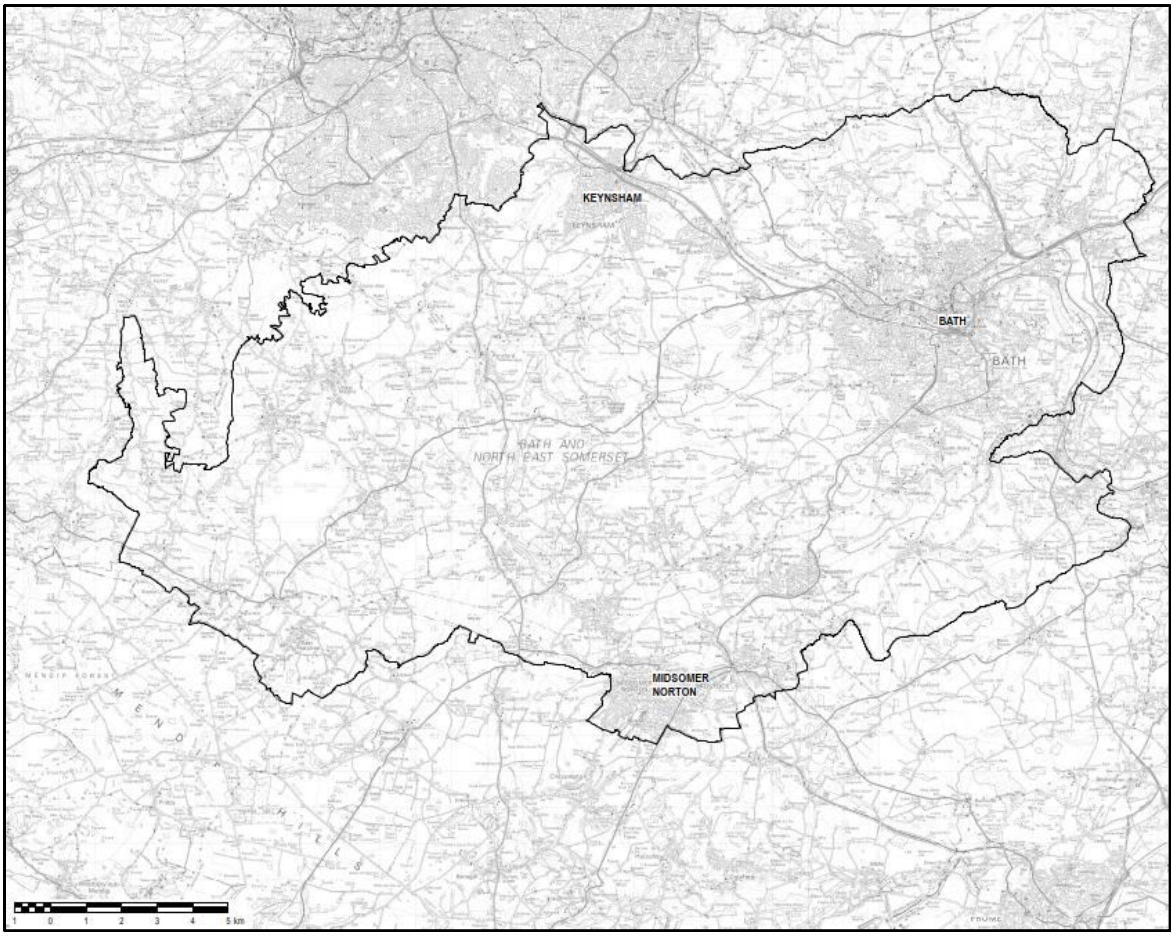


Figure 79: Bath and North East Somerset Boundary Map

Step 2: Consideration of the Primary Constraints to Wind Energy Development

Map References & Titles:

1. W2-B&NES-0.5MW: Wind Resource for 500kW Wind Turbines Constraints – Areas to Exclude from Further Consideration
2. W2- B&NES -1.0MW: Wind Resource for 1.0MW Wind Turbines Constraints – Areas to Exclude from Further Consideration
3. W2- B&NES -2.5MW: Wind Resource for 2.5MW Wind Turbines Constraints – Areas to Exclude from Further Consideration

The purpose of this step was to identify the maximum potential wind energy resource across B&NES through the identification of various constraints.

The primary constraints are described in more detail below and a comprehensive list of the constraints is given in Appendix H. The buffer distances are specific to the different turbine sized and a few of the designations are constrained to their extent only.

The W2 wind constraints maps illustrate the primary constraints to the development/ deployment of wind turbines. Many of the constraints can be attributed to statutory designations such as those that protect the environment or heritage. For the GIS mapping process, the constraint, except where specifically stated, relates to the extent of the designation only (with no additional constraint buffer applied beyond the boundary). The constraints applied to the maps in Step 2 were as follows:

- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC);
- RAMSAR sites (Not present in B&NES);
- National Nature Reserves (NNR) (Not Present in B&NES);
- Sites of Special Scientific Interest (SSSI);
- Scheduled Monuments;
- Listed Buildings, noise buffers have been applied if the building is residential;
- Registered Historic Parks and Gardens; and
- Registered Battlefields.

Many of the 'buffer distances' applied in the maps, are linked to minimising potential impacts upon people or infrastructure. The extent of the buffer areas applied was informed directly by the characteristic s of the turbines being assessed (e.g. height of the turbine).

This assessment is based on constraints associated with 500kW, 1.0MW and 2.5MW wind turbines to maintain consistency with the method set out in the NPPF[227].

Noise buffers[228] have been applied by AECOM around existing dwellings in B&NES. Given the noise-related impact wind turbines can have on building occupants, particularly residents, and the spatial extent that such an effect can have on identifying potentially available wind resources. The noise impact can also affect any dwellings close to the border in adjacent authorities; therefore, the noise buffers were also applied to those dwellings. Where it was not possible to identify residential sites among all buildings in external areas, noise buffers have been used to buffer all buildings. These buffers are labelled on the maps separately.

For ease of reference, the assumptions applied to constraints mapping for wind development are provided in Table 48.

Table 48: Wind Turbine Noise Buffers and Topple Distances

Turbine Size	Noise Buffer	Topple Distance+10% Buffer (Tip Height Plus 10%)
2.5 MW	600 m	148.5 m
1 MW	500 m	110 m
500 kW	400 m	77 m

[227] E.g. as defined in SQW Energy Renewable and Low-Carbon Energy Capacity Methodology – Methodology for the English Regions

[228] The noise buffers are based on SQW Energy Renewable and Low-Carbon Energy Capacity Methodology – Methodology for the English Regions. However, the noise buffers in the following policy should be considered on a site by site basis:
Wind Turbines (Minimum Distances from Residential Premises) Bill
https://publications.parliament.uk/pa/ld201011/ldbills/017/11017.1-i.html
It is understood that the authority may grant planning permission for the construction of a wind turbine generator which does not meet the minimum distance stated in the Bill if the owners of all residential premises which fall within the minimum distance requirement for the proposed wind turbine generator (as stated in the Bill) agree in writing to the construction of the wind turbine generator.

The following constraints and their buffer distances (where one has been applied) are fixed for different turbine sizes.

- Ancient Woodlands – a 15-metre buffer has been applied to avoid root damage[229];
- Broadleaved Woodland a 15-metre buffer has been applied to avoid root damage;
- Existing buildings (extent);
- Watercourses – including major, secondary, and minor rivers, canals and lakes; - a 2-metre buffer has been applied to rivers and streams;
- Active mines/quarries; and
- Local Nature Reserves.

The following constraints and their buffer distances (where one has been applied) are likely to change when considering different turbine sizes.

- Major transport infrastructure – topple distances buffers have been applied;
- Minor transport infrastructure – topple distances+10% buffers have been applied;
- Dwellings – noise buffers have been applied;
- MoD Sites; and
- MoD Low Flying Zones.
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind)

It should be noted that, whilst the above issues have been considered in the selection of the Search Areas (SAs), the SAs are not final because:

- The SAs remain subject to further investigation based on information provided in this report (e.g. grid connection or landscape sensitivity) and other considerations through the Local Plan process;
- The SAs are formed using specific technology typologies which, if different from the development proposals, may require the mapping exercise to be rerun;
- If a private landowner wanted a wind turbine closer to their building than was recommended, and nothing else was adversely affected, then loosening of noise restrictions could be considered.

Additionally, it is important to note that proposals for wind turbines above 2.5MW will change the shape and extent of the SAs and further work will be needed when considering the proposals, particularly around reapplying the primary constraints listed above.

A higher resolution version of this map is contained in the accompanying document ‘Bath and North East Somerset RERAS – Maps’.

[229] https://www.gov.uk/guidance/ancient-woodland-and-veteran-trees-protection-surveys-licences

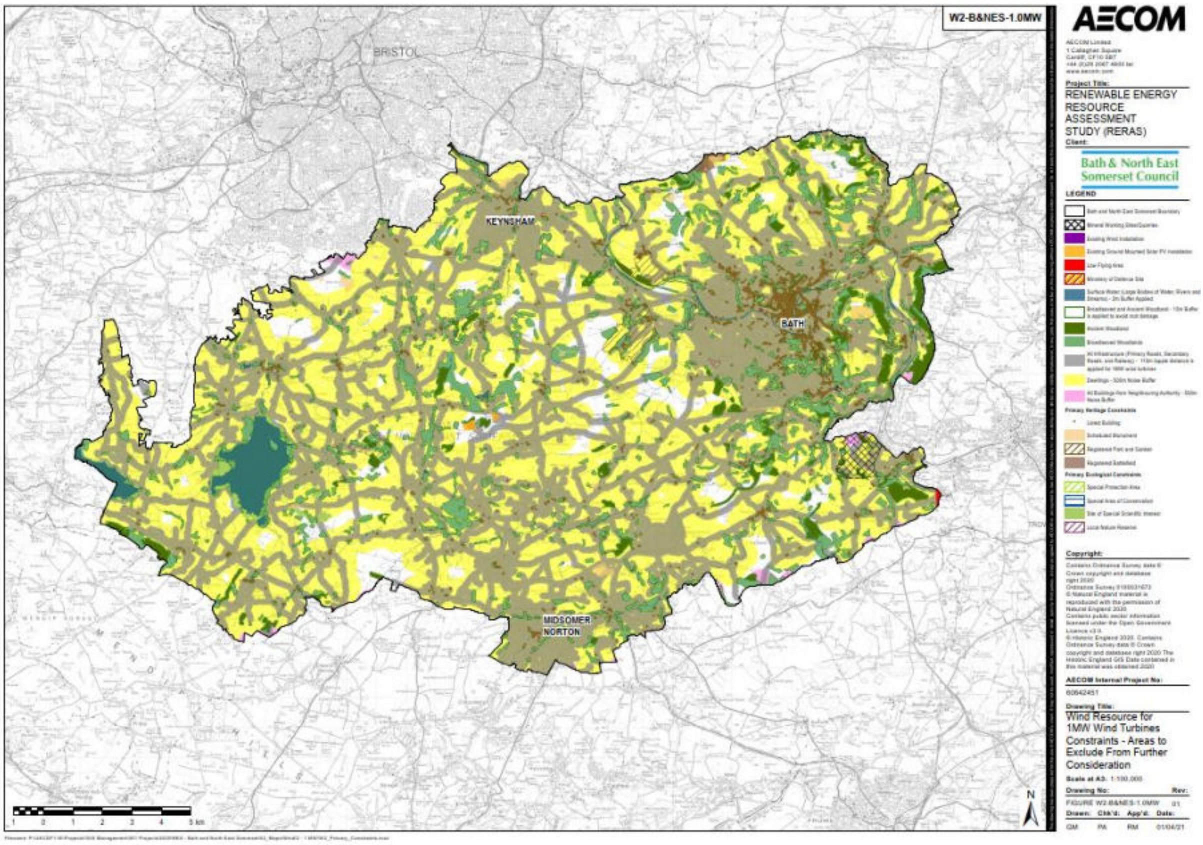


Figure 80: W2-B&NES-1.0MW: Wind Resource for 1.0MW Wind Turbines Constraints – Areas to Exclude from Further Consideration Map

A comprehensive table of the constraints is given in Appendix H.

Policy Recommendation

Policy Reference: WF-PR-8 (Refer to Table 41 in Section 17)

It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity will, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple-distances), site specific constraints, and other policy considerations should be looked upon favourably..

Step 3: Remaining Land Parcels After Applying the Constraints

Map References & Titles:

1. W3-B&NES-0.5MW: Remaining Land Parcels for 500kW Wind Turbines After Constraining of the Areas that are Excluded from Further Consideration in W2 Map
2. W3-B&NES -1.0MW: Remaining Land Parcels for 1.0MW Wind Turbines After Constraining of the Areas that are Excluded from Further Consideration in W2 Map
3. W3-B&NES -2.5MW: Remaining Land Parcels for 2.5MW Wind Turbines After Constraining of the Areas that are Excluded from Further Consideration in W2 Map

W3 maps show the remaining potential wind resource[230] after removing the areas that were constrained in Step 2 of the mapping process. Table 49 summarises this information. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[230] Labelled as "Unconstrained Wind Resource" on the W3 maps.

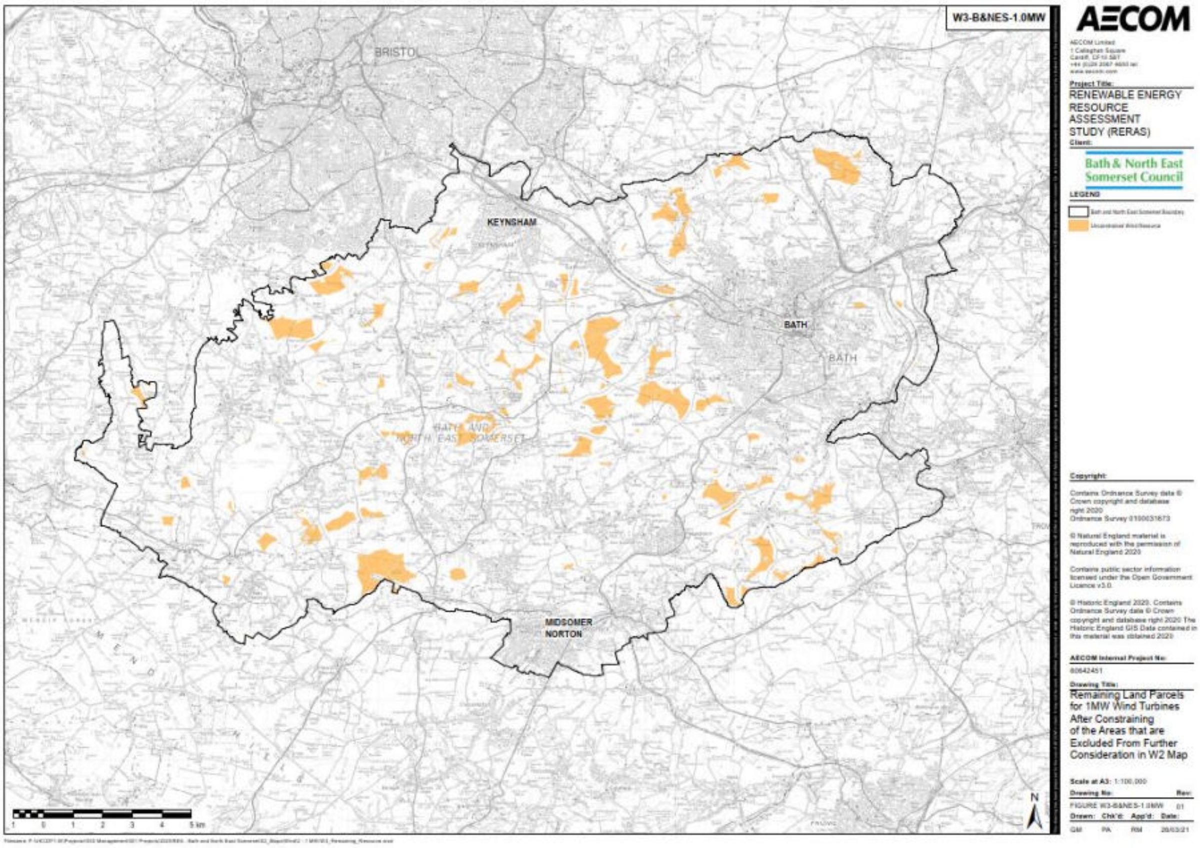


Figure 81: W3-B&NES-1.0MW: Remaining Land Parcels for 1.0MW Wind Turbines After Constraining of the Areas that are Excluded from Further Consideration in W2 Map

Table 49: Remaining Land Available for Wind Turbines at this Stage of the Assessment and Potential Total Installed Capacity Based on the Available Area

Map Reference	Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW) [231]
W3-B&NES-0.5MW	The remaining available area for 500kW wind turbines at this stage of the assessment	37.20	One turbine to be sited in each identified area[232].
W3-B&NES-1.0MW	The remaining available area for 1.0MW wind turbines at this stage of the assessment	18.11	144.88
W3-B&NES-2.5MW	The remaining available area for 2.5MW wind turbines at this stage of the assessment	8.05	72.45

[231] It should be noted the areas for different wind turbines areas overlap and therefore the maximum potentials in this table cannot be added together.
[232] It has been agreed for this assessment that one 500kW turbine would be sited on each parcel of land identified as suitable for 500kW turbines.

Step 4: Wind Resource Based on Wind Speed in B&NES

Map References & Titles:

1. W4-B&NES-0.5MW: Suitable Areas of Land for Installation of 500kW Wind Turbines Constrained by Wind Speed Only
2. W4-B&NES-1.0MW: Suitable Areas of Land for Installation of 1.0MW Wind Turbines Constrained by Wind Speed Only
3. W4-B&NES-2.5MW: Suitable Areas of Land for Installation of 2.5MW Wind Turbines Constrained by Wind Speed Only

The areas shown on the W4 maps are only constrained by the B&NES boundary and ability to utilise the available resource based on wind speed at a particular height above ground level (agl).

The maps show wind speeds sufficient for the development of wind farms. The performance of wind turbines is a function of wind speed. Utilising Ordnance Survey maps and Meteorological Office data, AECOM has created a 1.5km^2 grid GIS data layer for the area showing average annual wind speed at 45m agl attributed to each individual 1.5km^2 cell.

No wind energy potential was assumed for the 500kW, and 1.0MW turbine size in areas with an average annual wind speed of less than 6.0 m/s, meaning the wind speed resource areas for the 500 kW and 1.0 MW turbine sizes are the same. A similar assumption was made for the 2.5 MW turbine size, but with wind speeds of less than 5.0 m/s. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

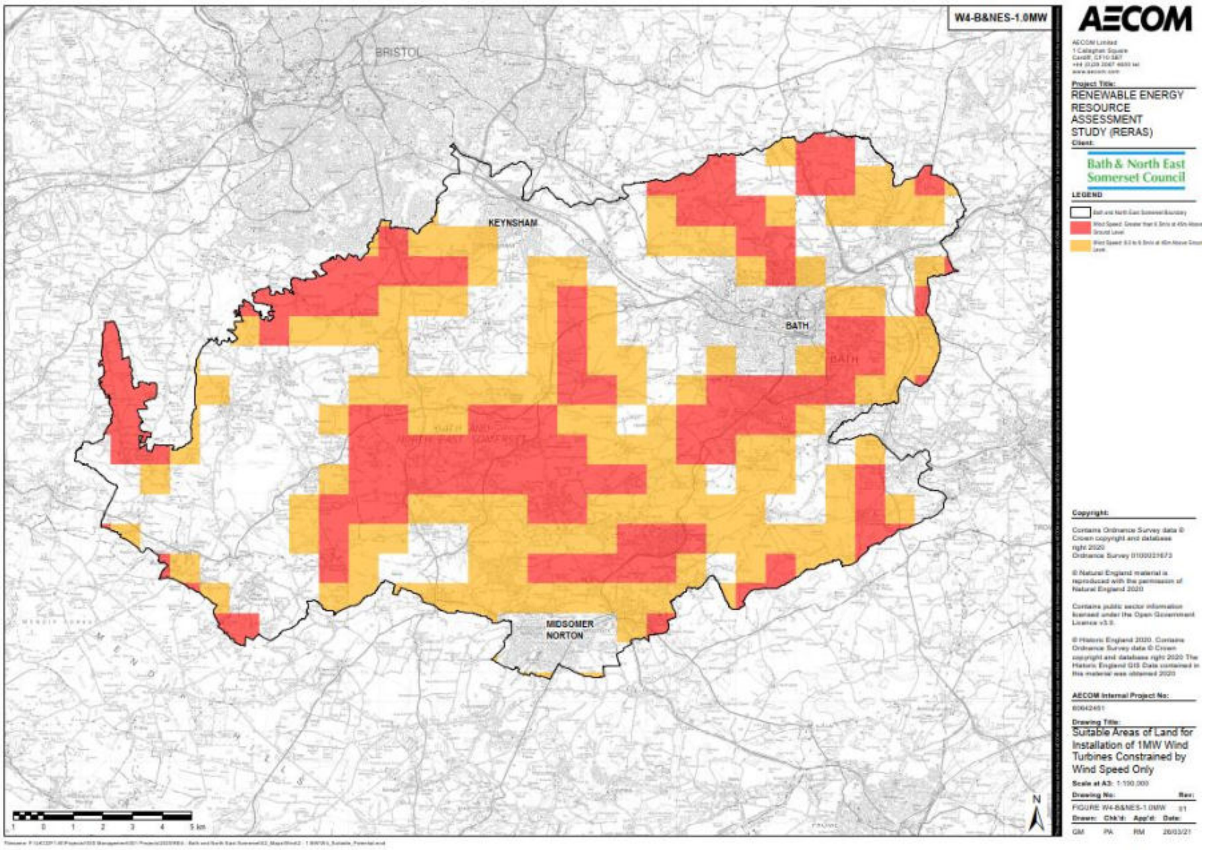


Figure 82: W4-B&NES-1.0MW: Suitable Areas of Land for Installation of 1.0MW Wind Turbines Constrained by Wind Speed Only Map

The wind resource areas for wind turbines can be seen in Table 50.

Table 50: Wind Resource Based on Wind Speed in B&NES Compared to the Total B&NES Area of 351.1 km^2

	2.5MW Turbines	1.0MW and 500kW Turbines
Total Bath and North East Somerset Area (km^2)	351.10	351.10
Suitable Area (km^2)	343.55	218.33
Proportion of Area Suitable (%)	98%	62%

Step 5: Remaining Potential Wind Resource After Combining W3 maps (Resource After Constraining) and W4 (Showing Sufficient Wind Speeds)

Map References & Titles:

1. W5-B&NES-0.5MW: Remaining Land Parcels from Resource Map (W3) After Constraining the Unsuitable Areas due to Wind Speed Map (W4) for Installation of 500kW Wind Turbines
2. W5-B&NES-1.0MW: Remaining Land Parcels from Resource Map (W3) After Constraining the Unsuitable Areas due to Wind Speed Map (W4) for Installation of 1MW Wind Turbines
3. W5-B&NES-2.5MW: Remaining Land Parcels from Resource Map (W3) After Constraining the Unsuitable Areas due to Wind Speed Map (W4) for Installation of 2.5MW Wind Turbines

Unsuitable areas due to insufficient wind speed were removed from W3 maps and presented in Figure 83. Table 51 below shows the remaining potential wind resource[233] at this stage and its potential total installed capacity. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[233] Labelled as "Unconstrained Wind Resource" on W5 maps.

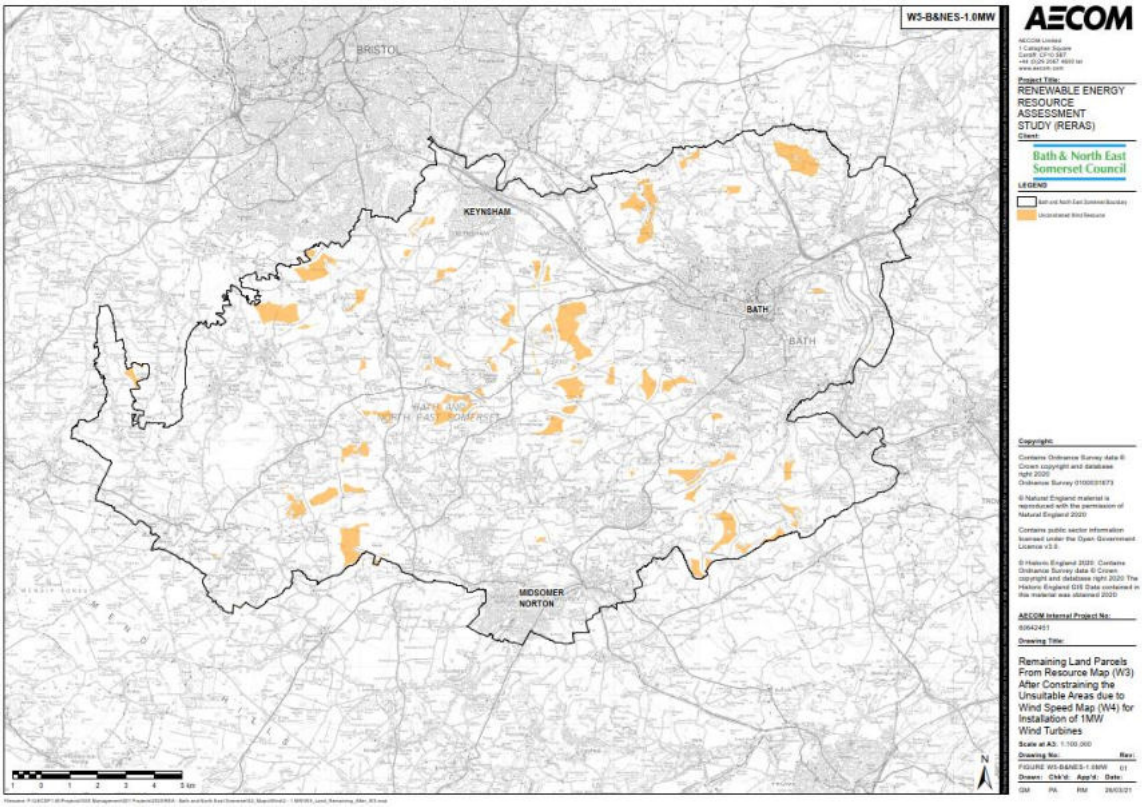


Figure 83: W5-B&NES-1.0MW: Remaining Land Parcels from Resource Map (W3) After Constraining the Unsuitable Areas due to Wind Speed Map (W4) for Installation of 1MW Wind Turbines Map

It should be noted the areas for the sized different wind turbines overlap and therefore the maximum potentials in this table cannot be added together.

Table 51: Remaining Land Available for Wind Turbines at this Stage of the Assessment and Potential Total Installed Capacity Based on the Available Area

Map Reference	Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)
W5-B&NES-0.5MW	The remaining available area for 500kW wind turbines at this stage of the assessment	27.58	200 Search Areas One turbine to be sited in each identified area. 100MW
W5-B&NES-1.0MW	The remaining available area for 1.0MW wind turbines at this stage of the assessment	13.87	110.96
W5-B&NES-2.5MW	The remaining available area for 2.5MW wind turbines at this stage of the assessment	8.05	72.45

Step 6: Identification of Wind Search Areas and Maximum Available Wind Resource

Map References & Titles:

1. W6-B&NES-500kW: Remaining Land Parcels from W5 Map for 500kW Wind Turbines After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Allocated to 1.0MW and 2.5MW Wind Turbines
2. W6-B&NES-1.0MW: Remaining Land Parcels from W5 Map After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Insufficient to Support a Wind `Farm of 5MW or More Based on 1.0 MW Wind Turbines
3. W6-B&NES-2.5MW: Remaining Land Parcels from W5 Map After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Insufficient to Support a Wind Farm of 5MW or More Based on 2.5MW Wind Turbines

At this stage of the assessment, land slivers, fire breaks and tracks, as well as parcels of land insufficient to support a wind farm of 5MW or more, were removed from the Step 5 maps.

Additionally, suitable areas for 1.0MW and 2.5MW turbines are removed from the 500kW turbine map in this step.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

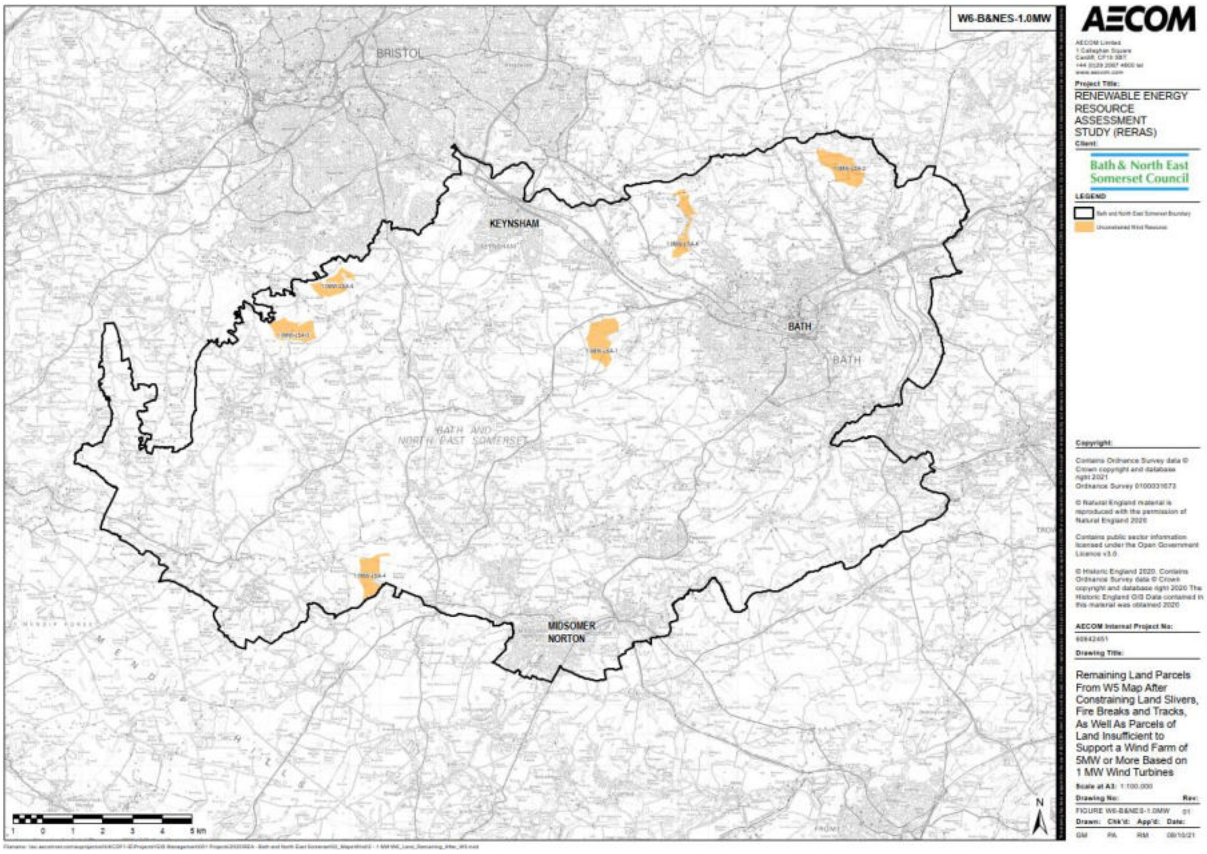


Figure 84: W6-B&NES-1.0MW: Remaining Land Parcels from W5 Map After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Insufficient to Support a Wind Farm of 5MW or More Based on 1.0 MW Wind Turbines Map

Maximum Available Wind Resource

Following constraining Steps 1 to 5, the remaining areas define the initial local Search Areas (SAs) for wind development in B&NES. Where there is a minor road, major road or any of the constraints mentioned above in previous sections that separate the identified locations, SAs have been defined for each site independently.

The total remaining potential wind resource[234] informs the calculation of the total potential capacity and informs renewable energy generation aims of B&NES. The 1.0MW and 2.5MW capacity figures are not cumulative; it was assumed that either all the turbines in these areas would be 1MW turbines or all would be 2.5MW turbines. In reality, a mixture of scales could be deployed. Assuming that a wind turbine will generate energy at peak for 25% of the time (2,190 hours) over the course of a year, the total potential energy (GWh) was calculated[235]. Therefore, additional future potential is outlined in Table 52.

Table 52: Identified Wind SAs in B&NES and Theoretical Maximum Potential Wind Resource

Map Reference	Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)[236]	Potential Total Electricity Generation (GWh)	Estimated Number of Turbines	Indicative Carbon Savings (2020 Grid Carbon Factor) tCO_{2e}
W6-B&NES-0.5MW	SAs for 500kW wind turbines in B&NES	6.84	136.00[237]	296.02	573	74,949
W6-B&NES-1.0MW	SAs for 1.0MW wind turbines in B&NES	5.11	40.88	88.98	41	22,529
W6-B&NES-2.5MW	SAs for 2.5MW wind turbines in B&NES	2.38	21.42	46.62	10	11,804

The remaining land available and potential installed capacity for each of the 1.0MW and 2.5MW Search Areas are shown in Table 53 and Table 54 respectively.

Table 53: Individual Identified 1.0MW Wind SAs in B&NES and Their Theoretical Maximum Potential Installed Capacity

SA Reference on Maps	SA Area (km^2)	Potential Total Installed Capacity (MW)[238]
1.0MW-1	1.085	8.68
1.0MW-2	1.074	8.59
1.0MW-3	0.851	6.81
1.0MW-4	0.779	6.23
1.0MW-5	0.673	5.39
1.0MW-6	0.643	5.15

Table 54: Individual Identified 2.5MW Wind SAs in B&NES and Their Theoretical Maximum Potential Installed Capacity

SA Reference on Maps	SA Area (km^2)	Potential Total Installed Capacity (MW)[239]
2.5MW-1	0.864	7.78
2.5MW-2	0.805	7.25
2.5MW-3	0.709	6.38

[234] Labelled as “Unconstrained Wind Resource” on W6 maps
[235] Average of the five previous years’ regional standard load factors published by BEIS
[236] It should be noted the areas for different wind turbines areas overlap and therefore the maximum potentials in this table cannot be added together.
[237] 272 additional small land parcels for 500kW turbines installations have been identified. It is assumed that one 500 kW turbine could be sited on each.
[238] Potential total installed capacities are calculated using density factors provided in Table 11.
[239] Potential total installed capacities are calculated using density factors provided in Table 11.

Step 7: Combined Wind Search Areas in Bath and North East Somerset

Map Reference & Title:

1. W7-B&NES: Combined Wind Search Areas in B&NES

Areas of constraint have been applied through mapping to identify the potentially suitable locations[240] for the development of wind farms, and these are labelled as wind farm Search Areas.

Policy Recommendation

Policy Reference: WF-PR-1 (Refer to Table 41 in Section 17)

It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints.

Policy Recommendation

Policy Reference: WF-PR-2 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines of the appropriate number and size (to make the most efficient use of the resource/ land) benefit from a presumption in favour of wind development when located within the areas identified for that use through the Local Plan.

W7-B&NES map illustrates the identified wind Search Areas (SAs) for each of the three wind turbine sizes, the 500kW SAs are coloured orange, the 1.0MW SAs blue striped and the 2.5MW SAs in pink. There were 272, 6 and 3 SAs identified for 500kW, 1.0MW and 2.5MW turbines, respectively. The SAs are referenced based on their corresponding wind turbine size and prioritised based on size (largest), e.g. 1.0MW-LSA-1 is the largest SA suitable for 1.0MW wind turbines installations. It was assumed that one 500kW turbine would be situated on each SA identified as suitable for a 500kW turbine.

This RERAS is primarily concerned with identifying wind development opportunities larger than 5MW, utilising 1.0MW and 2.5MW wind turbines as the basis for constraints mapping. The small scale SAs suitable for 500kW or smaller turbines are identified in the interest of completeness, and their potential is considered in the aims section of this study (Section 15)

Policy Recommendation

Policy Reference: WF-PR-3 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines >2.5MW within the areas identified through the Local Plan will benefit from a presumption in favour of wind development, subject to compliance with the primary constraints listed in Section 4.2.1 (e.g. noise, topple distances) and consideration of other site specific issues and constraints.

Policy Recommendation

Policy Reference: WF-PR-4 (Refer to Table 41 in Section 17)

It is recommended that proposals for wind turbines outside of areas identified as suitable for wind development through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.

[240]Labelled as "Unconstrained Wind Resource" on W7 map.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

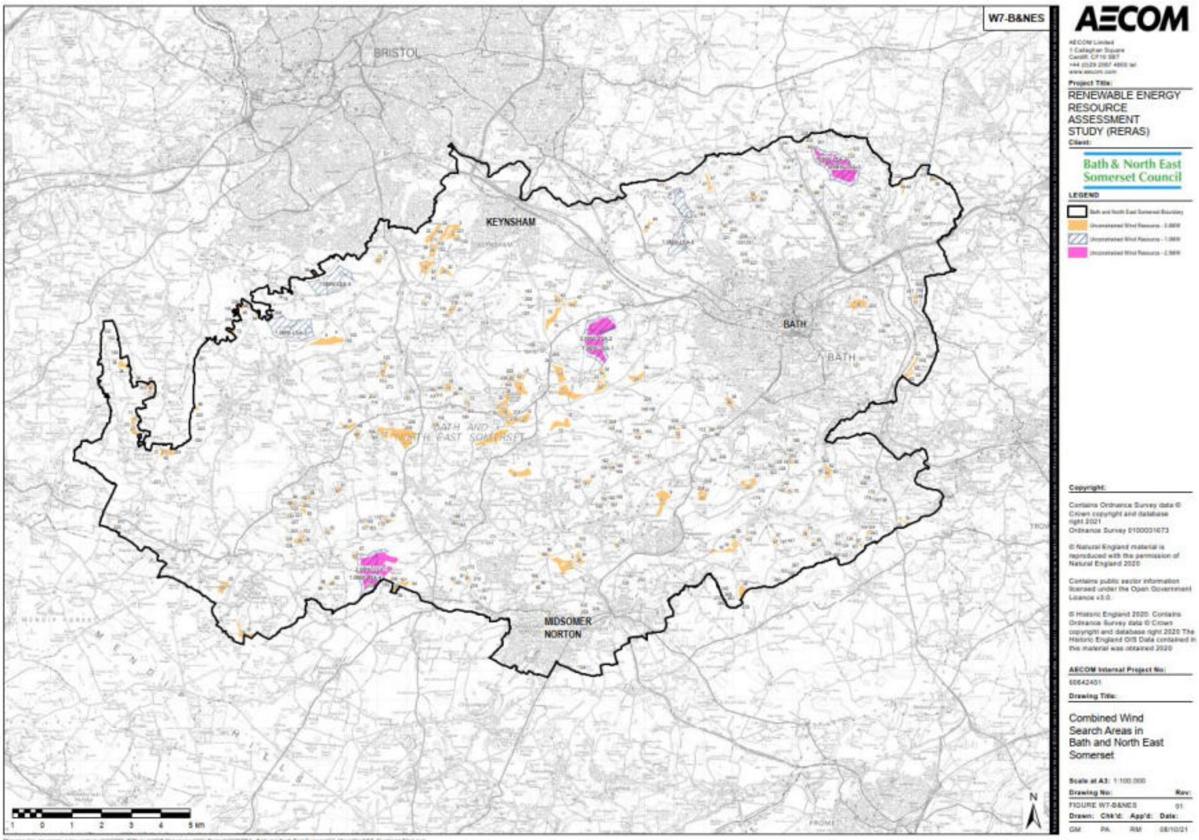


Figure 85: W7-B&NES: Combined Wind Search Areas in Bath and North East Somerset Map

A total of 6.84 km², 5.11 km² and 2.38 km² of land was identified as being potentially suitable for the installation of a 500kW, 1.0MW and 2.5MW wind turbines respectively. These areas comprise large parts of rural Bath and North East Somerset, as can be seen in Figure 85. It should be noted that these search areas will need to be refined further through the Local Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

Policy Recommendation

Policy Reference: WF-PR-5 (Refer to Table 41 in Section 17)

It is recommended that the SAs identified through the RERAS for 1MW and 2.5MW turbines are further refined and safeguarded through the Local Plan process.

Policy Recommendation

Policy Reference: WF-PR-7 (Refer to Table 41 in Section 17)

It is recommended that proposals for re-powering of wind farms at end-of-life to an equal or increased capacity, subject to compliance with noise, topple-distance, site specific constraints, and other policy considerations should be looked upon favourably.

Step 8: Wind Resource Other Constraints to Consider Further

Map Reference & Title:

1. W8-B&NES-0.5MW: Wind Resource Other Constraints – to Consider Further
2. W8- B&NES -1.0MW: Wind Resource Other Constraints – to Consider Further
3. W8- B&NES -2.5MW: Wind Resource Other Constraints – to Consider Further

Effects of other constraints that may impact wind development within the SAs were analysed in this section of the study. However, it was agreed these constraints would need to be examined as part of the Local Plan process and therefore, the identified SAs in mapping Step 6 have not been constrained further in this assessment.

W8 maps illustrate the following additional constraints.

- Other woodlands (Other than Broadleaved Woodland and Ancient Woodland)
- Area of Outstanding Natural Beauty (AONB)
- Natural England's Impact Risk Zones for Wind Development (IRZs)
- Unlicensed Aerodromes
- Minerals Safeguarding Areas
- World Heritage site and Setting
- National Air Traffic Control Services (NATS) Radar Safeguarding Areas
- Aviation Safeguarded Zone
- Flood Zones
- National Trust Inalienable Land

  Green Belt[241]
- MoD Safeguarding Zones
- Conservation Areas (Heritage)

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[241] As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources.'*

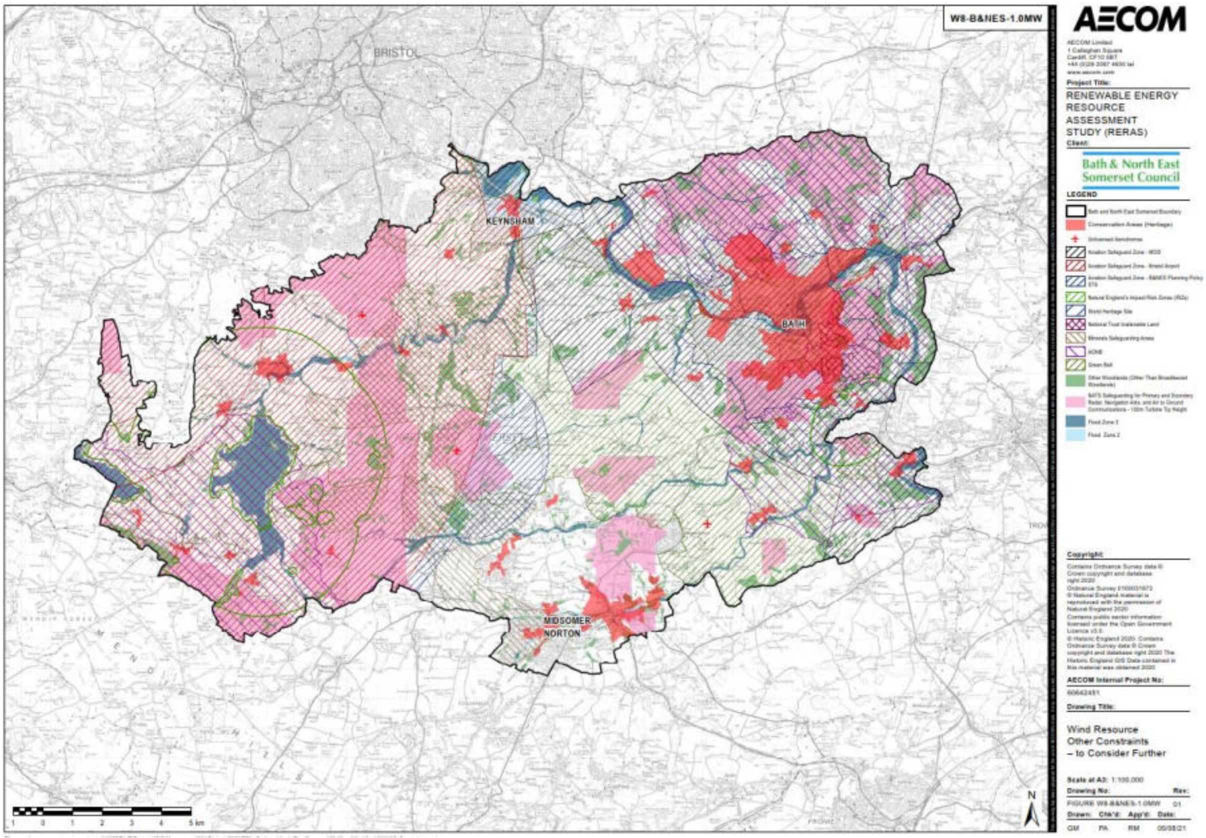


Figure 86: W8-B&NES-1.0MW: Wind Resource Other Constraints – to Consider Further Map

Step 9: Remaining Area of Local Search Areas after Applying Selected Additional Constraints

Map References & Titles:

1. W9-B&NES: Wind Local Search Areas from W7 Map and Natural England's Wind Impact Risk Zones (IRZs) in Bath and North East Somerset
2. W10-B&NES: Wind Local Search Areas from W7 Map and Areas of Outstanding Natural Beauty (AONB) in Bath and North East Somerset
3. W11-B&NES: Wind Local Search Areas from W7 Map and Flood Zones in Bath and North East Somerset
4. W12-B&NES: Wind Local Search Areas from W7 Map and Green Belt Area in Bath and North East Somerset

The additional maps in this section of the study overlay the following constraints on the identified wind Search Areas in Step 6 for illustrative purposes only. Figure 46 provides further information regarding each map's remaining area and potential capacity if the overlapping areas covering these constraints and SAs were removed.

- Natural England's Impact Risk Zones for Wind Development (IRZs)
- Area of Outstanding Natural Beauty (AONB)
- Flood Zones
- Green Belt

Higher resolution versions of these maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

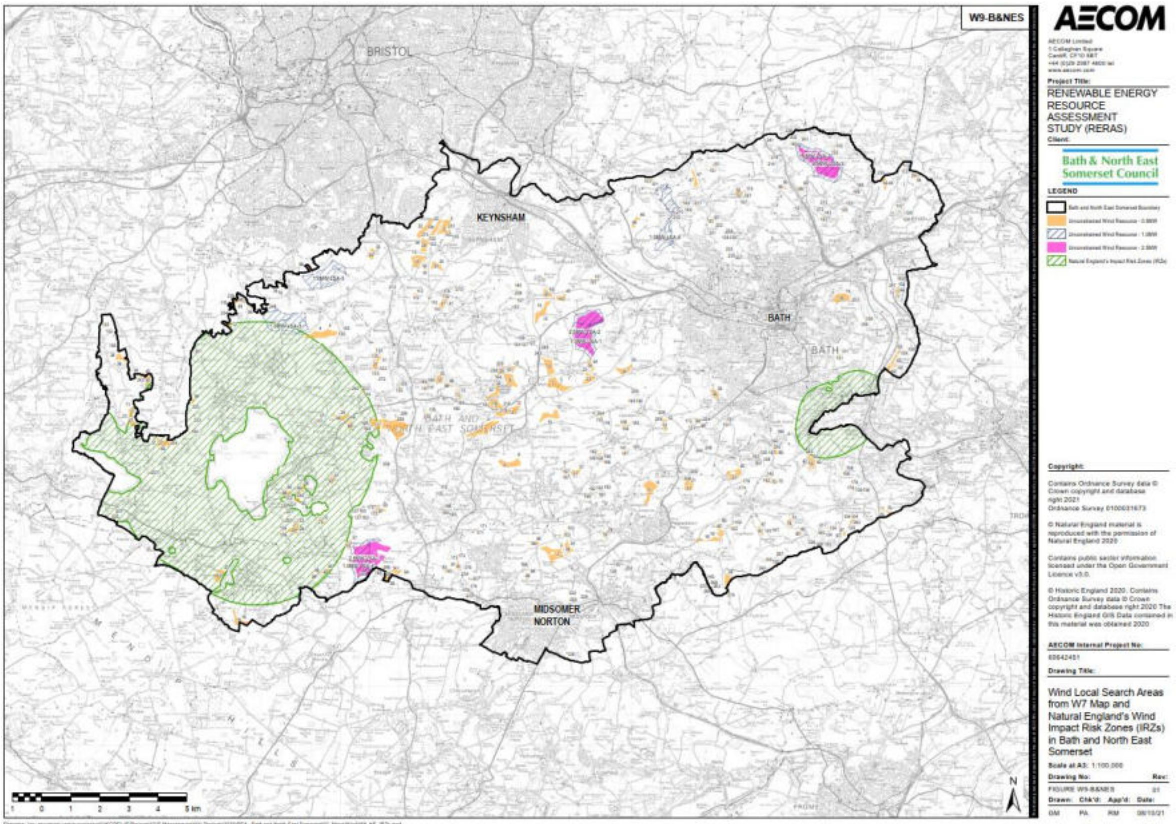


Figure 87: W9-B&NES: Wind Local Search Areas from W7 Map and Natural England's Wind Impact Risk Zones (IRZs) in Bath and North East Somerset Map

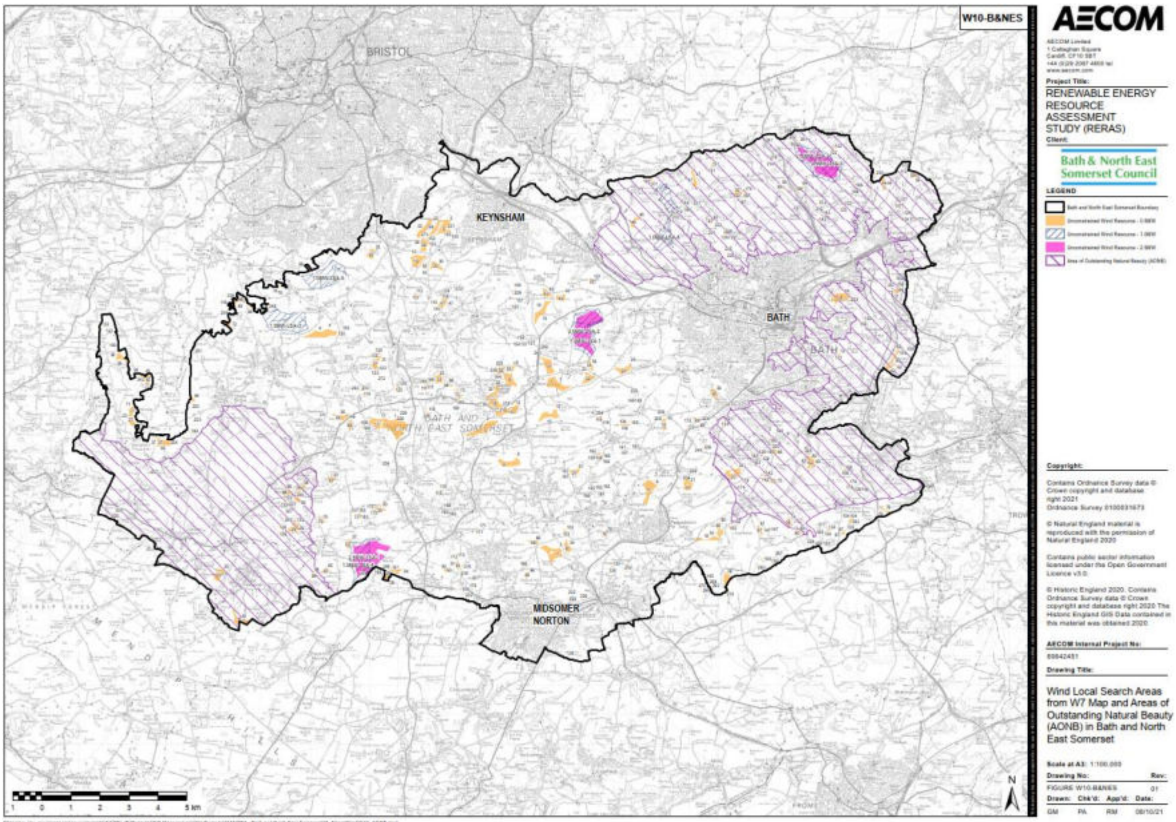


Figure 88: W10-B&NES: Wind Local Search Areas from W7 Map and Areas of Outstanding Natural Beauty (AONB) in Bath and North East Somerset Map

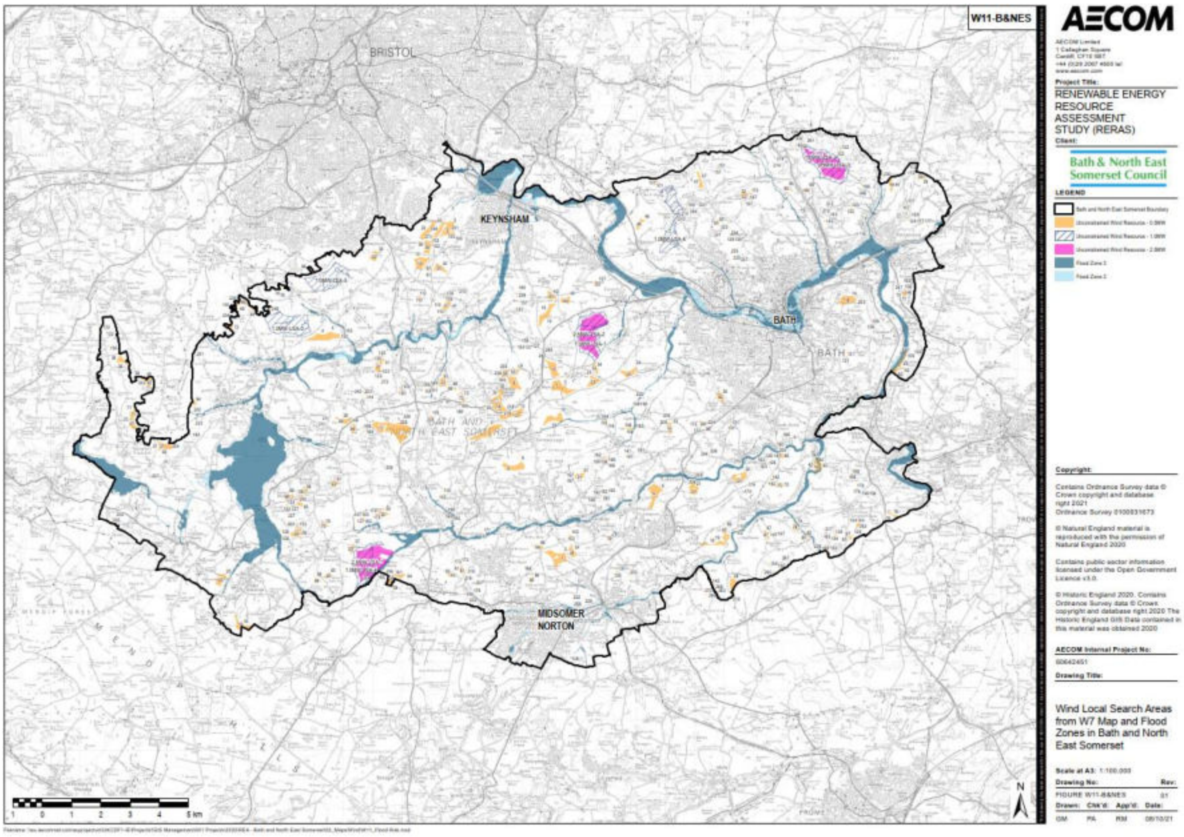


Figure 89: W11-B&NES: Wind Local Search Areas from W7 Map and Flood Zones in Bath and North East Somerset Map

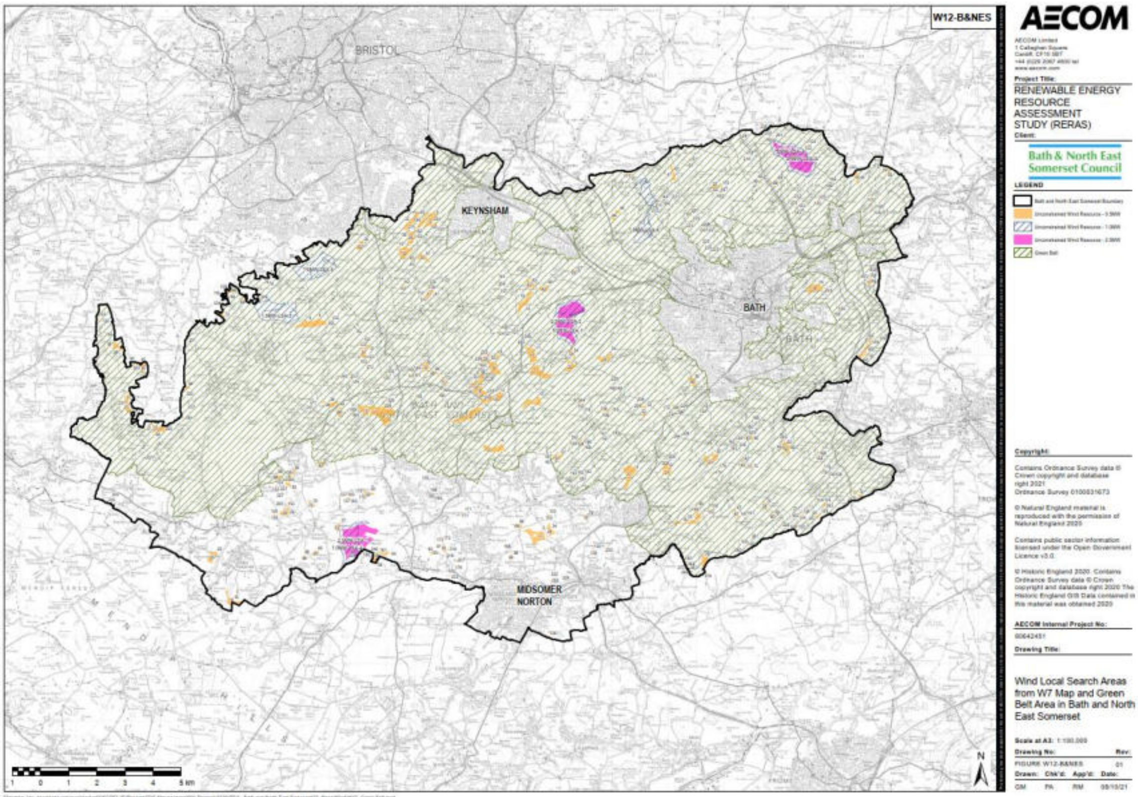


Figure 90: W12-B&NES: Wind Local Search Areas from W7 Map and Green Belt Area in Bath and North East Somerset Map

Table 55: Remaining Area of SAs After Applying Selected Additional Constraints for Illustrative Purposes Only

Map Reference	Notes	Additional Constraint Shown on the Map	Area of the Final Wind SAs Identified in Step 6 (km^2)	Potential Installed Capacity of the Final Wind SAs (MW)	Remaining SAs if Area of the Additional Constraint Is Removed (km^2)	Remaining Potential Installed Capacity of the SAs if Area of the Additional Constraint Is Removed (MW)
W9-B&NES	500kW Turbines SAs	Natural England's IRZs for Wind	6.84	136.00[242]	6.11	122.5
W9-B&NES	1.0MW Turbines SAs	Natural England's IRZs for Wind	5.11	40.88	4.90	39.22
W9-B&NES	2.5MW Turbines SAs	Natural England's IRZs for Wind	2.38	21.42	2.38	21.42
W10-B&NES	500kW Turbines SAs	AONB	6.84	136.00	5.53	94.5
W10-B&NES	1.0MW Turbines SAs	AONB	5.11	40.88	3.39	27.12
W10-B&NES	2.5MW Turbines SAs	AONB	2.38	21.42	1.67	15.03
W11-B&NES	500kW Turbines SAs	Flood Zones	6.84	136.00	6.73	131.5
W11-B&NES	1.0MW Turbines SAs	Flood Zones	5.11	40.88	5.08	40.64
W11-B&NES	2.5MW Turbines SAs	Flood Zones	2.38	21.42	2.33	20.97
W12-B&NES	500kW Turbines SAs	Green Belt	6.84	136.00	1.04	29.5
W12-B&NES	1.0MW Turbines SAs	Green Belt	5.11	40.88	0.78	6.24
W12-B&NES	2.5MW Turbines SAs	Green Belt	2.38	21.42	0.86	7.74

[242] It is assumed that one 500 kW turbine could be sited on each.

Wind Search Areas and MOD and Aviation Safeguarded Areas.

Map References & Titles:

1. W13-B&NES-0.5MW: Wind Local Search Areas for 500kW Turbines from W6 Map and MOD, NATS and Aviation Safeguarded Zones
2. W13-B&NES-1.0MW: Wind Local Search Areas for 1.0MW Turbines from W6 Map and MOD, NATS and Aviation Safeguarded Zones
3. W13-B&NES-2.5MW: Wind Local Search Areas for 2.5MW Turbines from W6 Map and MOD, NATS and Aviation Safeguarded Zones

Considering the risks of interference with radar and the impact of proposed wind turbine developments on aviation operations must be considered on a case-by-case basis. Therefore, was agreed not to add these constraints for unlicensed aerodromes in this study. However, the W13 maps are prepared to spatially indicate radar, MoD and aviation safeguarding areas and to assist developers and the Council with any dialogue/that consultation that may be required with these organisations in relation to wind turbine installations. It should be noted these maps are for information only, and these restrictions must be considered in more detail in the planning process. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

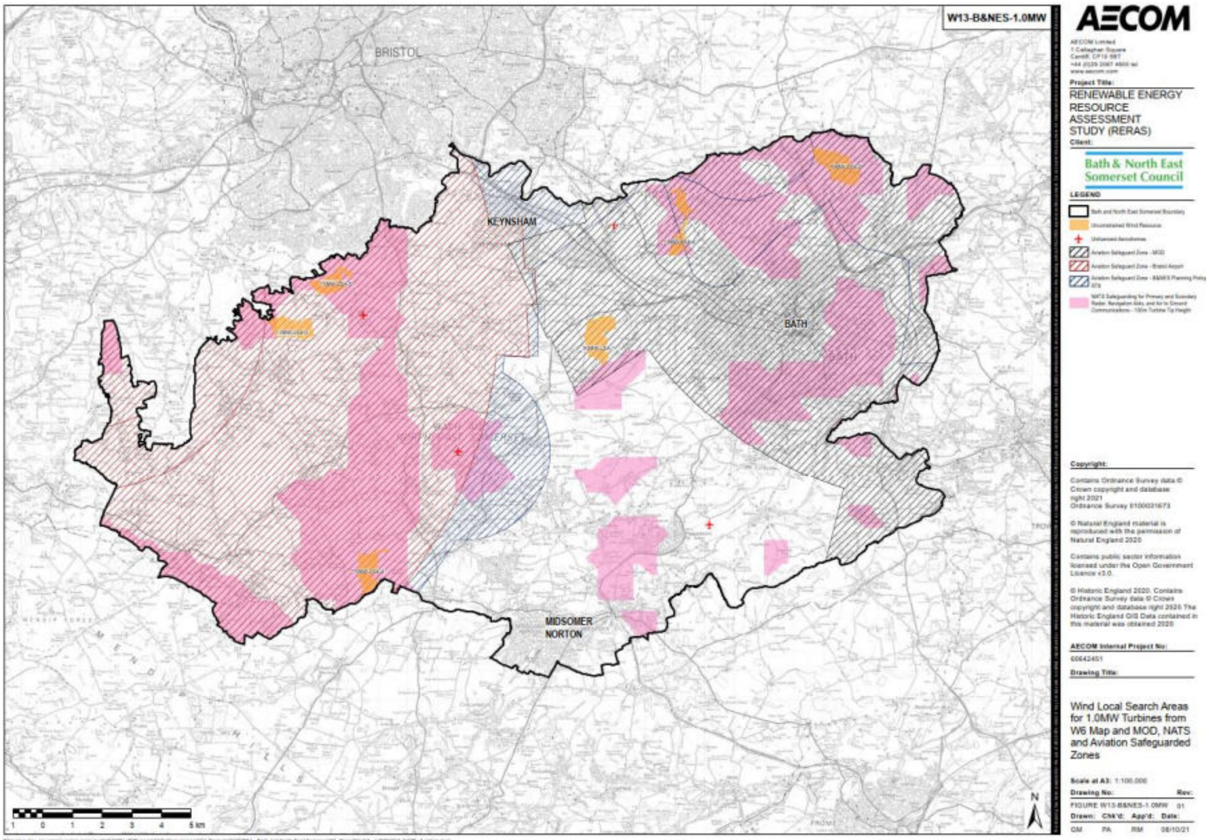


Figure 91: W13-B&NES-1.0MW: Wind Local Search Areas for 1.0MW Turbines from S6 Map and MOD, NATS and Aviation Safeguarded Zones

Wind SAs and Conservation Areas (Heritage)

Map Reference & Title

1. W14-B&NES: Combined Wind Search Areas and Conservation Areas (Heritage) in Bath and North East Somerset

In England, the planning authorities are obliged to designate as conservation areas any parts of their own area that are of special architectural or historic interest, the character and appearance of which it is desirable to preserve or enhance. Under the National Planning Policy Framework (NPPF) conservation areas are designated heritage assets and their conservation is to be given weight in planning permission decisions[243]. Therefore, the W14 map is prepared that shows the location of the Conservation Areas in relation to the SAs to assist the Council and developers when considering renewable energy proposals. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

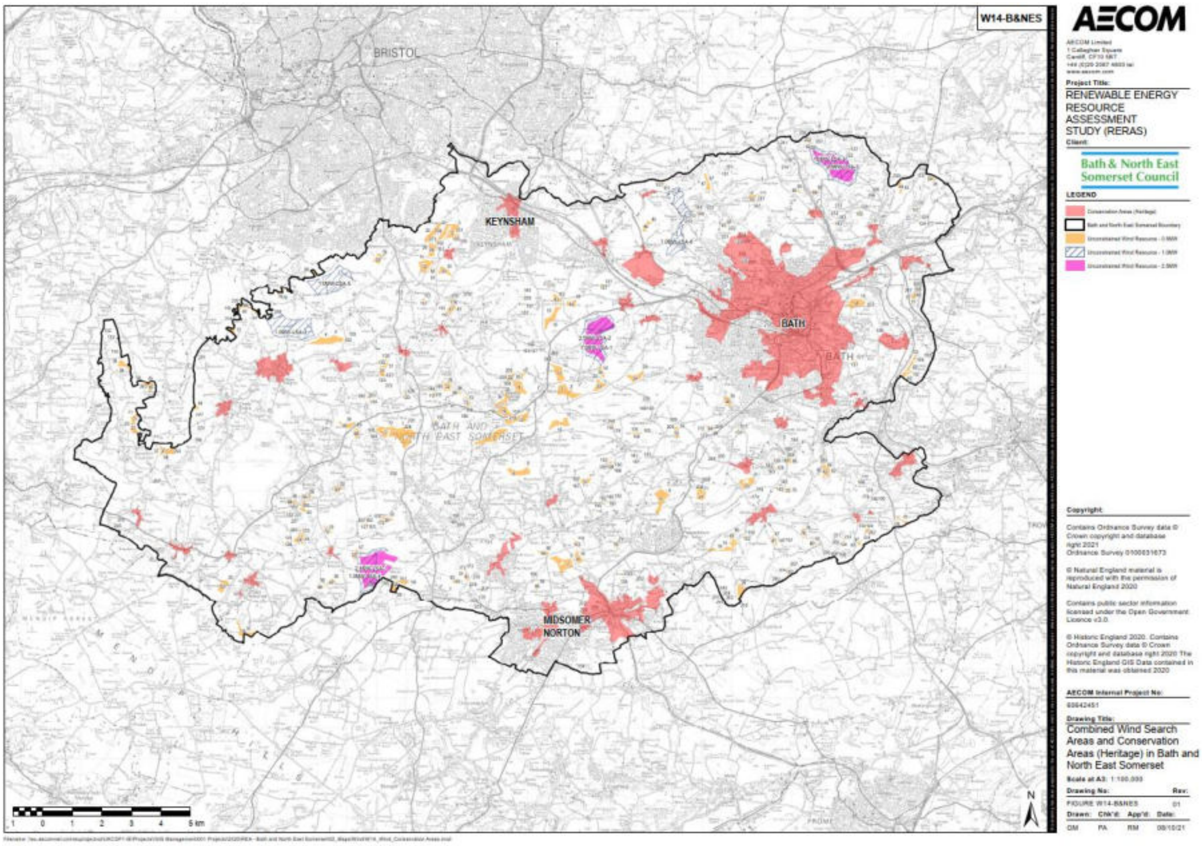


Figure 92: W14-B&NES: Combined Wind Search Areas and Conservation Areas (Heritage) in Bath and North East Somerset Map

[243] https://historicengland.org.uk/advice/hpg/has/conservation-areas/

Buffer Zones for Search Areas

Map Reference & Title:

Map References & Titles:

1. W15-B&NES-0.5MW: Buffer Zones for Wind Local Search Areas from 500kW Turbines
2. W15-B&NES-1.0MW: Buffer Zones for Wind Local Search Areas from 1.0MW Turbines
3. W15-B&NES-2.5MW: Buffer Zones for Wind Local Search Areas from 2.5MW Turbines

The final SAs were mapped separately for each of the turbine sizes. A buffer corresponding to each turbine size (see Table 48) is applied to the defined SAs to ensure safety requirements are incorporated in future developments.

Policy Recommendation

Policy Reference: WF-PR-6 (Refer to Table 41 in Section 17)

It is recommended that policy measures (e.g. safeguarding) are put in place to ensure that the areas identified for wind development through the Local Plan are not sterilised by non-wind development.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

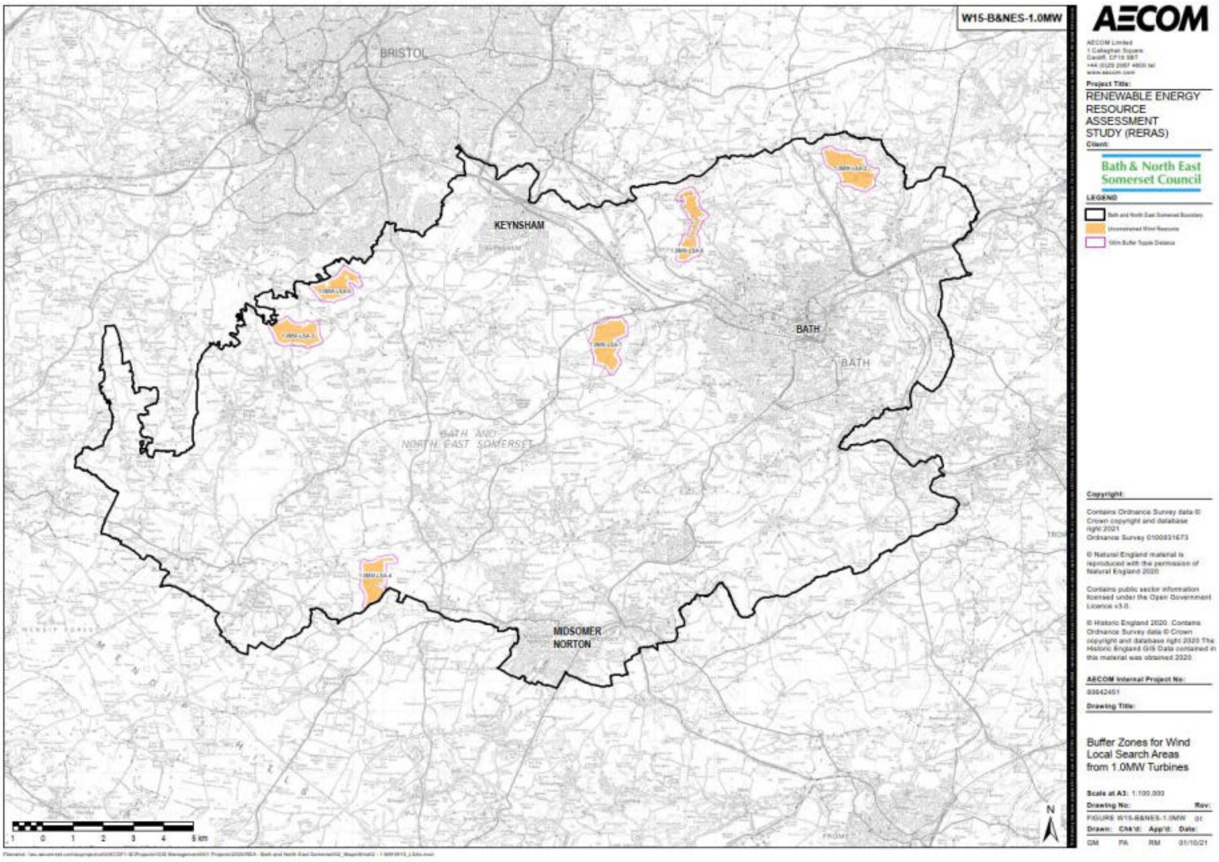


Figure 93: W15-B&NES-1.0MW: Buffer Zone for Wind Local Search Areas from 1.0MW Turbines Map

G.3 Pipeline Projects and Repowering Consideration

In this section of the report, data from Regen's Distribution Future Energy Scenarios (DFES) analysis was utilised to identify the pipeline wind projects and assess the repowering potential of existing wind energy installations to increase their capacity. Project readiness of the identified local SAs in relation to the current grid capacity and costs of grid upgrades are considered in G.4.

The methodology used for pipeline analysis and repowering assumptions in Regen's DFES analysis is provided below.

The starting point for the pipeline analysis for wind farms is the Distribution Network Operator's (DNO's) list of projects with an accepted grid connection offer but have not yet progressed further than that. In WPD's licence areas, the majority of such sites have accepted a connection offer in the last few years.

The stage of development for these pipeline sites is then assessed through stakeholder and industry engagement and discussion with the developers directly, where possible. The planning stage is another key factor that influences the rate at which sites connect to the electricity network; this factor tends to be of greater importance for wind farms than solar projects. Regen assumes that sites without evidence of recent activity or planning permission do not connect in the near term. It should be noted that any site with current planning permission is shown and removed as an available resource on W2 maps as consented (but not yet constructed) developments.

Additionally, an assumption was made that all wind farms at the end of their operational life are replaced with new turbines of either the same capacity or larger. Regen research shows that there is evidence from 'repowering events' to date of a large increase in capacity, sometimes doubling the initial capacity of the wind farm. The repowering assumptions in the Western Power Distribution (WPD) Distribution Future Energy Scenarios (DFES) 2020 were varied by scenario, but also by the age and size of a wind farm:

- Older sites with smaller capacity turbines were assumed to take advantage of improvements in technology to increase their capacity.
- Very small sites and domestic scale turbines were assumed to be replaced at the same capacity level.

WPD DFES 2020 includes four different scenarios which are summarized below[244].

1. Steady Progression

- Low levels of decarbonisation and societal change.
- Not compliant with the 2050 net zero emissions target.

2. System Transformation

- High level of decarbonisation with lower societal change. Larger, more centralised solutions are developed. This scenario has the highest levels of hydrogen deployment.

3. Consumer Transformation

- High levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and more decentralised solutions are developed. This scenario has significant electrification of domestic heat.

4. Leading the Way

- Very high levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and a mix of solutions are developed. This scenario aims for the "fastest credible" decarbonisation pathway

No pipeline projects or repowering in relation to wind development have been identified in B&NES. It should be noted that any site with current planning permission would be shown and constrained on W2 maps as consented (but not yet constructed) developments, however, there are currently no sites with planning permission within B&NES.

244 https://www.westernpower.co.uk/downloads-view-reciteme/228118

G.4 Proximity to Grid and Grid Capacity

Map Reference & Title:

1. W16-B&NES-1.0MW - 1.0MW Wind Search Areas and Grid Connection
2. W16-B&NES-2.5MW – 2.5MW Wind Search Areas and Grid Connection

Whilst private wire schemes are an option, and some already exist in the UK, onshore wind farms usually have a connection to the grid to export electricity, albeit with increasing curtailments.

Consideration of a viable connection point is an important factor when considering sites for new wind energy development. The cost of a grid connection depends on the distance to the nearest connection point the works needed to make that connection (there can be a number of complexities such as land ownership issues, whether the dig is hard or soft, etc) and the availability of capacity in the distribution network to take the additional power output. For this study, grid connection is assumed to be a discussion matter for national-level decision-makers and has not been used to constrain wind energy generation potential. In addition, as renewable deployment is a national priority, it is assumed that the grid requirement will be met to allow for sufficient additional capacity.

However, a high-level analysis exercise has been undertaken in consultation with the Distribution Network Operator, Western Power Distribution (WPD), to rank the 1.0MW and 2.5MW SAs and assess their project readiness based on the network capacity maps and connection points at the time of writing. The Search Areas are ranked from low priority (coloured red in the maps) to high priority (coloured blue in the maps), with high priority being most favourable for a new grid connection, as shown in the Figure 94 and Figure 95.

Figure 94: SAs Proximity to Grid and Grid Capacity Ranking Key (Refer to W16 Maps in Accompanying Document 'Bath and North East Somerset RERAS - Maps')

This ranking has only been taken as a single snapshot based on the latest information. It does not account for any future reinforcement that may be triggered by other new connections or condition-based replacement. Increases or decreases in future demand may also affect capacity and have not been considered within this study. Sites over 1MW may be required to go through the Statement of Works process to confirm acceptance of the connection on the transmission network.

Network access may be accelerated or achieved with reduced costs by progressing an alternative connection, which allows export to be limited at times of high export from other users.

A higher resolution version of this map is contained in the accompanying document ‘Bath and North East Somerset RERAS – Maps’.

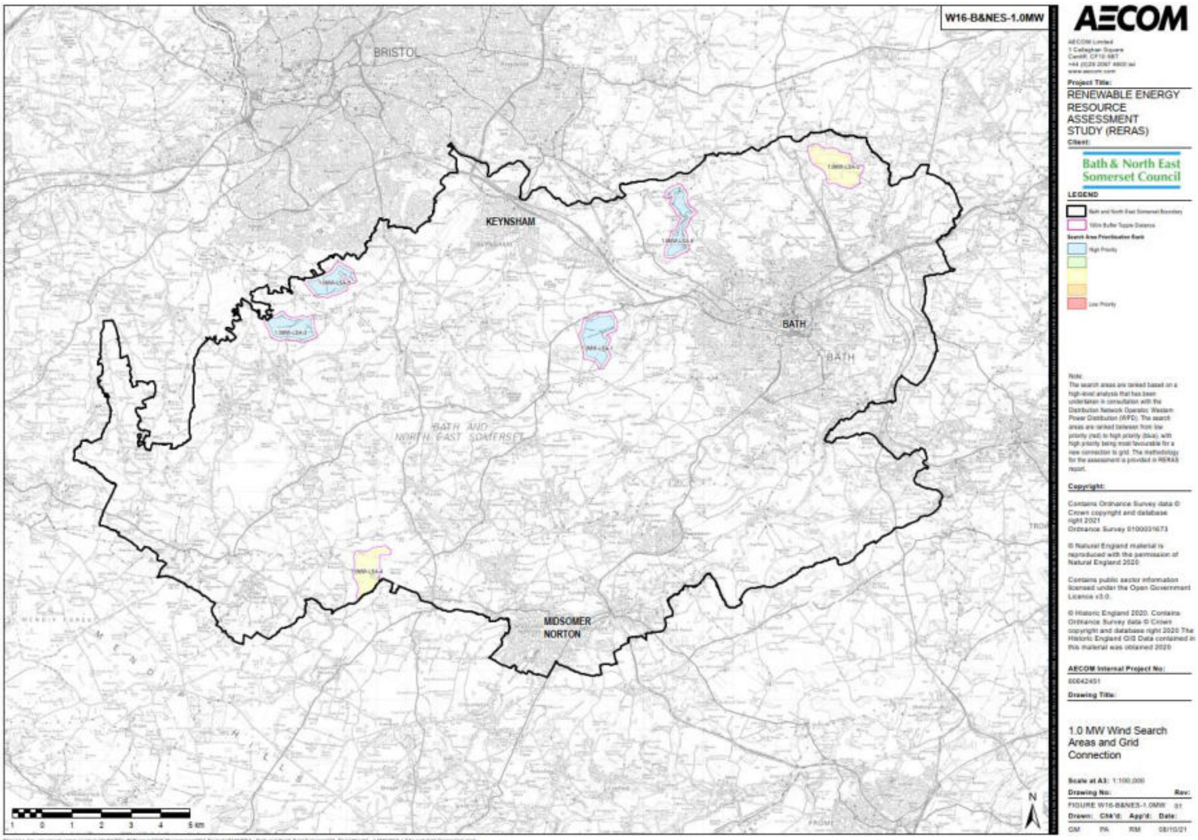


Figure 95: W16-B&NES-1.0MW: 1.0MW Wind Search Areas and Grid Connection Map

G.5 Landscape Sensitively Assessment

Map References & Titles:

1. W17-B&NES-500kW: Wind Local Search Areas for 500 kW Wind Turbines from W6 map and Landscape Sensitivity Results in Band C (61m to 100m) in Bath and North East Somerset Map
2. W17-B&NES-1MW: Wind Local Search Areas for 1 MW Wind Turbines from W6 map and Landscape Sensitivity Results in Band D (101m to 120m) in Bath and North East Somerset Map
3. W17-B&NES-2.5MW: Wind Local Search Areas for 2.5 MW Wind Turbines from W6 map and Landscape Sensitivity Results in Band E (121m to 150m) in Bath and North East Somerset Map

An additional parameter that can be considered in prioritising the Search Areas is Landscape Character Areas and the sensitivity of these landscapes to new wind farm developments. A flowchart presenting the steps taken in completing mapping the results of a landscape sensitivity for wind farms is shown in Figure 96.

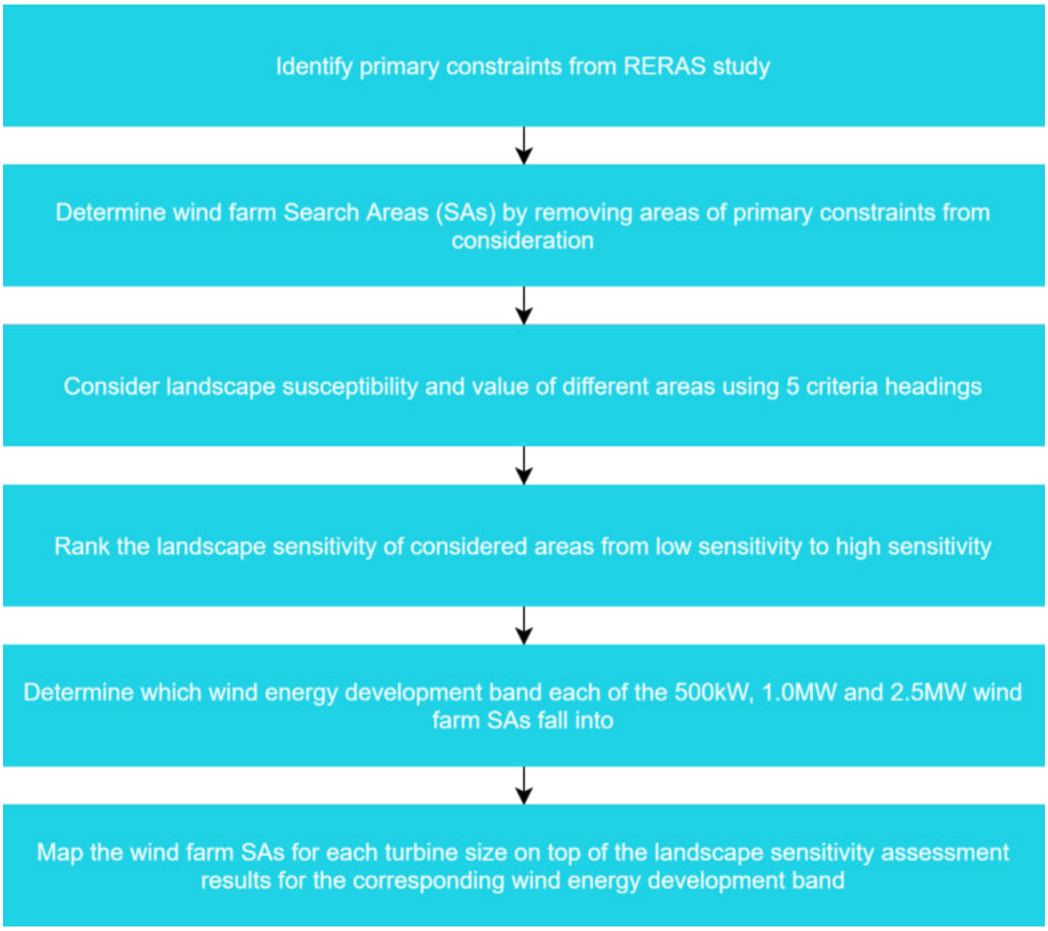


Figure 96 Steps Taken in Landscape Sensitivity Study for Wind Farm Search Areas

Land Use Consultants (LUC) has conducted a landscape sensitivity assessment for wind energy development as part of this RERAS. Results of the assessment provide an initial indication of the relative landscape sensitivity of different areas within B&NES to accommodate wind farm energy developments. The findings of the study, combined with the identified Search Areas (SAs), are presented in this section of the report. The landscape sensitivity assessment considers the landscape susceptibility[245] and landscape value[246] using 5 criteria headings:

- Landform and scale (including sense of openness / enclosure);
- Landcover (including field and settlement patterns);
- Historic landscape character;
- Visual character (including skylines); and
- Perceptual and scenic qualities.

Once the above criteria were assessed individually, the results were combined to produce an overall sensitivity level, as shown in Table 56.

[245] How vulnerable the landscape is to change from the type being assessed, in this case solar PV and wind energy developments
[246] Consensus about importance, which can be recognised through designation as well as through descriptions within the 2014 Landscape Character Assessment

Table 56: The Five-Point Scale Landscape Sensitivity Scale

Sensitivity Level	Definition
High (H)	Key characteristics and qualities of the landscape are highly vulnerable to change from wind and solar energy development. Such development is likely to result in a significant change in character.
Moderate - High (M-H)	Key characteristics and qualities of the landscape are vulnerable to change from wind and solar energy development. There may be some limited opportunity to accommodate wind turbines/ solar panels without significantly changing landscape character. Great care would be needed in siting and design.
Moderate (M)	Some of the key characteristics and qualities of the landscape are vulnerable to change. Although the landscape may have some ability to absorb wind and solar energy development, it is likely to cause a degree of change in character. Care would be needed in siting and design.
Low - Moderate (L-M)	Fewer of the key characteristics and qualities of the landscape are vulnerable to change. The landscape is likely to be able to accommodate wind and solar energy development with limited change in character. Care is still needed when siting and designing to avoid adversely affecting key characteristics.
Low (L)	Key characteristics and qualities of the landscape are robust in that they can withstand change from the introduction of wind turbines and solar panels. The landscape is likely to be able to accommodate wind and solar energy development without a significant change in character. Care is still needed when siting and designing these developments to ensure best fit with the landscape.

Additionally, the assessment considers the suitability of different turbine heights (to blade tip), based on bandings that reflect those most likely to be put forward by developers (now and in the future). These are set out in Table 57 below.

Table 57: Wind Turbine Development Sizes Considered in the Landscape Sensitivity Assessment

Wind Energy Development Banding	Turbine Height (to blade tip)
Band A	18m – 25m
Band B	26m – 60m
Band C	61m– 100m
Band D	101m– 120m
Band E	121m – 150m

The complete assessment methodology and results of a landscape sensitivity assessment in included in the accompanying document 'Landscape Sensitivity Assessment Solar PV and Wind Energy Development – Prepared by LUC – 2021'.

W17 maps show the landscape sensitivity assessment results overlayed on the identified wind farm Search Areas. The figures rank the areas considered for the landscape sensitivity study in line with the sensitivity levels shown in Table 56 and provide guidance on the potential effects of different scale wind development on the landscape. Higher resolution versions of these maps including 500kW, 1.0MW and 2.5MW turbine wind SAs are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'. Table 58 and Table 59 below present the results of the landscape sensitively assessment for 1.0MW and 2.5MW wind SAs.

Table 58: Individual Identified 1.0MW Wind SA's in B&NES and Their Landscape Sensitivity Levels

SA Reference on Maps	Sensitivity Level	
1.0MW-1	Moderate - High	High
1.0MW-2	High	
1.0MW-3	High	
1.0MW-4	Moderate - High	High
1.0MW-5	High	
1.0MW-6	High	

Table 59: Individual Identified 2.5MW Wind SA's in B&NES and Their Landscape Sensitivity Levels

SA Reference on Maps	Sensitivity Level
2.5MW-1	High
2.5MW-2	High
2.5MW-3	High

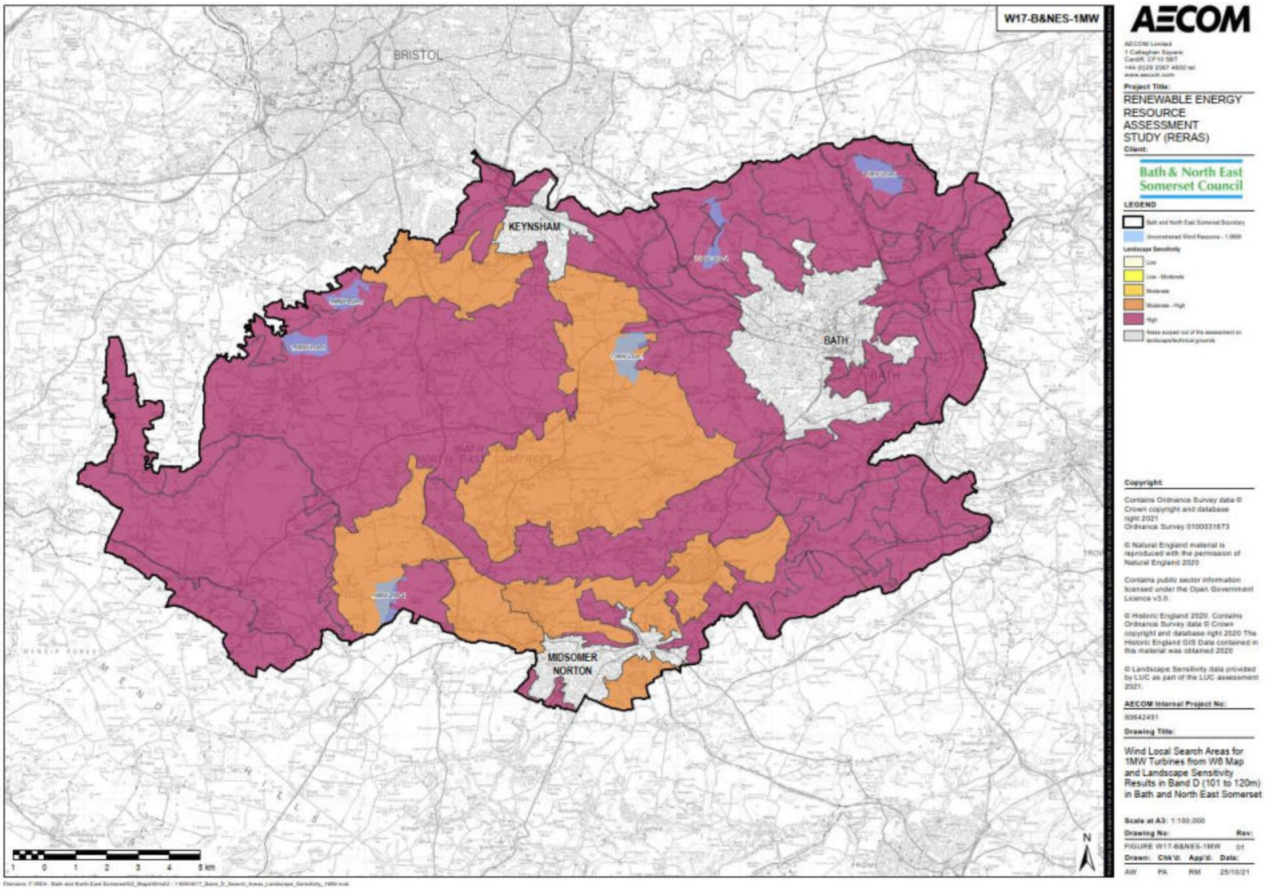


Figure 97: W17-B&NES-1MW: Wind Local Search Areas for 1 MW Wind Turbines from W6 map and Landscape Sensitivity Results in Band D (101m to 120m) in Bath and North East Somerset Map

G.6 Further Constraints to Wind Energy sites

Further constraints to onshore wind development not considered within this RERAS may include (and this is not meant to be an exhaustive list):

- Practical access to sites required for development.
- Landowner willingness for development to go ahead.
- National planning policies, outside of the Council's control;
- Community support; and
- Time to complete planning procedures.

G.7 Summary and Potential Opportunities for Future Development

Wind generation has the potential to be a significant source of renewable energy generation in B&NES, with the identification of:

- 272 SAs for small (500kW) turbines;
- 6 SAs for medium (1.0MW) turbines; and,
- 3 SAs for large (2.5MW) turbines.

The W7 map highlights that there is a considerable overlap of 1.0MW and 2.5MW SAs, with there being significant opportunities for 500kW turbine installations across the B&NES area. Table 60 shows details of the SAs and their potential installed capacity and energy generation.

Table 60: Identified Wind SAs in B&NES - Theoretical Maximum Potential Wind Resource

Map Reference	Note	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)	Potential Total Electricity Generation (GWh)
W6-B&NES-0.5MW	SAs for 500kW wind turbines in B&NES	6.84	136.00[247]	296.02
W6-B&NES-1.0MW	SAs for 1.0MW wind turbines in B&NES	5.11	40.88	88.98
W6-B&NES-2.5MW	SAs for 2.5MW wind turbines in B&NES	2.38	21.42	46.62
	Total		180.01[248]	391.80

Additionally, SAs have been further prioritised using the WPD grid connection analysis (for information purposes only) and the LUC landscape sensitivity assessment. The WPD grid connection analysis can be used to identify the most favourable locations when considering updates to the grid. The LUC landscape sensitivity assessment can be used to guide the Council to the locations that will have the least impact on the landscape.

The only other technology addressed in this study with the potential to produce more renewable electricity was solar PV.

Due to the benefits of wind developments (typically greater CO_2 saving per square metre) as well as the relatively smaller number of sites (and area) for such development as opposed to solar, consideration should be given to protecting such sites solely for wind development as well as against sterilisation from other forms of nearby development.

Moreover, the effects of other constraints such as AONB and Green Belt areas that may impact wind development that would need to be examined as part of the Local Plan process were analysed and included in the study as information to assist the Council in developing its proposed policy approach. Appendix I includes details of these additional constraints and potential capacity of the SAs if the

[247] 272 additional small land parcels for 500kW turbines installations have been identified. It is assumed that one 500 kW turbine could be sited on each.
[248] The potential from 1.0MW and 2.5MW Search Areas cannot be added together as some of the areas overlap. The maximum capacity in this table is taken from 1.0MW Search Areas plus and additional non-overlapping 2.5MW Search Areas.

overlapping areas covering these constraints and SAs were removed. The additional maps also cover radar, MoD and aviation safeguarding as well as Conservation Areas (Heritage) to assist developers and the Council with any dialogue/that consultation that may be required with these organisations regarding wind turbine installations.

Appendix H : Wind Energy Primary Resource Constraints Table

The detailed data sources and assumptions can be found below.

Constraint	Buffer	Notes
Special Protection Areas (SPA) and foraging buffers	Extent only	
Special Areas of Conservation (SAC)	Extent only	
RAMSAR sites	Extent only	Not present in B&NES
National Nature Reserves (NNR)	Extent only	Not present in B&NES
Sites of Special Scientific Interest (SSSI)	Extent only	
Scheduled Monuments	Extent only	
Listed Buildings, noise buffers have been applied if the building is residential	Extent only (including noise buffer if the building is a dwelling for buildings within B&NES and neighbouring authorities)	**Refer to Wind Turbines specifications tables for topple distances**
Registered Historic Parks and Gardens	Extent only	
Registered Battlefields	Extent only	
Ancient Woodlands[249]	15m	The buffer has been applied to avoid root damage
Broadleaved Woodland	15m	The buffer has been applied to avoid root damage
Major transport infrastructure – topple distances buffers have been applied.	Turbines Topple Distance+10%	**Refer to Wind Turbines specifications tables for Topple distances**
Minor transport infrastructure – topple distances buffers have been applied.	Turbines Topple Distance+10%	**Refer to Wind Turbines specifications tables for Topple distances**
Existing buildings	Extent only	

[249] https://www.gov.uk/guidance/ancient-woodland-and-veteran-trees-protection-surveys-licences

Dwellings	Wind Turbines noise buffers have been applied	**Refer to Wind Turbines specifications tables for noise buffers**
Watercourses – including major, secondary, and minor rivers, canals and lakes; - a 2 metre buffer has been applied to rivers and streams	2m	
MoD Sites	Extent only	
MOD Low Flying Zones	Extent only	
Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind)	Extent only	
Active mines/quarries	Extent only	
Local Nature Reserves	Extent only	

Appendix I : Wind Energy Resource Other Constraints Table

It was agreed that these constraints would need to be examined as part of the preparing the Local Plan and therefore, have not been constrained further in this assessment.

Constraint	Buffer	Notes
Other woodlands (Other than Broadleaved Woodland and Ancient Woodland)	Extent only	
Area of Outstanding Natural Beauty (AONB)	Extent only	
Natural England's Impact Risk Zones for Wind Development (IRZs)	Extent only	
Unlicensed Aerodromes	Extent only	
Minerals Safeguarding Areas	Extent only	
National Air Traffic Control Services (NATS) Radar Safeguarding Areas	Extent only	
Aviation Safeguarded Zones	Extent only	Bristol Airport and B&NES Planning Policy ST8
Flood Zones	Extent only	
National Trust Inalienable Land	Extent only	
Green Belt[250]	Extent only	
MoD Safeguarding Zones	Extent only	
Conservation Areas (Heritage)	Extent only	
World Heritage Sites	Extent only	

[250] As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources'*

Appendix J : Solar PV Farms Methodology

J.1 Introduction

This section provides details of the assessment of the potential for Solar Photovoltaic (PV) Farms within B&NES. Information on solar PV can be found in Section 5.

The Department for Business Energy and Industrial Strategy (BEIS) -formerly the Department for Energy and Climate Change (DECC) defines a “stand-alone” installation as a “solar photovoltaic electricity generating facility that is not wired through a building, or if it is wired through a building, the building does not have the ability to use 10% or more of the electricity generated”.

PV solar cells/ panels generate renewable electricity from the direct conversion of solar irradiation. PV is recognised as one of the key technologies in meeting the UK target of net zero greenhouse gas emissions by 2050. Electricity will be increasingly important in supporting net zero delivery, potentially providing around half of the UK's final energy demand as its use for heat and in transport increases[251].

In 2019, 28% of renewable installations across the UK installed capacity were solar PV. This figure is expected to increase due to the falling costs of PV modules leading to increasing viability of ground-mounted solar installations[252]. The Contracts for Difference (CfD) scheme is the Government’s main mechanism for supporting new low carbon electricity generation projects. The scheme is being updated to support the UK’s 2050 net zero target delivery whilst simultaneously minimising consumer costs[253].

This section provides the approach to a high-level assessment of the potential solar resource for ‘stand-alone’ PV farms, it is primarily concerned with identifying opportunities for solar PV development of larger than 5MW.

[251] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943714/Modelling-2050-Electricity-System-Analysis.pdf
[252] https://www.gov.uk/government/statistics/regional-renewable-statistics
[253] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945301/cfd-cm-scheme-update-2020.pdf

J.2 Mapping

The solar PV farm potential in B&NES was determined through a series of steps in which the primary constraints associated with such development have been considered. The datasets corresponding to these constraints are overlaid in stages, by applying to GIS mapping, to produce the Search Areas shown in the RERAS. This assessment considers a combination of primary constraints comprising those that exclude certain places from being considered as potentially suitable as areas of search for locating solar PV farms (e.g., international nature conservation designations), as well as those that require further consideration through the Local Plan process. These constraints and the GIS mapping stages at which they were applied was discussed and agreed with B&NES Council.

Maps have been produced to illustrate, at each stage of the study process, the primary constraints and opportunities.

The flowchart shown in Figure 98 shows the steps taken and the output maps at each stage of the mapping process. These maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

For an in-depth, step-by-step explanation of the mapping process, please see Appendix J.

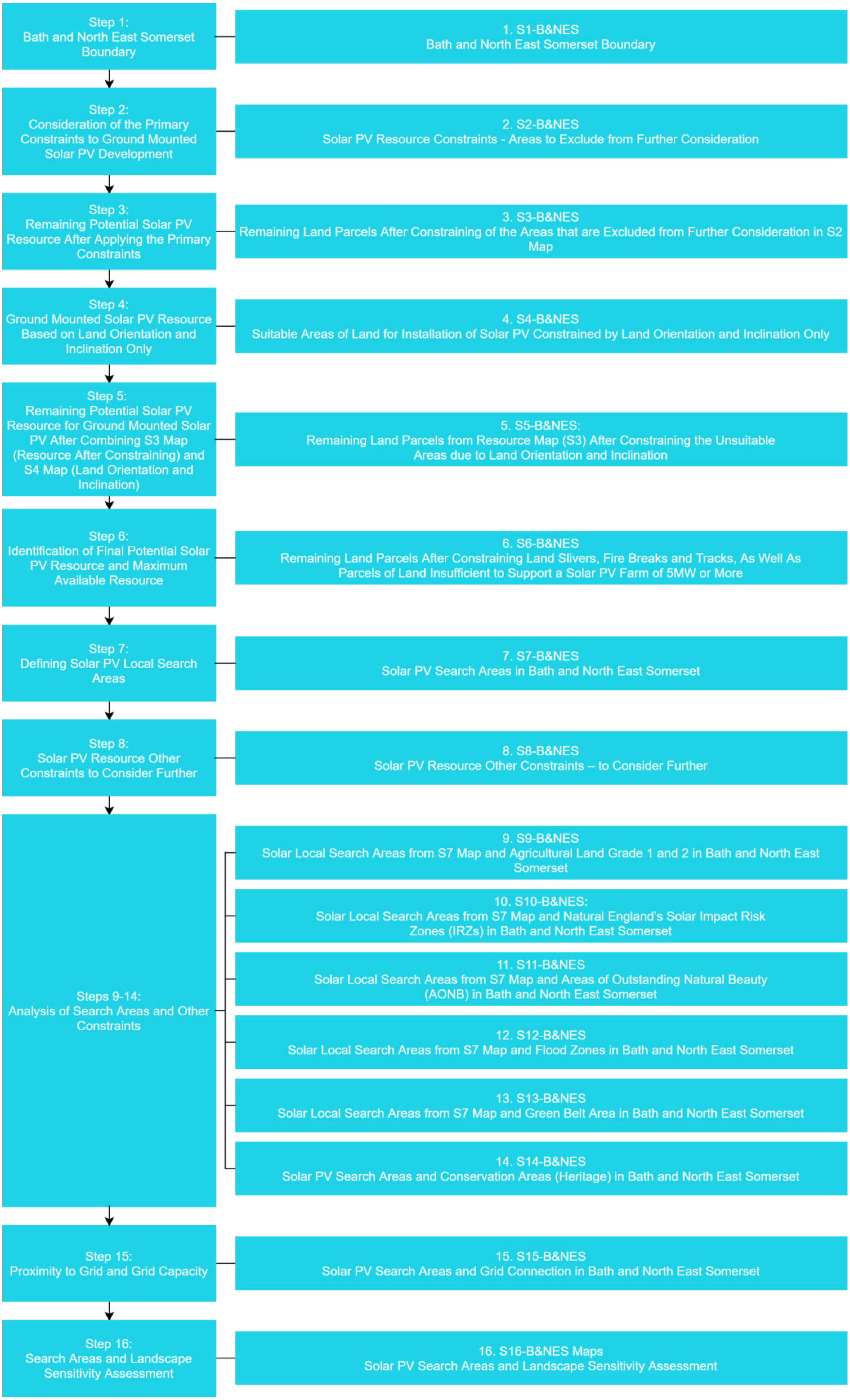


Figure 98: Flowchart of Solar PV Farm Mapping Process

Throughout, reference is made to titles and reference numbers to correspond with maps. Screenshots of these maps are included throughout this section. Higher-resolution maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

Step1: Bath and North East Somerset Boundary

Map Reference and Title:

1. S1-B&NES: Bath and North East Somerset Boundary

This map shows the B&NES boundary, as is shown in Figure 99 below. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

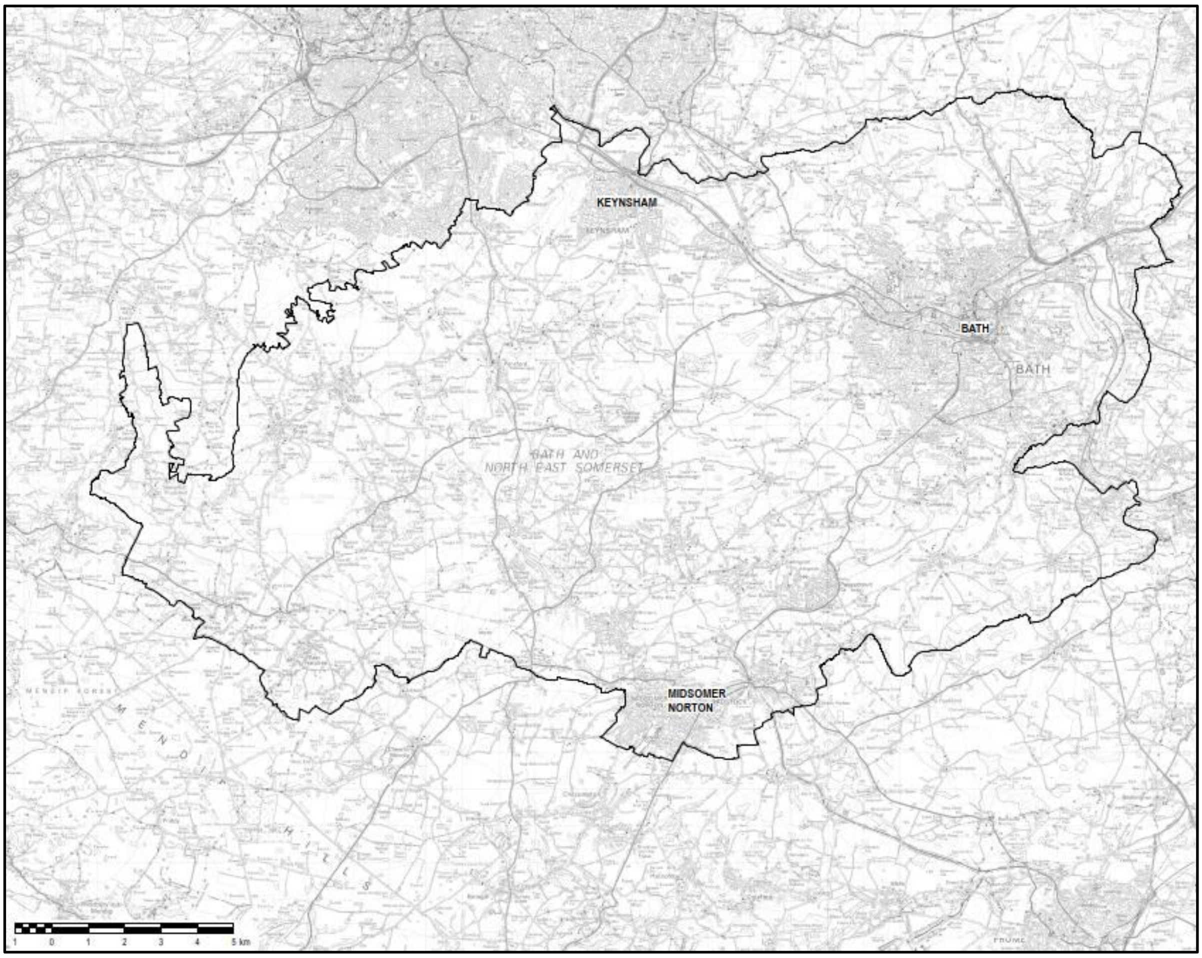


Figure 99: Bath and North East Somerset Boundary Map

Step 2: Consideration of the Primary Constraints to Ground Mounted Solar PV Development

Map Reference & Title:

1. S2-B&NES: Solar PV Resource Constraints - Areas to Exclude from Further Consideration

The purpose of this step was to identify the maximum potential for solar PV farm installation across B&NES through the identification of constrained areas.

Therefore, consideration was given to the primary constraints associated with restrictions to solar energy development. A comprehensive list of the constraints is given in Appendix K. The solar PV farm S2 constraints map illustrates the primary constraints to the development/ deployment of Solar PV farms in B&NES. For mapping purposes, the constraints, except where specifically stated, relate to the designation's extent only with no additional buffer distances applied.

The constraints applied to the maps in Step 2 were as follows:

- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC);
- RAMSAR sites (Not Present in B&NES);
- National Nature Reserves (NNR) (Not Present in B&NES);
- Sites of Special Scientific Interest (SSSI);
- Scheduled Monuments;
- Listed Buildings, noise buffers have been applied if the building is residential;
- Registered Historic Parks and Gardens; and
- Registered Battlefields.

Many of the 'buffer distances', applied in the maps are specifically linked to minimising potential impacts upon people or infrastructure through the application in the maps of buffer areas. The extent of the buffer areas is informed directly by the nature/extent of the natural/built environment and the characteristics of the generating technology. This assessment is based on constraints associated with a typical 5MW solar PV array[254].

The following constraints and their buffer distances (where one has been applied) were considered:

- Ancient Woodlands – a 15-metre buffer has been applied to avoid root damage[255];
- Broadleaved Woodland - a 15-metre buffer has been applied to avoid root damage;
- Major transport infrastructure;
- Minor transport infrastructure;
- Existing buildings/settlements;
- Watercourses – including major, secondary, and minor rivers, canals, and lakes; - a 2-metre buffer has been applied to rivers and streams;
- MoD Sites;
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind);
- Active mines/quarries; and
- Local Nature Reserves;

It should be noted that, whilst the above issues have been considered in the selection of the SAs, the SAs remain subject to further investigation based on information provided in this report (e.g. grid connection or landscape sensitivity) or other site specific characteristics through the Local Plan process as part of developing a strategy for renewable energy development.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[254] It should be noted that this does not preclude the potential development / deployment of larger or smaller PV farms across the area.
[255] https://www.gov.uk/guidance/ancient-woodland-and-veteran-trees-protection-surveys-licences

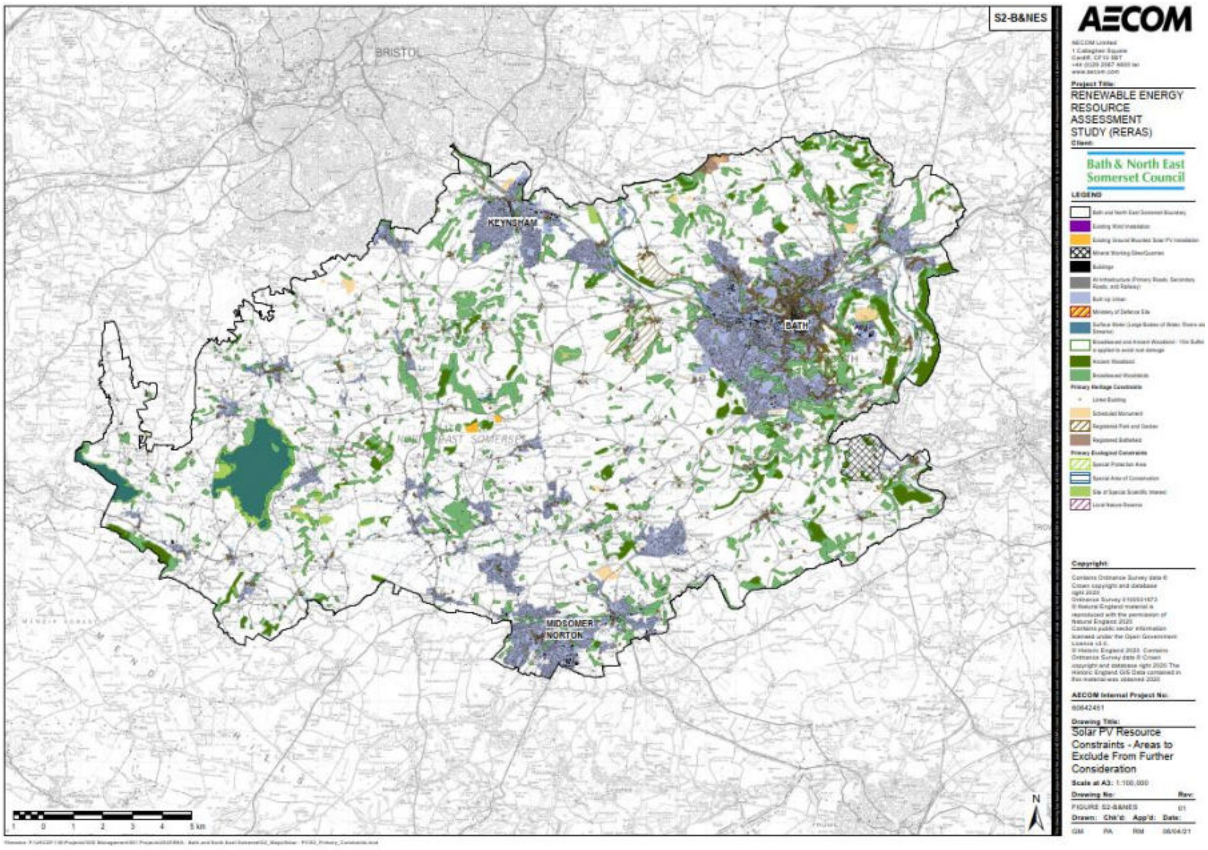


Figure 100: S2-B&NES: Solar PV Resource Constraints - Areas to Exclude from Further Consideration Map

A comprehensive table of the constraints is given in Appendix K

Policy Recommendation

Policy Reference: SF-PR-4 (Refer to Table 42 in Section 17)

It is recommended that proposals for re-powering of solar PV farms at end-of-life to an equal or increased capacity, subject to compliance with primary constraints, site specific constraints, and other policy considerations should be looked upon favourably..

As explained above, areas of constraint have been applied through mapping to identify potentially suitable locations for the development of solar PV farms, and these are labelled as solar PV farm Search Areas. However, these search areas will need to be refined further through the Local Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

Step 3: Remaining Land Parcels After Applying the Constraints

Map Reference & Title:

1. S3-B&NES: Remaining Land Parcels After Constraining of the Areas that are Excluded from Further Consideration in S2 Map

S3 map shows the remaining solar PV resource[256] after removing the areas that were constrained in Step 2 of the mapping process. Table 61 summarises this information.

[256] Labelled as "Unconstrained Land" on S3 map

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

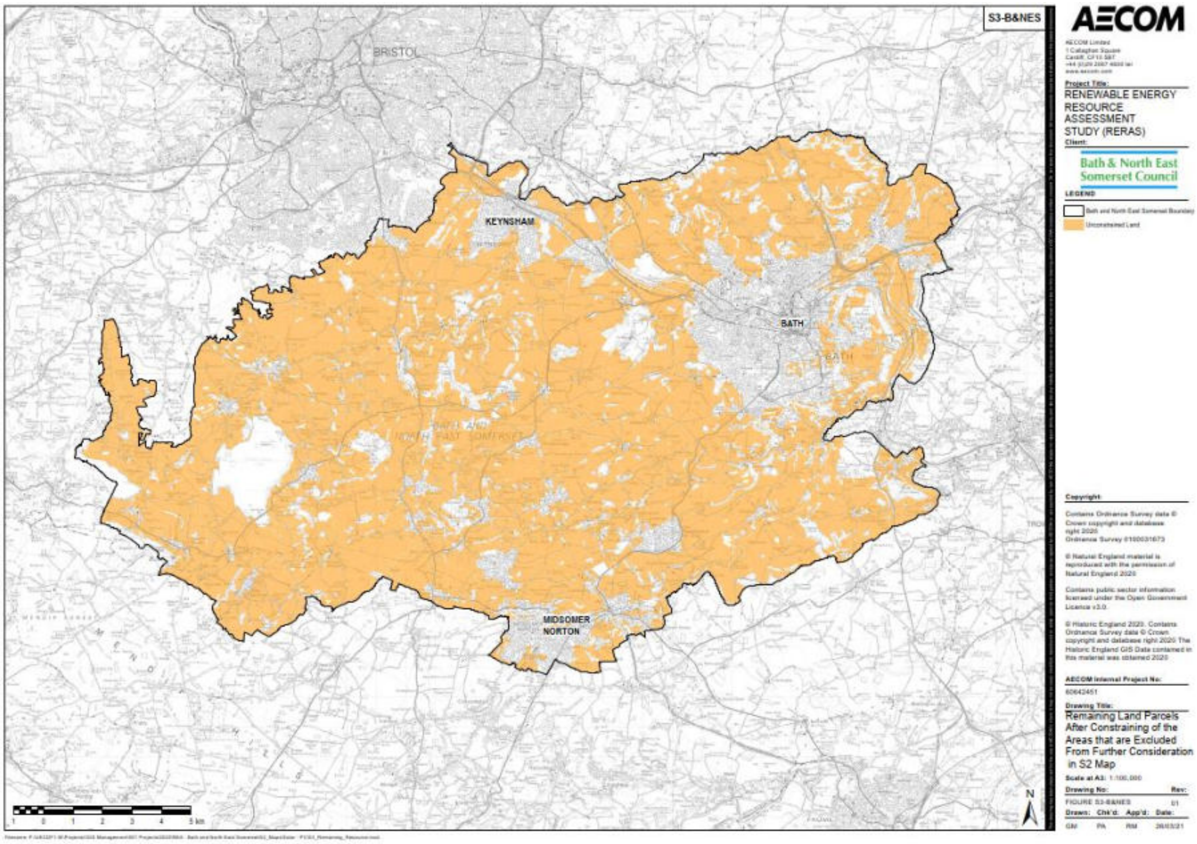


Figure 101: S3-B&NES: Remaining Land Parcels After Constraining of the Areas that are Excluded from Further Consideration in S2 Map

Table 61: Remaining Land Available for Ground Mounted Solar PV Farms at this Stage of the Assessment and Potential Total Installed Capacity Based on the Available Area

Map Reference	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)
S3-B&NES	242.34	10,097.5[257]

Step 4: Ground Mounted Solar PV Resource Based on Land Orientation and Inclination

Map Reference & Title:

1. S4-B&NES: Suitable Areas of Land for Installation of Solar PV Constrained by Land Orientation and Inclination Only

The areas shown on the S4 map were only constrained by the B&NES boundary and the ability of the technology to utilise the available resource based on land orientations and inclinations.

The performance of a photovoltaic panel system is directly related to the inclination, orientation and degree of shading of the panels. For the purposes of identifying the areas suitable for PV farm development, assumptions have been made on the suitability of slope gradient and orientation for PV

[257] According to the DECC UK Solar PV Strategy Part 1: 'Roadmap to a Brighter Future', the land area required for a 1MW fixed-tilt PV array is approximately 6acres (or 2.4Ha or 0.024km^2).

deployment which are summarised in this section. At this stage of the study, a fixed frame PV panel was assumed.

Using data from Ordnance Survey[258], AECOM has created a data layer for the B&NES area showing orientation of slope and potential for shading. The following assumptions have been applied in this study:

Table 62: Suitability of Sites for PV Installation at Varying Inclinations

Suitability of Sites	Inclinations
All suitable:	Inclinations between 0-3 degrees from the horizontal (red coloured areas on S3 map)
Only south-west to south east facing areas are suitable. All other orientations are considered constrained	Inclinations between 3-15 degrees from the horizontal (orange coloured areas on S4 map).
All constrained	Inclinations >15 degrees from the horizontal

All areas with inclinations of 0-3^{o} from the horizontal were assumed suitable and optimum (red coloured areas on S4 maps). For the areas with inclinations between 3-15^{o} from the horizontal, only south-west to south-east facing areas were assumed to be suitable (amber areas on S4 maps). All other areas were deemed unsuitable for ground-mounted solar PV installation. Table 63 presents the results of this analysis.

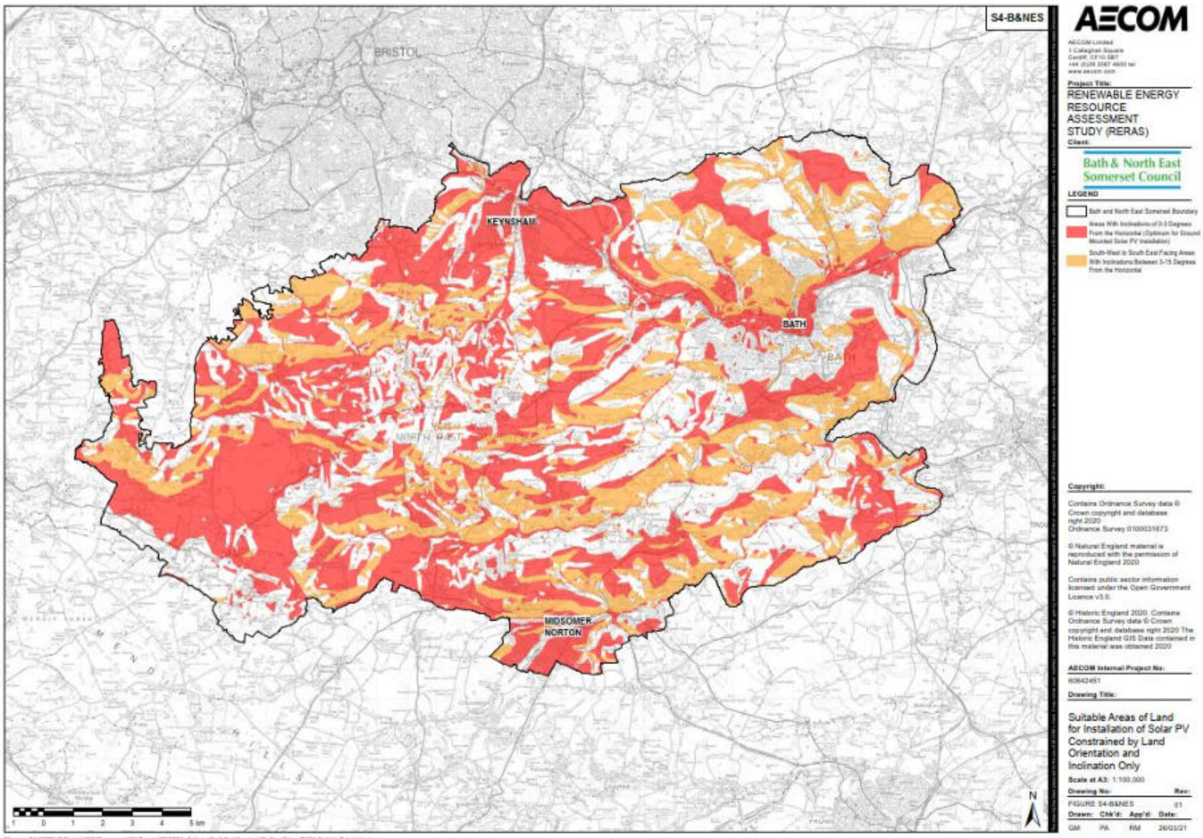


Figure 102: S4-B&NES: Suitable Areas of Land for Installation of Solar PV Constrained by Land Orientation and Inclination Only Map

[258] Ordnance Survey, Terrain 50 dataset.

Table 63: Resource Area for Ground Mounted Solar PV Based on Land Orientation and Inclination Only

Map Reference	Total Area of B&NES (km²)	Resource Area for PV (km²)	Percentage of Total Area
S4-B&NES	351.10	217.9	62.1%

Step 5: Remaining Potential Solar PV Resource After Combining S3 Map (Resource After Constraining) and S4 Map (Land Orientation and Inclination)

Map Reference & Title:

1. S5-B&NES: Remaining Land Parcels from Resource Map (S3) After Constraining the Unsuitable Areas due to Land Orientation and Inclination

At this stage of the assessment, unsuitable areas due to inappropriate land orientation and inclination were removed from S3 maps and presented. Table 64 below shows the remaining potential solar PV resource[259] at this stage and its potential total installed capacity. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

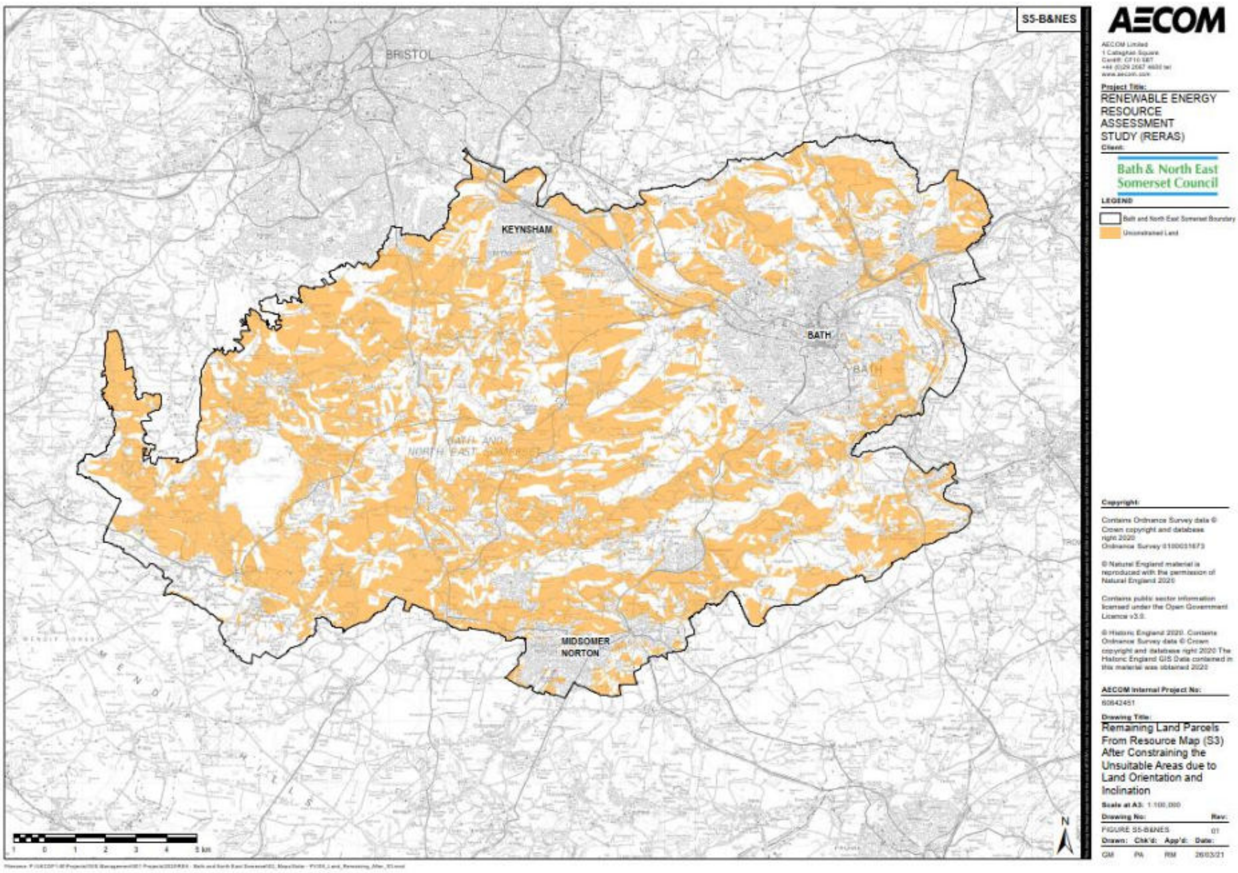


Figure 103: S5-B&NES: Remaining Land Parcels from Resource Map (S3) After Constraining the Unsuitable Areas due to Land Orientation and Inclination Map

[259] Labelled as "Unconstrained Land" on S5 map

Table 64: Remaining Land Available for Ground Mounted Solar PV Farms at this Stage of and its Potential Total Installed Capacity

Map Reference	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)
S5-B&NES	152.09	6,337.1[260]

Step 6: Identification of Final Potential Solar PV Resource and Maximum Available Resource

Map Reference & Title:

1. S6-B&NES: Remaining Land Parcels After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Insufficient to Support a Solar PV Farm of 5MW or More

At this stage of the assessment, land slivers, fire breaks and tracks, as well as parcels of land insufficient to support a solar PV farm of 5MW or more, were removed from Step 5 maps. It should be noted that schemes smaller than 5MW may be brought forward and these would need to be considered on their own merits.

Following the application of the primary constraints, the remaining potential solar PV resource[261] informs the calculation of the maximum potential generation capacity. This number then informs identification of the theoretical maximum renewable energy generation in Bath and North East Somerset, see Section 15.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

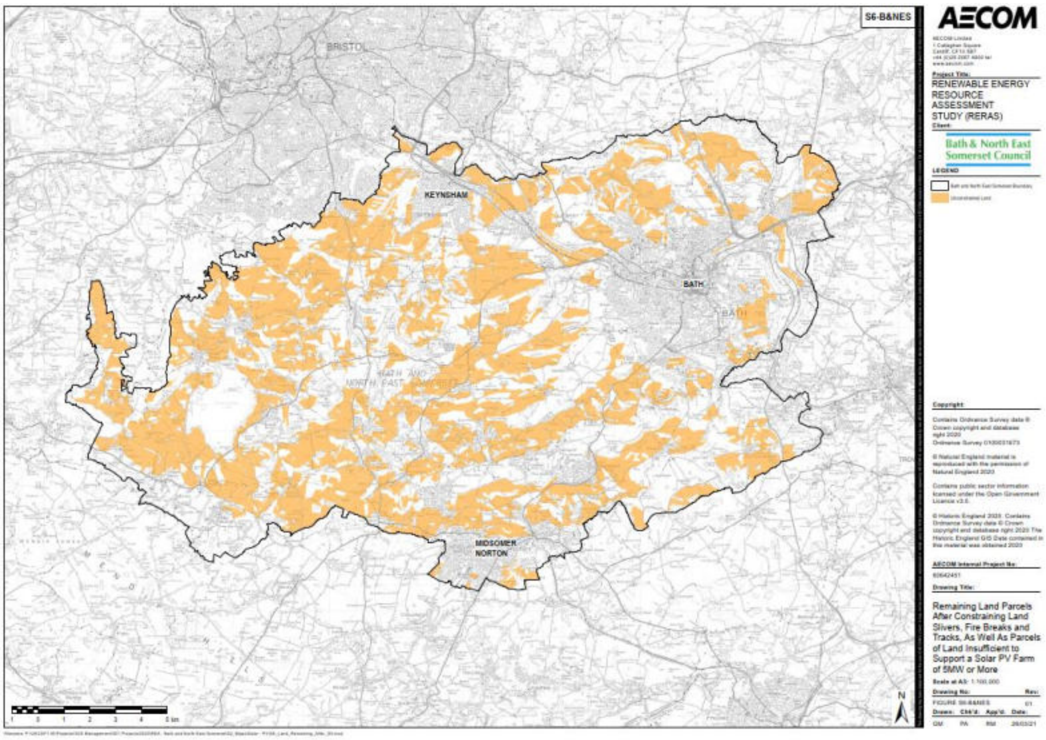


Figure 104: S6-B&NES: Remaining Land Parcels After Constraining Land Slivers, Fire Breaks and Tracks, As Well As Parcels of Land Insufficient to Support a Solar PV Farm of 5MW or More Map

[260] According to the DECC UK Solar PV Strategy Part 1: 'Roadmap to a Brighter Future', the land area required for a 1MW fixed-tilt PV array is approximately 6acres (or 2.4Ha or 0.024km^2).
[261] Labelled as "Unconstrained Land" on S6 map

The additional future potential electricity generation is outlined in Table 65.

Table 65: Remaining Land Available for Ground Mounted Solar PV Farms at this Stage of the and its Potential Total Installed Capacity

Map Reference	Remaining Available Land Area (km^2)	Potential Total Installed Capacity (MW)	Potential Energy Generated (GWh)	Indicative Carbon Savings (2020 Grid Carbon Factor) CO_{2e}
S6-B&NES	126.71	5,279.6	5,121	1,296,586

Step 7: Defining Solar PV Local Search Areas

Map Reference & Title:

1. S7-B&NES: Solar PV Search Areas in Bath and North East Somerset

This RERAS is primarily concerned with identifying solar PV development opportunities larger than 5MW; AECOM has created a GIS grid layer. On this map, each square is equivalent to the spatial requirement of a 5MW solar farm. As the S6 map illustrates, there is a significant amount of remaining solar PV resources[262] which are suitable for ground-mounted PV installations in B&NES. 'Stand-alone' PV farms >5MW must be appropriately sited; however, with a large number of potential sites, to assist with further analysis in relation to the electricity grid and landscape assessment, the S7 map illustrates the grid overlaid on the remaining area of potential solar PV resource. Therefore, each square is defined and referenced as a solar PV SA in B&NES. Whilst this map was utilised for identifying the nearest transformer to each of the SAs, the squares also provide the reader with a sense of scale of the potential solar PV farms.

Policy Recommendation

Policy Reference: SF-PR-1 (Refer to Table 42 in Section 17)

It is recommended that the SAs identified through the RERAS are further refined through the Local Plan process, taking account of other considerations and constraints. As part of this a strategy approach which takes account of clustering and the potential need to manage cumulative impact should be considered.

Policy Recommendation

Policy Reference: SF-PR-2 (Refer to Table 42 in Section 17)

It is recommended that proposals for solar PV farms within the areas identified for that use through the Local Plan benefit from a presumption in favour of solar development.

Policy Recommendation

Policy Reference: SF-PR-3 (Refer to Table 42 in Section 17)

It is recommended that proposals for solar development outside of areas identified as suitable for that use through the Local Plan should be considered positively, providing it can demonstrate that proposals are compliant with relevant policy and site-specific issues and constraints can be mitigated to the satisfaction of the Council.

As explained above, areas of constraint have been applied through mapping to begin to identify potentially suitable locations for the development of solar PV farms, and these are labelled as solar PV farm Search Areas. However, these search areas will need to be refined further through the Local

[262] Labelled as "Unconstrained Land" on S7 map

Plan process, taking into account other considerations and constraints, as part of developing a strategy for renewable energy development.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

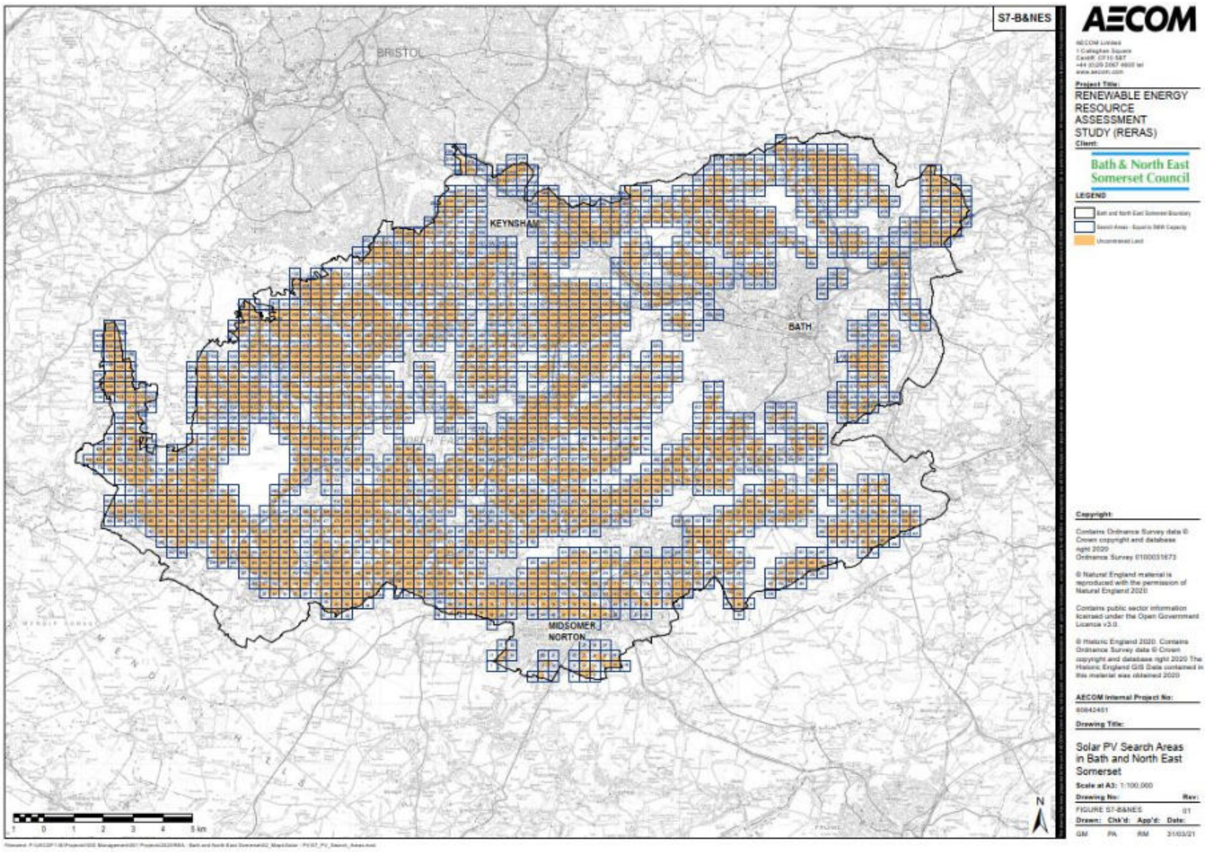


Figure 105: S7-B&NES: Solar PV Search Areas in Bath and North East Somerset Map

A total of 126.71km^2 of land was identified as being suitable potentially for the installation of a solar PV farm, with this area comprising of a majority of the rural areas within B&NES, this can be seen in Figure 105.

It was assumed the land area required for a 5MW fixed-tilt PV array is approximately 30 acres (or 12Ha or 0.12km^2)[263] and that a solar farm will generate energy at peak for 11% of the time (964 hours) over the course of a year[264].

Step 8: Solar PV Resource Other Constraints – to Consider Further

Map Reference & Title:

1. S8-B&NES: Solar PV Resource Other Constraints – to Consider Further

This section of the study analyses the effects of other constraints that may impact ground-mounted solar PV development within the SAs. The constraints highlighted in this section of the study would need to be examined and considered as part of the Local Plan process and therefore, the identified SAs in mapping Step 6 have not been constrained further during this stage.

263 According to the DECC UK Solar PV Strategy Part 1: 'Roadmap to a Brighter Future', the land area required for a 1MW fixed-tilt PV array is approximately 6acres (or 2.4Ha or 0.024km^2). *See above link*
264 Average of the five previous years' regional standard load factors published by BEIS.

S8 maps illustrate the following other constraints (see Appendix L).

- Other woodlands (Other than Broadleaved Woodland and Ancient Woodland)
- Area of Outstanding Natural Beauty (AONB)
- Natural England's Impact Risk Zones for Solar Development (IRZs)
- Minerals Safeguarding Areas
- World Heritage site and Setting
- Flood Zones
- National Trust Inalienable Land
- Agricultural Land Classification (ALC).
- MoD Safeguarding Zones
- Green Belt[265]
- Conservation Areas (Heritage)

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

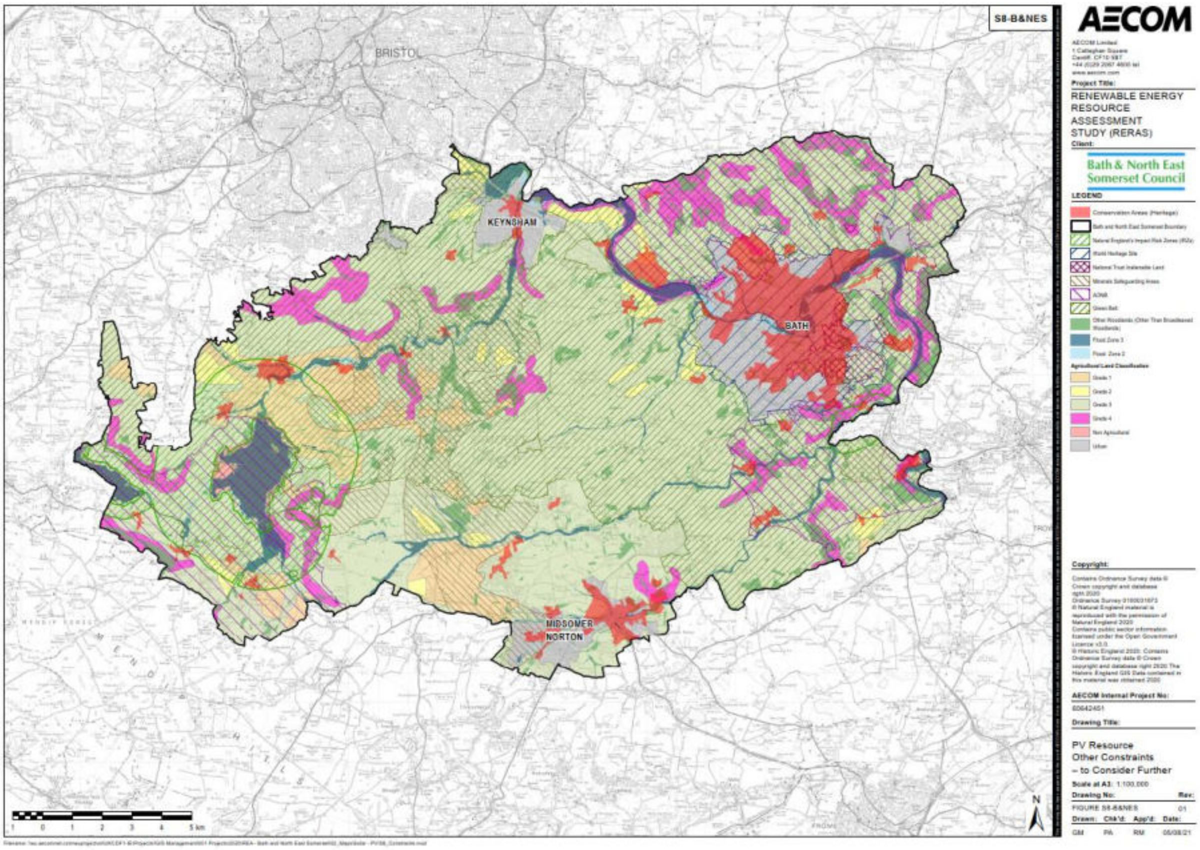


Figure 106: S8-B&NES: Solar PV Resource Other Constraints – to Consider Further Map

265 As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources.'*

Remaining Area of Search Areas after Applying Selected Additional Constraints

Map References & Titles:

1. S9-B&NES: Solar Local Search Areas from S7 Map and Agricultural Land Grade 1 and 2 in Bath and North East Somerset
2. S10-B&NES: Solar Local Search Areas from S7 Map and Natural England's Solar Impact Risk Zones (IRZs) in Bath and North East Somerset
3. S11-B&NES: Solar Local Search Areas from S7 Map and Areas of Outstanding Natural Beauty (AONB) in Bath and North East Somerset
4. S12-B&NES: Solar Local Search Areas from S7 Map and Flood Zones in Bath and North East Somerset
5. S13-B&NES: Solar Local Search Areas from S7 Map and Green Belt Area in Bath and North East Somerset
6. S14-B&NES: Solar PV Search Areas and Conservation Areas (Heritage) in Bath and North East Somerset

Maps are produced to show the impacts of applying the following overlays to the solar PV SAs map, map S7. Table 66 provides further information regarding each map's remaining area and potential capacity if the overlapping areas covering these constraints and SAs were removed.

- Agricultural Land Grade 1 and 2
- Natural England's Impact Risk Zones for Solar Development (IRZs)
- Area of Outstanding Natural Beauty (AONB)
- Flood Zones
- Green Belt

Higher resolution versions of these maps are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

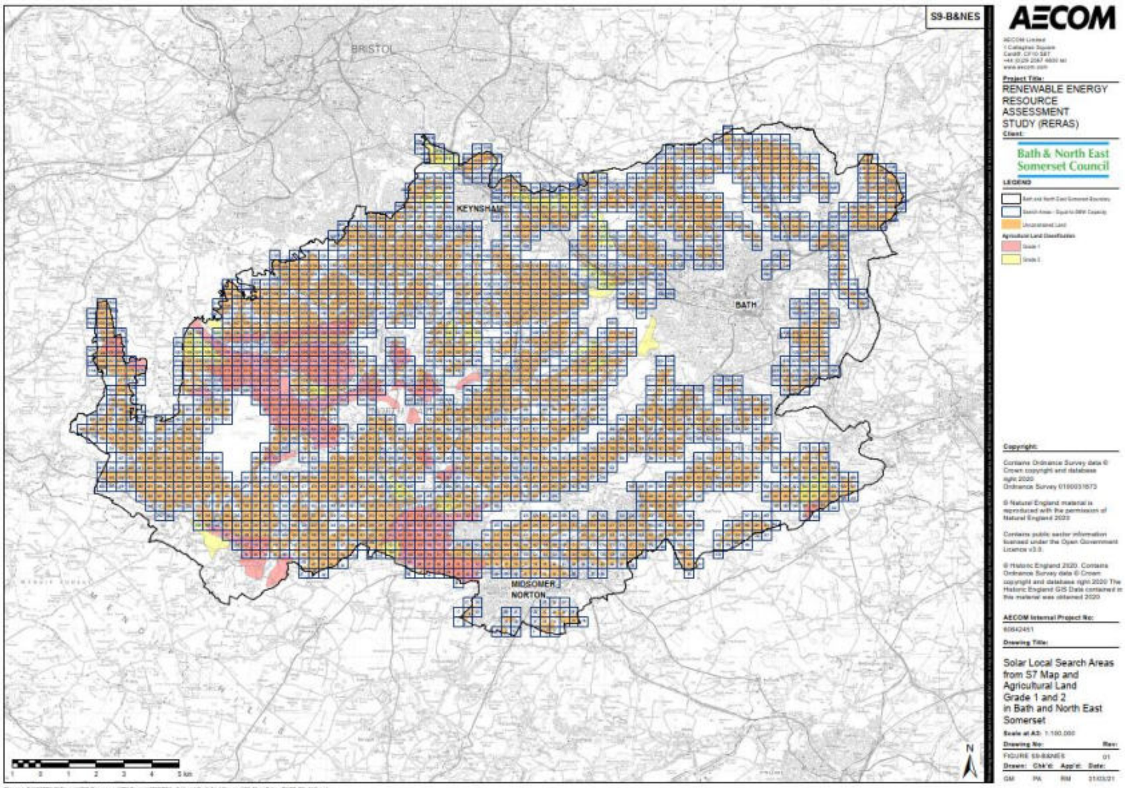


Figure 107: S9-B&NES: Solar Local Search Areas from S7 Map and Agricultural Land Grade 1 and 2 in Bath and North East Somerset Map

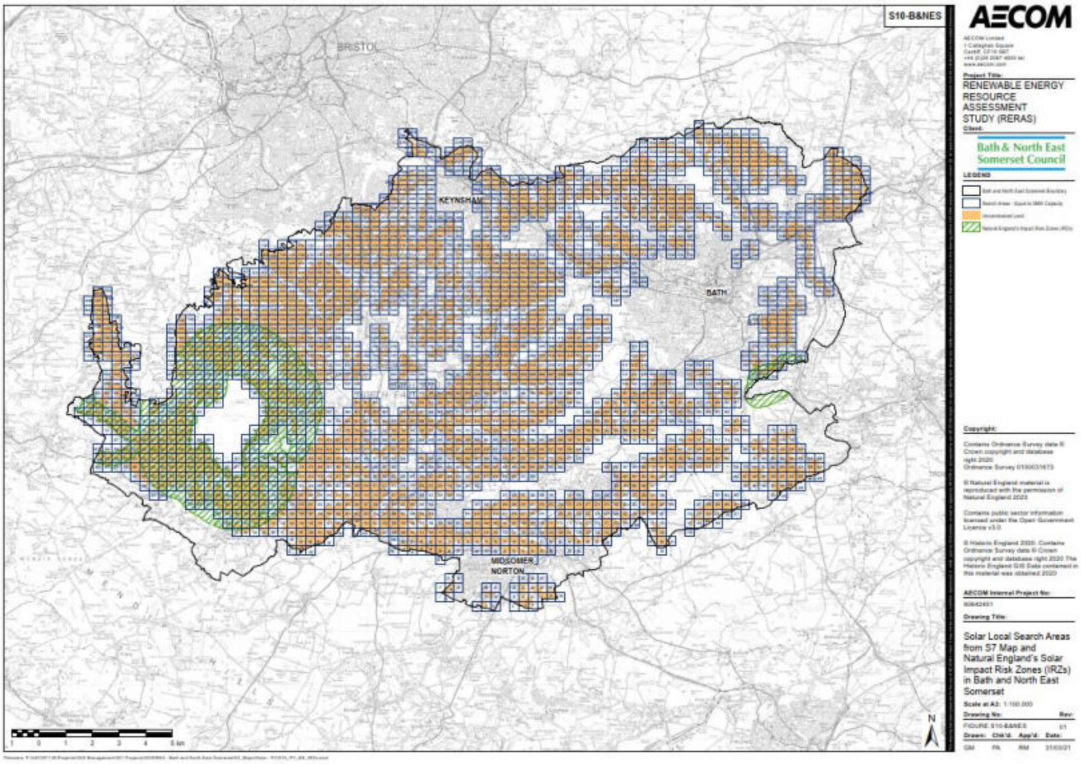


Figure 108: S10-B&NES: Solar Local Search Areas from S7 Map and Natural England's Solar Impact Risk Zones (IRZs) in Bath and North East Somerset Map

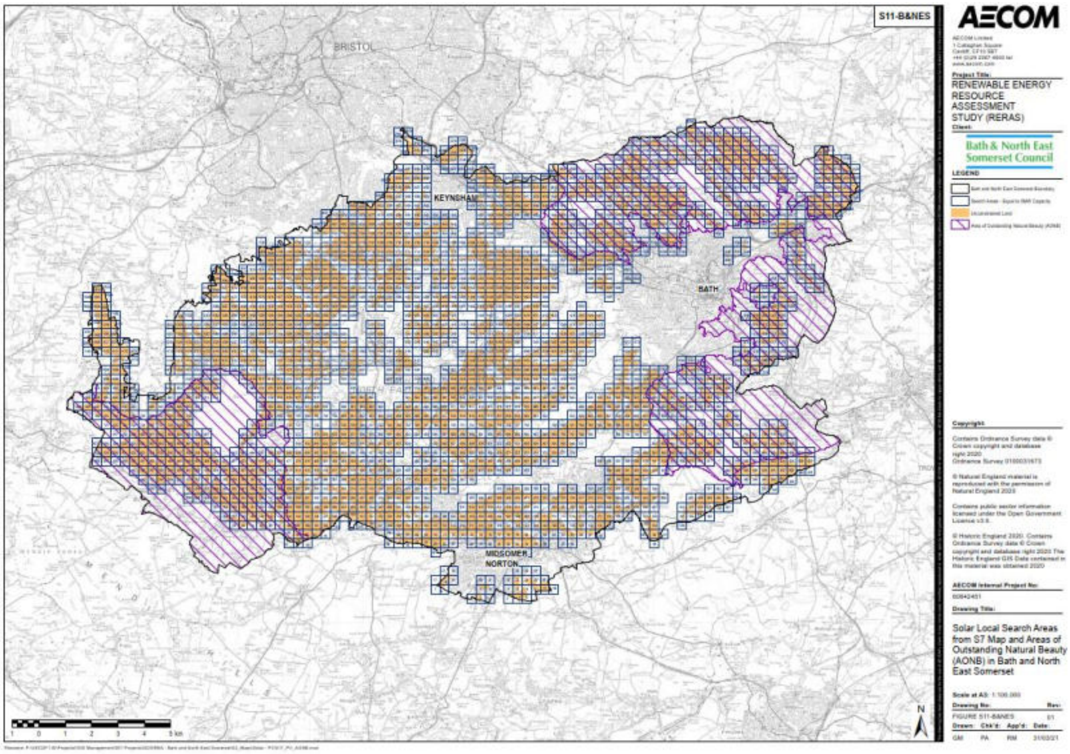


Figure 109: S11-B&NES: Solar Local Search Areas from S7 Map and Areas of Outstanding Natural Beauty (AONB) in Bath and North East Somerset Map

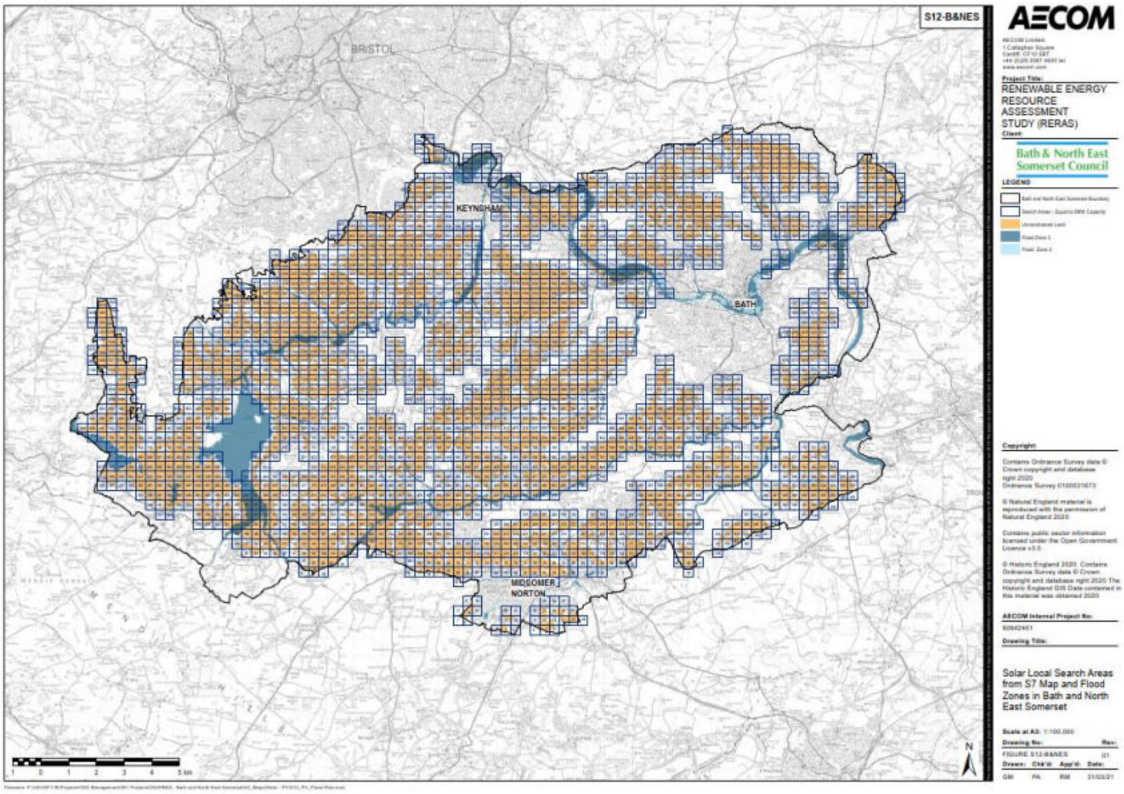


Figure 110: S12-B&NES: Solar Local Search Areas from S7 Map and Flood Zones in Bath and North East Somerset Map

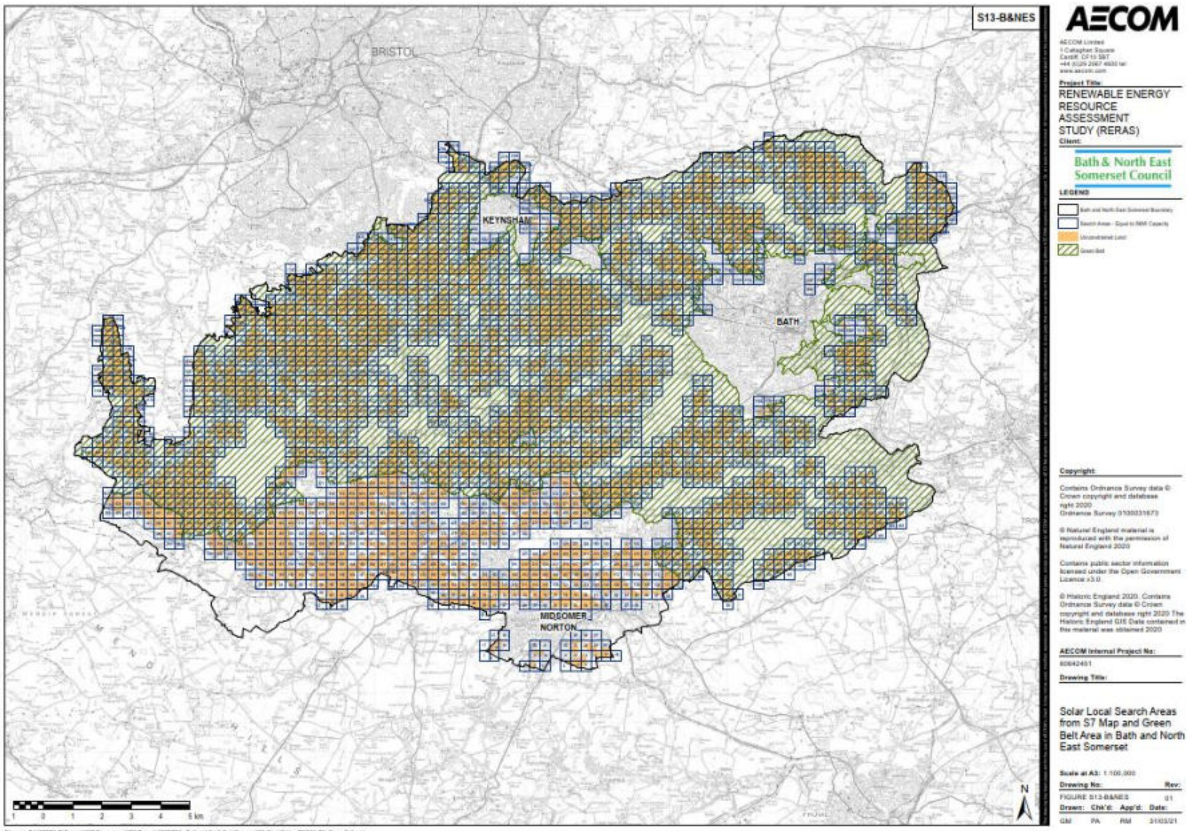


Figure 111: S13-B&NES: Solar Local Search Areas from S7 Map and Green Belt Area in Bath and North East Somerset Map

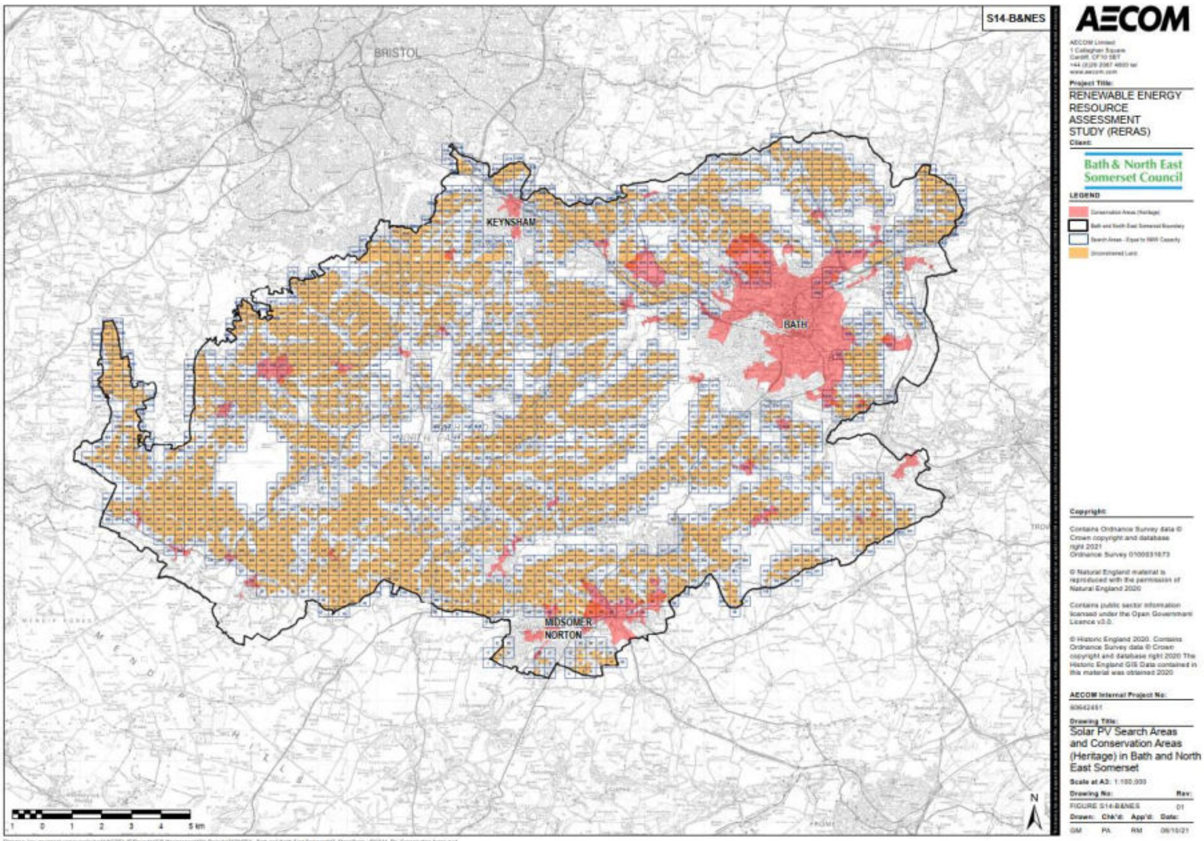


Figure 112: S14-B&NES: Solar PV Search Areas and Conservation Areas (Heritage) in Bath and North East Somerset Map

Table 66: Remaining Area of SAs After Applying Selected Other Constraints for Illustrative Purposes Only

Map Reference	Additional Constraint Shown on the Map	Area of the Final Solar SAs Identified in Step 6 (km^2)	Potential Installed Capacity of the Final Solar SAs (MW)	Remaining SAs if Area of the Additional Constraint Is Removed (km^2)	Remaining Potential Installed Capacity of the SAs if Area of the Additional Constraint Is Removed (MW)
S9-B&NES	Agricultural Land Grade 1 and 2	126.71	5,279.6	111.17	4,632.1
S10-B&NES	Natural England's IRZs for Solar	126.71	5,279.6	108.31	4,512.9
S11-B&NES	AONB	126.71	5,279.6	98.38	3,849.2
S12-B&NES	Flood Zones	126.71	5,279.6	120.75	5,031.3
S13-B&NES	Green Belt	126.71	5,279.6	29.87	1,244.6

J.3 Pipeline Projects

In this section of the report, Regen's DFES analysis is utilised to identify pipeline solar PV projects in B&NES. Project readiness of the identified Search Areas in relation to the current grid capacity and potential costs of grid upgrades are considered in Section 5.6. The methodology used for pipeline analysis is in line with the method outlined in Section G.3.

No pipeline projects in relation to solar development have been identified in B&NES. It should be noted that any site with current planning permission is shown and constrained on S2 maps as consented (but not yet constructed) developments.

J.4 Proximity to Grid and Grid Capacity

Map Reference & Title:

1. S15-B&NES: Solar PV Search Areas and Grid Connection in Bath and North East Somerset

Whilst private wire schemes are an option, and some already exist in the UK, solar farms usually have a connection to the grid to export electricity, albeit with increasing curtailments.

Consideration of a viable connection point is an important factor when considering sites for new solar energy development. The cost of a grid connection depends on the distance to the nearest connection point the works needed to make that connection (there can be a number of complexities such as land ownership issues, whether the dig is hard or soft, etc) and the availability of capacity in the distribution network to take the additional power output. For this study, grid connection is assumed to be a discussion matter for national-level decision-makers and has not been used to constrain solar PV energy generation potential. In addition, as renewable deployment is a national priority, it is assumed that the grid requirement will be met to allow for sufficient additional capacity.

However, a high-level analysis exercise has been undertaken in consultation with the Distribution Network Operator, Western Power Distribution (WPD), to rank the solar PV SAs and assess their project readiness based on the network capacity maps and connection points at the time of writing. (August 2021) The solar SAs have been divided into 50MW parcels in to allow WPD to perform their assessment of the sites. Additionally, there has been a rise in 50MW or lower solar PV farms proposal in the South West of England region. This could be due to the fact that electricity generators that generate lower than 50MWe are exempts from the requirement for an electricity licence[266].

The Search Areas are ranked from low priority (coloured red in the maps) to high priority (coloured blue in the maps), with high priority being most favourable for a new grid connection, as shown in Figure 113 and Figure 114.

Figure 113: SAs Proximity to Grid and Grid Capacity Ranking Key (Refer to S15 Map in Accompanying Document 'Bath and North East Somerset RERAS - Maps')

This ranking has only been taken as a single snapshot based on the latest information. It does not account for any future reinforcement that may be triggered by other new connections or condition-based replacement. Increases or decreases in future demand may also affect capacity and have not been considered within this study. Sites over 1MW may be required to go through the Statement of Works process to confirm acceptance of the connection on the transmission network.
Network access may be accelerated or achieved with reduced costs by progressing an alternative connection, which allows export to be limited at times of high export from other users. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[266] Class A: Small generators – Generates lower than 50 megawatts with a declared net capacity of up to 100 megawatts. https://www.legislation.gov.uk/uksi/2001/3270/schedule/2/made

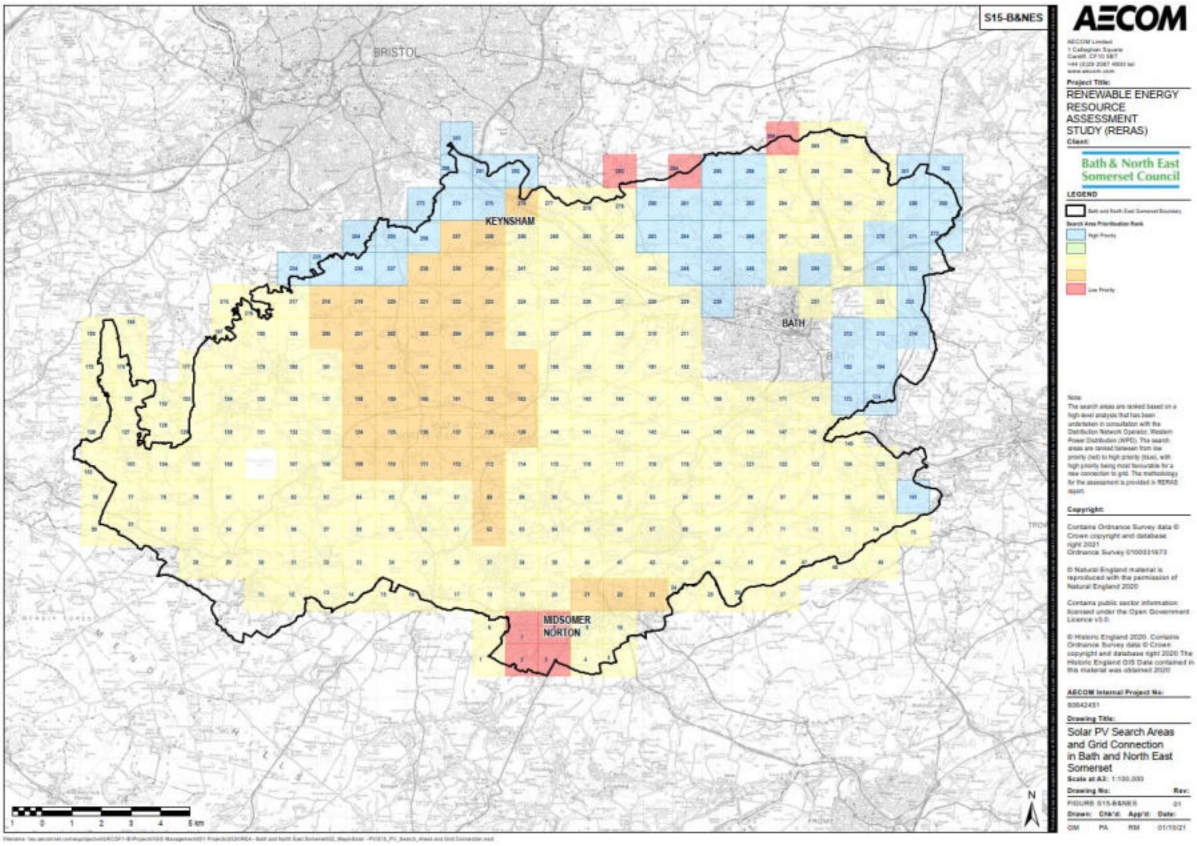


Figure 114: S15-B&NES: Solar PV Search Areas and Grid Connection in Bath and North East Somerset Map

J.5 Landscape Sensitivity Assessment

Map References & Titles:

1. S16-B&NES-Band A: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band A (≤5ha) in Bath and North East Somerset Map
2. S16-B&NES-Band B: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band B (6ha to 10ha) in Bath and North East Somerset Map
3. S16-B&NES-Band C: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band C (11ha to 15ha) in Bath and North East Somerset Map
4. S16-B&NES-Band D: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band D (16ha to 30ha) in Bath and North East Somerset Map

An additional parameter that can be considered in prioritising the Search Areas is Landscape Character Areas and the sensitivity of these landscapes to new solar PV farm developments. A flowchart presenting the steps taken in completing mapping the results of a landscape sensitivity for solar PV farms is shown in Figure 115.

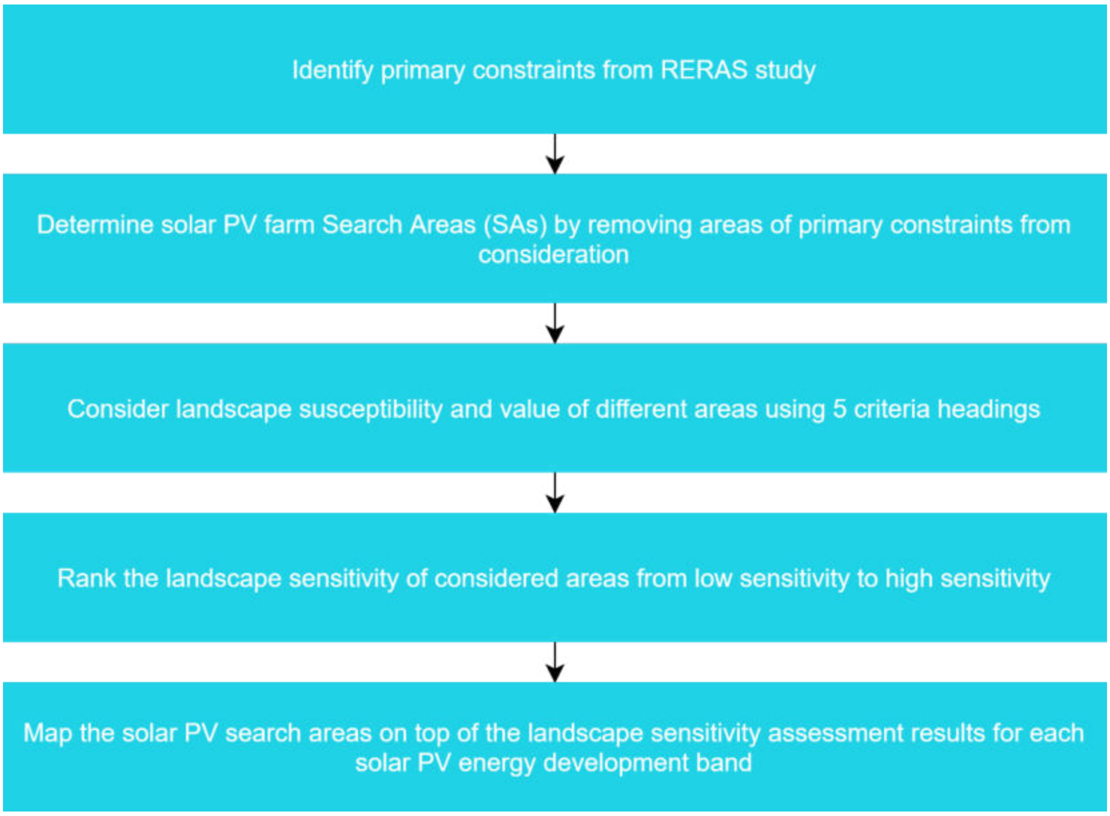


Figure 115 Steps Taken in Landscape Sensitivity Study for Solar PV Farm Search Areas

Land Use Consultants (LUC) has conducted a landscape sensitivity assessment for solar PV energy development as part of this RERAS. Results of the assessment provide an initial indication of the relative landscape sensitivity of different areas within B&NES to accommodate solar PV farm energy developments. The findings of the study, combined with the identified Search Areas (SAs), are presented in this section of the report. The landscape sensitivity assessment considers the landscape susceptibility[267] and landscape value[268] using 5 criteria headings:

- Landform and scale (including sense of openness / enclosure);
- Landcover (including field and settlement patterns);
- Historic landscape character;
- Visual character (including skylines); and
- Perceptual and scenic qualities.

Once the above criteria were assessed individually, the results were combined to produce an overall sensitivity level, as shown in Table 67.

[267] How vulnerable the landscape is to change from the type being assessed, in this case solar PV and wind energy developments
[268] Consensus about importance, which can be recognised through designation as well as through descriptions within the 2014 Landscape Character Assessment

Table 67: The Five-Point Scale Landscape Sensitivity Scale

Sensitivity Level	Definition
High (H)	Key characteristics and qualities of the landscape are highly vulnerable to change from wind and solar energy development. Such development is likely to result in a significant change in character.
Moderate - High (M-H)	Key characteristics and qualities of the landscape are vulnerable to change from wind and solar energy development. There may be some limited opportunity to accommodate wind turbines/ solar panels without significantly changing landscape character. Great care would be needed in siting and design.
Moderate (M)	Some of the key characteristics and qualities of the landscape are vulnerable to change. Although the landscape may have some ability to absorb wind and solar energy development, it is likely to cause a degree of change in character. Care would be needed in siting and design.
Low - Moderate (L-M)	Fewer of the key characteristics and qualities of the landscape are vulnerable to change. The landscape is likely to be able to accommodate wind and solar energy development with limited change in character. Care is still needed when siting and designing to avoid adversely affecting key characteristics.
Low (L)	Key characteristics and qualities of the landscape are robust in that they can withstand change from the introduction of wind turbines and solar panels. The landscape is likely to be able to accommodate wind and solar energy development without a significant change in character. Care is still needed when siting and designing these developments to ensure best fit with the landscape.

The assessment also judges the suitability of different scales of solar PV developments based on bandings that reflect those that are most likely to be put forward by developers. The sizes[269] used for the assessment are set out in Table 68.

Table 68: Solar PV Farm Development Sizes Considered in the Landscape Sensitivity Assessment

Solar PV Development Banding	Area
Band A	≤5ha
Band B	6ha – 10ha
Band C	11ha – 15ha
Band D	16ha – 30ha

The complete assessment methodology and results of a landscape sensitivity assessment in included in the accompanying document 'Landscape Sensitivity Assessment Solar PV and Wind Energy Development – Prepared by LUC – 2021'.

S16 maps show the landscape sensitivity assessment results overlayed on the identified solar PV farm Search Areas. The figures rank the areas considered for the landscape sensitivity study in line with the sensitivity levels shown in Table 67 and provide guidance on the potential effects of different scale solar PV development on the landscape. Higher resolution versions of these maps including bands A to D for solar PV SAs are contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

[269] The sizes of solar PV developments indicate the areas taken up by solar PV panels only.

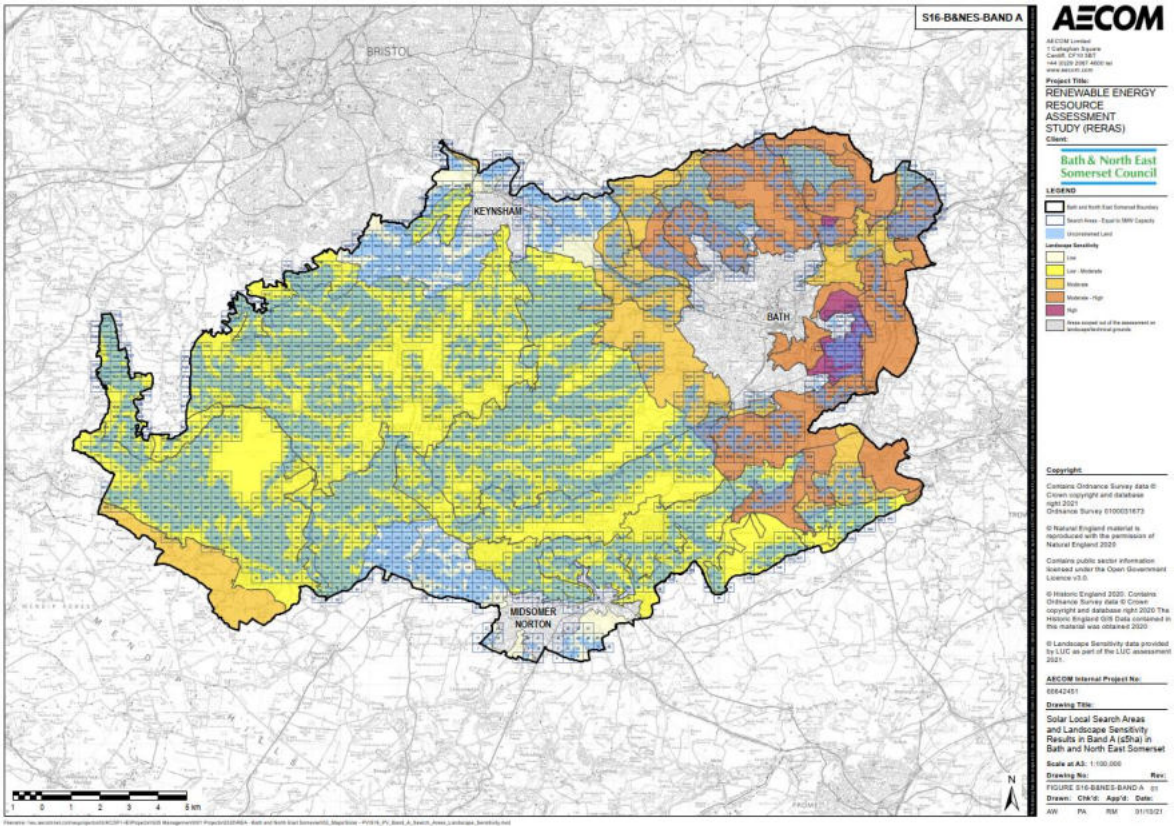


Figure 116: S16-B&NES-Band A: Solar Local Search Areas from S6 Map and Landscape Sensitivity Results in Band A (≤5ha) in Bath and North East Somerset Map Further Constraints to Solar PV Farm Sites

J.6 Further Constraints to Solar PV Sites

Further constraints to solar PV farm development that are not considered within this RERAS include (and this is not meant to be an exhaustive list):

- Practical access to sites required for the development;
- Landowner willingness for development to go ahead;
- National planning policies, which are outside of the Council's control
- Community support; and
- Time to complete planning procedures.

J.7 Potential Opportunities for Future Development

Solar PV has the potential to be a significant source of renewable energy generation in B&NES, with the largest potential of any of the technologies in the study.

Across B&NES, 126.71km^2 of land was identified as suitable for solar PV development, covering a significant amount of the rural land within B&NES.

Moreover, the effects of other constraints such as Agricultural Land Classification (ALC) or Green Belt areas that may impact ground-mounted solar PV development within the SAs were considered by spatial mapping the SAs and the constraints on separate maps.

Additionally, SAs have been further prioritised using the WPD grid connection analysis results (for information purposes only) and the LUC landscape sensitivity assessment. The WPD grid connection analysis can be used to identify the most favourable locations when considering the connection to the grid. The LUC landscape sensitivity assessment can be used to guide the Council to the locations that will have the least environmental impact.

Appendix K : Solar PV Farms Primary Resource Constraints Table

The detailed assumptions and list can be found below:

Constraint	Buffer	Notes
Special Protection Areas (SPA) and foraging buffers	Extent only	
Special Areas of Conservation (SAC)	Extent only	
RAMSAR sites	Extent only	Not present in B&NES
National Nature Reserves (NNR)	Extent only	Not present in B&NES
Sites of Special Scientific Interest (SSSI)	Extent only	
Scheduled Monuments	Extent only	
Listed Buildings,	Extent only	
Registered Parks and Gardens	Extent only	
Registered Battlefields	Extent only	
Ancient Woodlands – a 15 metre buffer has been applied to avoid root damage[270]	Extent only	
Broadleaved Woodland, a 15-meter buffer has been applied to avoid root damage	15m	The buffer has been applied to avoid root damage
Major transport infrastructure.	Extent only	
Minor transport infrastructure.	Extent only	
Existing buildings/settlements	Extent only	
Watercourses – including major, secondary, and minor rivers, canals, and lakes; - a 2-metre buffer has been applied to rivers and streams	2m	
MoD Sites	Extent only	

[270] https://www.gov.uk/guidance/ancient-woodland-and-veteran-trees-protection-surveys-licences

Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind)	Extent only
Active mines/quarries	Extent only
Local Nature Reserves	Extent only

Appendix L : Solar PV Farms Other Constraints Table

It was agreed that these constraints would need to be examined as part of preparing the Local Plan and therefore, have not been constrained further in this assessment.

Constraint	Buffer	Notes
Other woodlands (Other than Broadleaved Woodland and Ancient Woodland)	Extent only	
Area of Outstanding Natural Beauty (AONB)	Extent only	
Natural England's Impact Risk Zones for Solar PV Development (IRZs)	Extent only	
Minerals Safeguarding Areas	Extent only	
Flood Zones	Extent only	
National Trust Inalienable Land	Extent only	
Green Belt[271]	Extent only	
Conservation Areas (Heritage)	Extent only	
World Heritage Sites	Extent only	
Agriculturally Classified Land	Extent Only	Grades 1 to 5, non-agricultural and urban classified land

[271] As stated in the NPPF, paragraph 151: *'When located in the Green Belt, elements of many renewable energy projects will comprise inappropriate development. In such cases developers will need to demonstrate very special circumstances if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources'*

Appendix M : Biomass Energy Resource Methodology

M.1 Introduction

Biomass is a broad term covering all organic material and can be generally defined as material of recent biological origin, derived from plant or animal matter. This could include materials from plants (for example forestry residues, Miscanthus and short rotation coppice) and animals (for example poultry litter)[272]. Biomass is normally considered a carbon neutral fuel, as the carbon dioxide emitted during burning has been (relatively) recently absorbed from the atmosphere by photosynthesis and no fossil fuel is involved. However, there are carbon emissions associated with the sourcing, processing and transportation of the biomass that should be accounted for.

This section mainly focuses on the type of 'dry' biomass that is more commonly combusted either to generate heat or to produce electricity.

The biomass heating is an established and proven technology; however, it is relatively rare when compared to solar panels and wind farms. The technology can be used to provide heat to buildings of all sizes, either through individual boilers or via district heating networks. Biomass can also be incorporated in a fuel electricity plant or CHP plant due to the low carbon emissions associated with its use[273].

Unlike solar and wind renewable energy sources, biomass fuel is not abundant and free. When comparing costs, wood chips and pellets are becoming progressively more competitive compared to increasing gas prices. However, biomass prices are known to fluctuate due to various market forces.

The Biomass in a Low Carbon Economy[274] report by the Climate Change Committee (CCC) states:

> *"Sustainably harvested biomass can play a significant role in meeting long-term climate targets, provided it is prioritised for the most valuable end-uses."*

Combined Heat and Power (CHP)

A combined heat and power engine (CHP) is a highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process. By generating heat and power simultaneously, CHP can potentially produce less carbon emissions compared to the separate means of conventional generation via individual boilers in buildings coupled with electricity from centralised power stations[275]. The technology is well established, and there is a wealth of options for different fuel types, and system design. However, it should be noted that due to changing carbon factors, fossil fuelled systems on their own will no longer achieve carbon savings against a gas boiler counterfactual over the plant lifecycle.

The economic viability of the system is normally achieved due to the difference in cost between grid electricity and the CHP fuel source, known as the 'spark spread', and the general principle that operating the CHP system for longer usually provides greater benefits because savings are typically achieved for each unit of electricity and useful heat which are generated. There can be a substantial greenhouse gas emission benefit due to the difference in emission factors for delivered energy and the improved energy utilisation. Energy export is also possible, depending on the site energy demand profile.

For the engine to operate safely, the heat it generates must be removed; a CHP system requires a suitable thermal energy demand in order to operate properly. The correct sizing of a CHP system is critical because an over-sized system may not be able to run for long hours if the thermal demand is insufficient, often leading to increased maintenance costs and engine failures.

272 https://www.ons.gov.uk/economy/environmentalaccounts/articles/aburningissuebiomassisthebiggestsourceofrenewableenergyconsumedintheuk/2019-08-30#:~:text=Embed%20this%20interactive%20Copy,material%20from%20plants%20or%20animals.
273 https://gov.wales/sites/default/files/publications/2018-10/planning-implications-renewable-energy-development.pdf
274 https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf
275 https://www.gov.uk/guidance/combined-heat-and-power DECC, June 2021

CHP plants are available in various scales, from micro-CHP domestic applications to large industrial applications and CHP plants serving district heating schemes[276].

Building integrated woodchip-fuelled systems are typically fed automatically by screw-drives from fuel hoppers and incorporate gas firing and automatic de-ashing. Systems are designed to burn without emitting smoke and must meet strict air quality emission limits to comply with the Clean Air Act[277].

It should be noted that the current trend is to move away from centralised electricity plants that do not utilise any of the waste heat. Therefore, any new large plant is likely to be required to have a higher thermal efficiency and linked in with some processes to use heat (e.g. steam, waste treatment, etc).

The focus of this section of the study is on establishing the potential biomass resource defined as either:

Energy crops (e.g. miscanthus, short-rotation coppice, etc.); or

Wood fuel resource.

Unlike wind farms, biomass can be utilised for the generation of electricity, heat & domestic hot water (DHW).

There is currently a large-scale biomass installation in Bath and North East Somerset. The installation is a 2.0MW CHP at Queen Charlton Quarry, Keynsham[278].

Advantages of Biomass

Unlike wind farms, biomass can be utilised to generate electricity and heat and domestic hot water (DHW). The use of energy crops, forestry residues and recycled wood waste for energy generation can have a number of advantages

- Provide opportunities for agricultural diversification;
- Encourage increased management of woodland;
- Can have positive effects on biodiversity;
- Remove biodegradable elements from the waste stream;
- Potential CO_2 savings;
- Miscanthus planting increases the soil organic carbon[279].

In relation to biomass, the Biomass in a Low Carbon Economy[280] report by the Climate Change Committee (CCC) states:

"Sustainably harvested biomass can play a significant role in meeting long-term climate targets, provided it is prioritised for the most valuable end-uses."

The report also confirms a significant potential to increase domestic production of sustainable biomass to meet between the equivalent of 5% and 10% of energy demand from UK sources by 2050.

Key Issues for Biomass

Some of the potential issues of using biomass are as follows:

- Guarantee that there will be a sustainable fuel source once a biomass plant is built;
- Assessing the conflict of land use and virgin feedstocks;
- The extensive time taken for plant stocks to grow;
- The carbon emissions released in the processing and transportation of the biomass fuels and the need for re-planting; and

[276] https://gov.wales/sites/default/files/publications/2018-09/generating-your-own-energy-combined-heat-power.pdf
[277] Clean Air Act 1993 - https://www.legislation.gov.uk/ukpga/1993/11/contents
[278] This is from the REGO database
[279] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5340280/
[280] https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf

- The health concerns relating to the emissions of burning biomass.

Health Concerns

If strict air quality requirements are not met, there can be concerns about the impact on human health from the resulting emissions. These emissions include particulate matter (PM) and gases such as carbon monoxide (CO), carbon dioxide (CO_2) and nitrogen oxides (NO_x).

Small PM, less than 10 micrometres in diameter, can lead to severe health problems as they can affect both the heart and the lungs. Biomass burning leads to emissions of PM_{10} and $PM_{2.5}$, putting the size of the PM released below the 10-micrometre diameter. NO_x emissions also impose health issues, including breathing problems, headaches and reduced lung function[281].

Future Direction of Biomass

As biomass in a finite supply, it is crucial to prioritise optimum use of biomass. The Climate Change Committee report 'Biomass in a Low-Carbon Economy'[282] states that harvested biomass should be used to sequester atmospheric carbon whilst simultaneously providing a useful energy service. This means that the use of biomass for heating buildings or using biomass for generating power without carbon capture and storage should be phased out.

These concerns may mean that the use of biomass is only considered in limited circumstances.

M.2 Energy Crops

Mapping

The potential energy crop resource in B&NES was determined by, utilising GIS maps, overlaying potential primary constraints onto the areas identified as having potential for growing such crops. The constraints were identified in consultation with B&NES Council and are provided in detail in this section. In order to avoid competition between land uses (i.e. food crops, livestock grazing, energy crops, etc), Agricultural Land Classification (ALC) land grades 1, 2 and 3 are constrained out and not considered further. Therefore, this study assumed that energy crops could only be grown on agricultural land of Grade 4, which is not constrained by environmental or historical protected areas. Maps have been produced to illustrate each stage of the process of identifying primary constraints and also maps that identify the extent of the area of land with potential opportunities. The flowchart shown in Figure 117 shows the process steps and the outputs at each mapping stage. More detail on the series of steps is provided in this section.

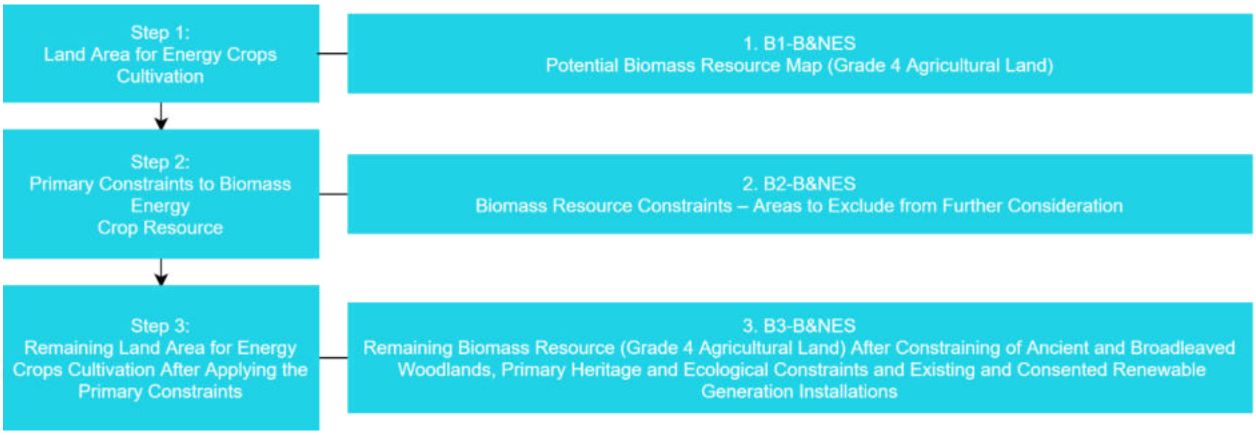


Figure 117: Flowchart of Energy Crop Mapping Process

The titles/references correspond with maps in the accompanying document 'Bath and North East Somerset RERAS – Maps.

[281] https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1708081027_170807_AQEG_Biomass_report.pdf
[282] Climate Change Committee, 'Biomass in a Low-Carbon Economy, 2018; https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf

Step 1: Land Area for Energy Crops Cultivation

Map Reference and Title:

1. B1- B&NES: Potential Biomass Resource Map (Grade 4 Agricultural Land)

In order to avoid competition between land uses (i.e. food crops, livestock grazing, energy crops, etc), Agricultural Land Classification (ALC) land grades of 1, 2 and 3 are constrained out. Therefore, this study assumed that energy crops could only be grown on agricultural land of Grade 4[283,284] which is not constrained by environmental or historical protected areas. These constraints were considered in the following mapping step.

B1 map illustrates the grade 4 agricultural land across Bath and North East Somerset, which amounts to 38.67km^2.

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

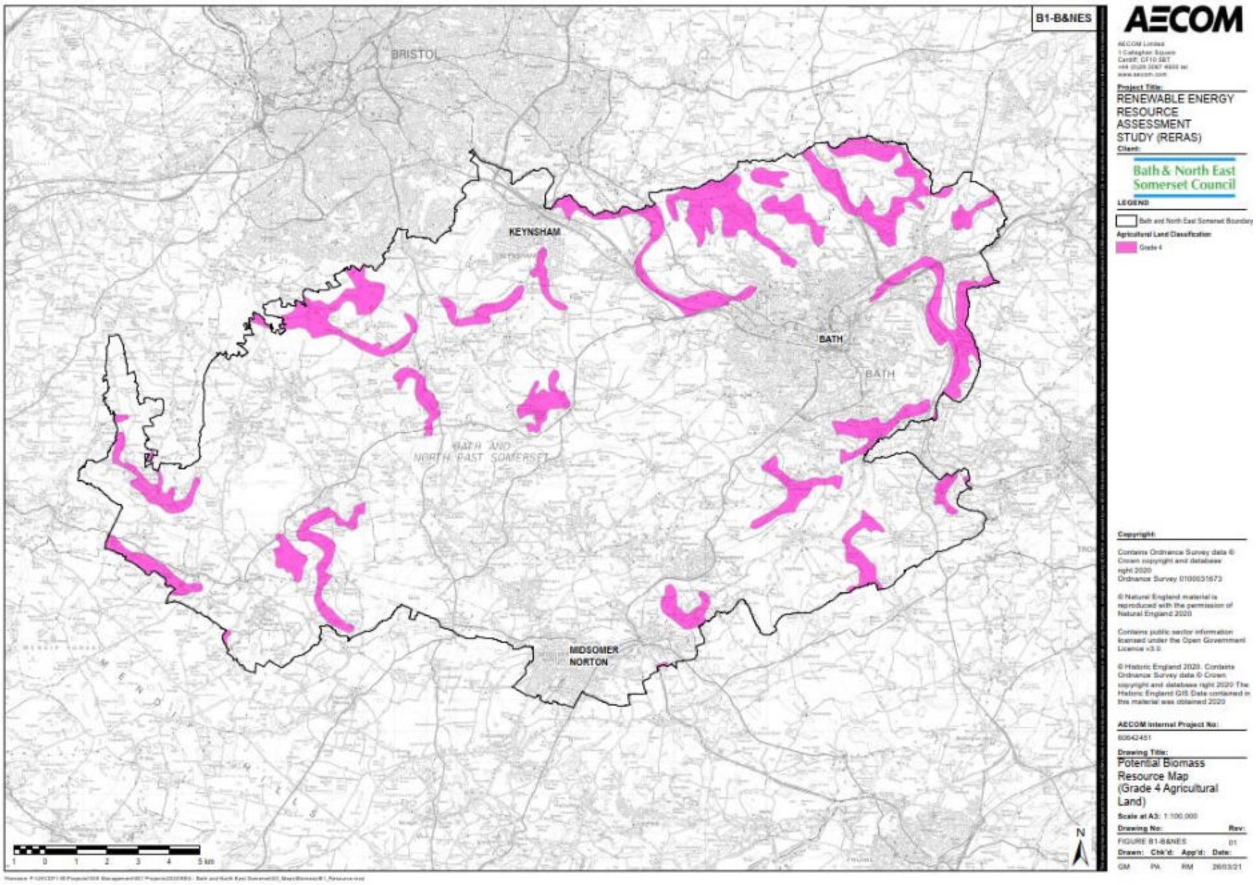


Figure 118: B1-B&NES: Potential Biomass Resource Map (Grade 4 Agricultural Land) Map

[283] Poor quality agricultural land. Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

[284] The Bioeconomy Consultants (2012), Domestic Energy Crops; Potential and Constraints Review, A report for DECC, URN: 12D/081

Step 2: Primary Constraints to Biomass Energy Crops Resource

Map Reference and Title:

1. B2- B&NES: Biomass Resource Constraints – Areas to Exclude from Further Consideration

To further establish the maximum potential biomass energy crops resource across the B&NES area, consideration was given to the primary constraints associated with restrictions to harvesting energy crops. The assessment used the following primary constraints:

- Areas of broadleaved woodland.
- Areas of environmental protection (including ancient woodlands);
- Areas of historical and cultural importance.
- Operational and consented (but not yet constructed) renewables energy development sites (solar PV and wind)

A comprehensive table of the constraints is given in Appendix N and B2 map illustrates these constraints. A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

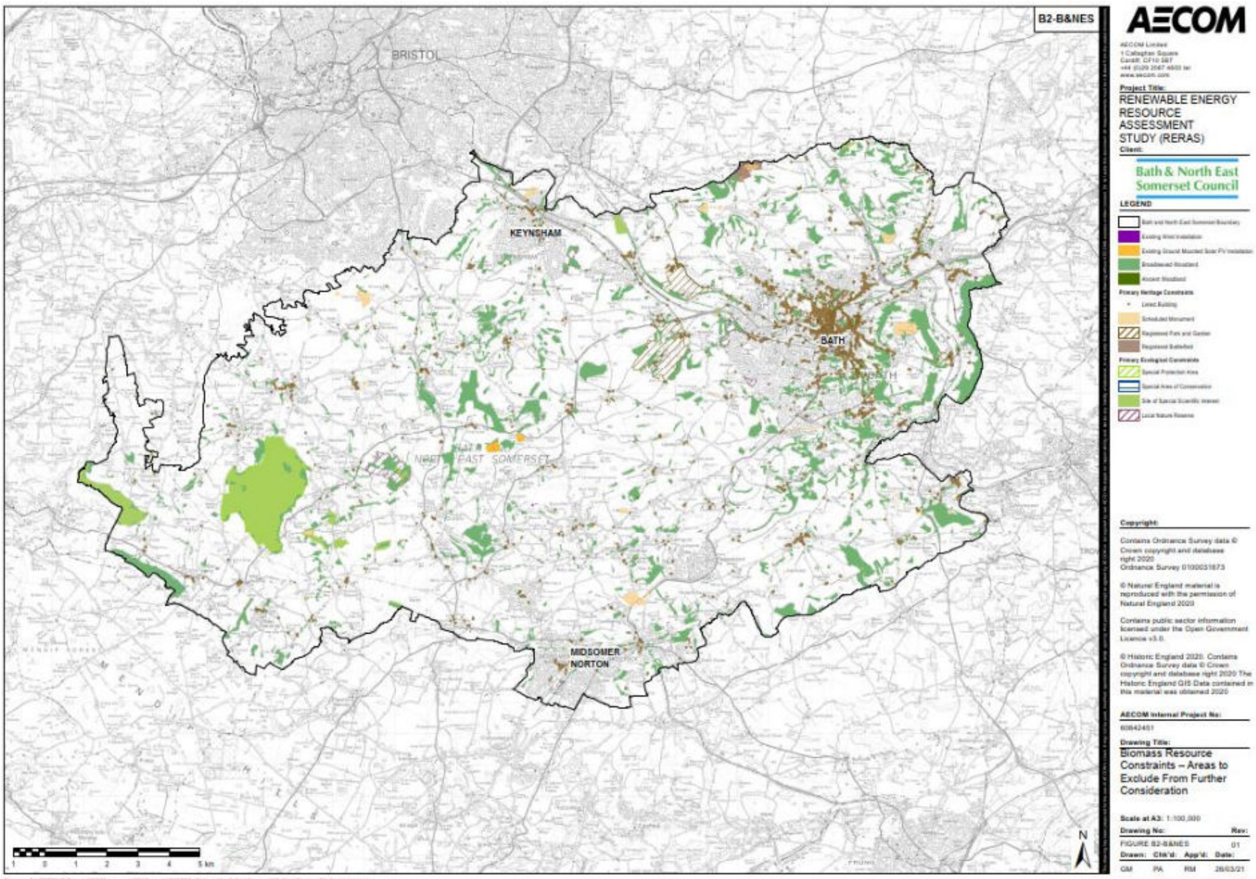


Figure 119: B2-B&NES: Biomass Resource Constraints – Areas to Exclude from Further Consideration Map

Step 3: Remaining Land After Applying the Constraints and Crop Yield

Map Reference and Title:

1. B3- B&NES: Remaining Biomass Resource (Grade 4 Agricultural Land) After Constraining of Ancient and Broadleaved Woodlands, Primary Heritage and Ecological Constraints and Existing and Consented Renewable Generation Installations

B3 map shows the remaining available land for energy crop cultivation after removing the constrained areas in Step 2 of the mapping process.

The theoretical maximum area of land that could be planted with energy crops across Bath and North East Somerset is 29.82km^2.

Policy Recommendation

Policy Reference: BM-PR-1 (Refer to Table 45 in Section 17)

It is recommended that proposals utilising biomass are looked upon favourably where:

a. a whole life carbon benefit can be evidenced; and
b. the development should be located away from urban areas (and preferably in areas off the gas grid).

A higher resolution version of this map is contained in the accompanying document 'Bath and North East Somerset RERAS – Maps'.

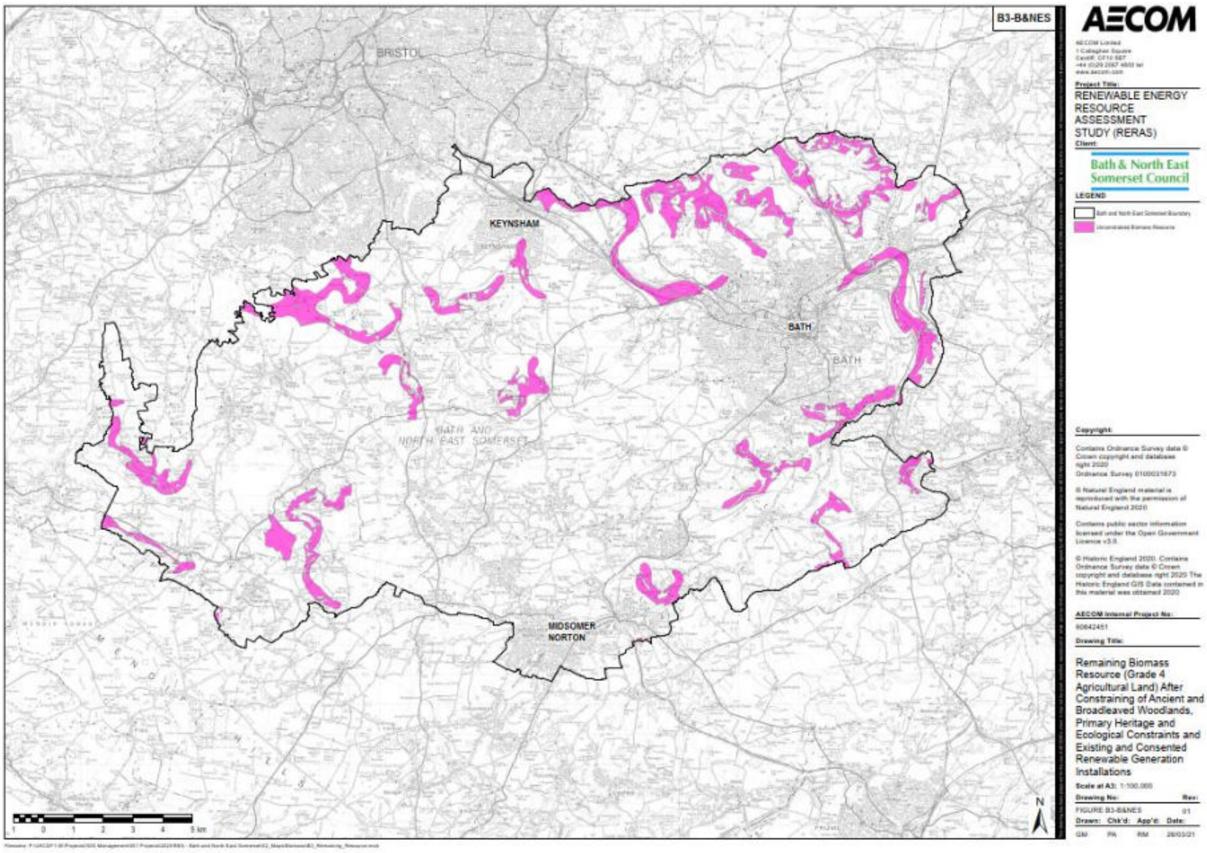


Figure 120: B3-B&NES: Remaining Biomass Resource (Grade 4 Agricultural Land) After Constraining of Ancient and Broadleaved Woodlands, Primary Heritage and Ecological Constraints and Existing and Consented Renewable Generation Installations Map

Competition with other crops, existing areas of energy crops cultivation, livestock grazing, solar PV farms, and unsuitable topography provide limitations on where energy crops can be planted[285].

It was assumed that only 10% of the suitable land area identified for energy crops could actually be planted with energy crops

Therefore, the total usable area of land for energy crops across Bath and North East Somerset is 2.98km^2

Installed Power and Heat Generation Capacity

The Forest Research[286] gives a figure of 7 to 12 oven-dry tonnes/ha/annum yield for short rotation coppice and 12 to14 oven-dry tonnes (odt)/ha/annum yield for miscanthus. However, in reality, the actual yield will vary within a range, depending on a number of factors such as land grade, crop species, soil types, how many years a particular crop has been established at a site, and so on. Therefore, an average figure of 11 odt per hectare for energy crop yield was assumed in potential installed capacity calculations.

The amount of energy that could potentially be produced from biomass will depend on whether the fuel is burnt in boilers that only generate heat or combusted in Combined Heat and Power units (where the heat is used).

For the purposes of this assessment, it was assumed that the energy crop resource is used to fuel a biomass CHP system to produce electricity and heat.[287]

A typical biomass CHP system will require about 6,000odt (oven-dry tonnes) of energy crops for each 1MWe of installed power generation capacity

The biomass CHP system will also simultaneously produce about 2MWt

The total potential installed capacity from energy crops across Bath and North East Somerset is 0.55MWe and 1.09MWt

Table 69 confirms the maximum potential energy crop resource in Bath and North East Somerset.

Table 69: Total Potential Energy Crop Resource in Bath and North East Somerset

Energy Crop Resource in 2030	
Total Available Area (km^2)	29.82
Usable Area (km^2)	2.98
Yield (odt per km^2)	1,100
Yield (odt)	3,280
Required Yield per MWt	6.000
Potential Installed Capacity (MWe)	0.55
Heat to Power Ratio	2:1
Potential Installed Capacity (MWt)	1.09

There is a potential installed capacity across B&NES of 0.55MWe and 1.09MWt, which, for comparison, is equal to supplying energy to 47 primary schools annually.[288].

[285] Renewable Energy in the South West, Revision 2020, Annex 1; https://www.cse.org.uk/downloads/reports-and-publications/planning/renewables/revision2020_annexes.pdf
[286] https://www.forestresearch.gov.uk/tools-and-resources/biomass-energy-resources/fuel/energy-crops/
[287] This is an average figure to cover a range of different technology types, and sizes, with different efficiencies. For example, a smaller scale facility (about 2MWe) using a steam turbine with an efficiency of about 20%, might require up to 8,000 oven dry tonnes/annum. However, a larger facility (5-10MWe), using gasification, with an efficiency of up to 30%, might require about 5,000 oven dry tonnes per annum.
[288] DEC database is used to calculate average annual heat demand in a typical primary school.

M.3 Wood Fuel

Usable Land and Yield

Wood fuel is the fuel that can be harvested from the small round wood stems, tips and branches of felled timber trees and thinning, and poor quality round wood[289].

The Forest Research[290] confirms that 200 oven-dried tonnes (odt) of wood fuel per km^2 of woodland per annum[291] could be available.

The total area of national forest across Bath and North East Somerset is 35.28km^2

200 oven-dried tonnes of wood fuel per km^2 of woodland per annum is available

The total wood fuel yield across Bath and North East Somerset is calculated as 7,056odt per annum.

Installed Power and Heat Generation Capacity

The amount of energy that could potentially be produced from biomass will be dependent on whether the fuel is burnt in boilers that only generate heat or combusted in Combined Heat and Power units.

For the purposes of this assessment, it is assumed that the energy resource from wood fuel is utilised for SH or DHW or both (i.e. a biomass boiler)[292].

A typical biomass boiler will require about 660odt (oven-dry tonnes) of wood fuel for each 1MWt of installed

The total potential installed capacity from wood fuel across Bath and North East Somerset is 10.7MWt

Table 70 below confirms the maximum potential wood fuel biomass resource in Bath and North East Somerset.

Table 70: Total Potential Energy Resource from Wood Fuel in Bath and North East Somerset

Wood Fuel Resource in 2030	
Available Area (km^2)	35.28
Yield (odt per km^2)	200
Yield (odt)	7,056
Required Yield per MWt	660
Potential Installed Capacity (MWt)	10.7

There is a maximum potential installed capacity across B&NES of 10.7MWt, equivalent to supplying energy to 153 typical primary schools annually[245]

It should be noted this is the maximum potential resource (yield) which in reality will be reduced further by other constraints such as local demand, economic viability and other use of the wood. Some of the constraints are discussed in the next section.

[289] National forest is all wood land within the National Forestry Inventory, i.e. All woodland 0.5 hectares and over.
[290] https://www.forestresearch.gov.uk/tools-and-resources/biomass-energy-resources/reference-biomass/facts-figures/potential-yields-of-biofuels-per-ha-pa/
[291] The figures are based on forestry residues, short round wood (SRW), thinnings, etc.
[292] Assuming a boiler efficiency of 80% and a capacity factor of 0.3.
[293] DEC database is used to calculate average annual heat demand in a typical primary school.

M.4 Further Constraints to Biomass Energy Resource

Where areas of land have been indicated as having potential for the growing of energy crops, further detailed studies are required prior to action. Furthermore, market demand is likely to play a vital role in what type of crop is grown, the location and quantity.

Even where there is a local demand for a biomass supply, constraints (not considered within this RERAS) can persist, including the proximity of supply to the plant and practical access to sites required to prepare and deliver fuel.

Further constraints to biomass that are not considered within this RERAS include (but are not necessarily restricted to:

- Landowner willingness;
- National planning policies, which are outside of the Council's control; and
- The time involved in the planning process.

Biomass is most usually utilised in CHP for industrial purposes (typically situated away from residential development) or for heating non-domestic buildings, particularly in non-urban off-gas areas where there are less likely to be Air Quality issues and sufficient room for fuel storage and access for delivery vehicles.

M.5 Potential Opportunities for Future Development

The potential available biomass resource within B&NES amounts to 0.55MWe and 11.79MWt which equates to 41.29GWht annually. This resource can be used to meet part of the heating demand in B&NES via renewables, including for use in individual boilers, via district heating networks or incorporated in a fuel electricity plant or CHP plant. It should be noted that the projected biomass use in the B&NES area (Sections 14) is less than the resource identified above. The amount of generation set out in future sections relates to the 2030 target and aligns with projected demand (including the assumption that all biomass is sourced locally).

Due to the finite supply of biomass, it is essential to ensure that the resource is used to its biggest advantage. A recent report from the Climate Change Committee[294] (CCC) states that biomass should only be used to sequester atmospheric carbon whilst simultaneously providing useful energy; this could include future opportunities for bioenergy with carbon capture and storage, which can provide a useful method for offsetting residual greenhouse gas emissions. Biomass should also only be considered in situations where there are few alternatives.

Alongside concerns relating to the finite supply of biomass resource, there are also health concerns associated with the emissions released as part of the process of burning biomass. The above concerns should not deter B&NES Council from maximising the use of the available biomass resource; however, consideration must be taken to ensure the most appropriate way of exploiting this resource is determined. Because of the flexibility of biomass fuel, it is suggested that a bespoke, independent and thorough investigation is conducted into any proposals received in respect of biomass projects, to ensure environmental benefit is secured.

Given the cost of CCUS projects, it may be that such projects are limited in the B&NES area. However, other projects potentially involving industrial manufacture/process, green hydrogen demonstration and production of biofuels may well be environmentally beneficial, particularly in off-gas grid areas where coal or oil is being displaced and where the biomass source is local and from sustainably managed sources.

In relation to biomass energy generation, potential opportunities for B&NES Council are:

- Investment interest of Energy Services Companies (ESCOs) may be secured through the identification of appropriate sites and heat demand.
- Biomass fed renewable installations can provide significant revenue streams to the Council, including the Renewable Heat Incentive.

[294] Climate Change Committee, 'Biomass in a Low-Carbon Economy, 2018; https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf

Appendix N : Biomass Energy Resource Primary Constraints Table

The detailed data sources and assumptions can be found below:

Constraint	Buffer	Notes
Special Protection Area (SPA)	Extent only	
Special Area of Conservation (SAC)	Extent only	
RAMSAR	Extent only	Not present in B&NES
SSSI	Extent only	
National Nature Reserves	Extent only	Not present in B&NES
Registered Parks and Gardens	Extent only	
Scheduled Monuments	Extent only	
Listed Buildings	Extent only	
BMV agricultural land grades 1, 2, 3a	Extent only	In order to avoid competition between food crops and livestock with fuel crops, land grades of 1, 2 and 3 are constrained out. Therefore, this study has assumed that energy crops can only be potentially grown on agricultural land of Grade 4[295,296]
Local Nature Reserves	Extent only	
Broadleaved Woodland	Extent only	
Ancient Woodland	Extent only	
Registered Battlefields	Extent only	
Operational and consented (but not yet constructed) ground mounted solar PV and wind installation	Extent only	

[295] Poor quality agricultural land. Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.
[296] The Bioeconomy Consultants (2012), Domestic Energy Crops; Potential and Constraints Review, A report for DECC, URN: 12D/081

Appendix O : Energy from Waste Methodology

O.1 Introduction

The Waste Management Plan for England[297] sets out the Government's ambitions to work towards a more sustainable and efficient approach to resource use and waste management. The plan states that all waste management plans must include measures so that, by 2035:

- Re-use and the recycling of municipal waste is increased to a minimum of 65% by weight.
- The amount of municipal waste landfilled is reduced by 10% or less of the total amount of municipal waste generated (by weight).

The West of England Joint Waste Core Strategy[298] (JWCS) sets out the strategic spatial planning policy to provide waste management infrastructure across the planning area. The plan aims to reduce waste taken to landfill minimising waste production, increasing recycling and composting, then recovering further value from any remaining waste.

The JWCS highlights that, although material recovery takes priority, energy recovery has a beneficial role to play in both sustainable waste management and as a low carbon energy source from an Energy from Waste (EfW) plant.

Part of the pathway to achieving these waste aims, includes using Energy Recovery Facilities (ERFs) for non-recyclable waste. The West of England Partnership (South Gloucestershire, North Somerset, Bath and North East Somerset and Bristol City) uses two ERFs to incinerate waste and produce energy for the National Grid.

This section determines the amount of potential electricity and heat generation available from the following waste streams in 2030:

Municipal Solid Waste (MSW)
- The 2030 MSW figure was determined by the council's waste prediction model and aligned with the 70% recycling rate target.
- It was assumed that the MSW would be used as fuel in a Combined Heat and Power (CHP) facility to produce energy and heat.

Commercial and Industrial Waste (C&I)
- The 2030 C&I waste figure was determined using the 2019 figure from the Waste Data Interrogator (WDI), the "Sustainability Turn" scenario of the DEFRA "Scenario-Building for Future Waste Policy" report and aligned with the 70% recycling rate target.
- It was assumed that the C&I would be utilised as a fuel in a Combined Heat and Power (CHP) facility to produce energy and heat.

Food Waste
- The 2030 food waste figure was determined by using the 2019 DEFRA value, assuming that the waste breakdown will remain constant and will increase at the same rate as the MSW between 2019 and 2030.
- Food waste can be anaerobically digested to produce a suitable gas for combustion and, if the plant is suitably enabled, generate both electricity and heat.

Agricultural Waste - Animal Manure
- The 2030 animal manure figure was determined using the assumption that the farming mix will not change significantly in B&NES, and therefore the latest livestock statistics can be used.
- Animal manure can be treated by anaerobic digestion and utilised in a CHP plant to generate both electricity and heat.

[297] Waste Management Plan for England, DEFRA, 2021; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955897/waste-management-plan-for-england-2021.pdf
[298] West of England Joint Waste Core Strategy, WEP, March 2011; https://www.westofengland.org/waste-planning/adopted-joint-waste-core-strategy

Agricultural Waste - Poultry Litter	• The 2030 poultry litter figure was determined using the assumption that the farming mix will not change significantly in B&NES, and therefore, the latest statistics for the number of poultry can be used. • A bespoke CHP facility would be required to facilitate the use of the poultry litter.
Sewage Sludge	• The 2030 sewage sludge figure was determined by the tonnes of sewage produced per person per year and the predicted 2030 population of B&NES • A CHP enabled anaerobic digestion plant would be suitable for utilising sewage sludge to produce both electricity and heat.

Anaerobic Digestion

Anaerobic Digestion (AD) can be defined as:

> *"a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is used for industrial or domestic purposes to manage waste and/or to release energy. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion[251]"*

The AD process produces a gas (biogas) with a high methane content. This methane can be captured and burned to produce heat and/or electricity and utilised as a transport fuel. The material that is left after AD occurs is called "digestate", a nitrogen-rich mixture that can be used as fertiliser for crops. AD plants utilise heat for their own process (parasitic load); therefore, some of the biogas can be used on-site to maintain the temperature of the digester.

Sewage sludge, farm slurry, and some Municipal Solid Waste (MSW) elements could be used as feedstock for an AD plant to generate gas and/ heat and electricity if CHP enabled.

AD can be incorporated in a farm-based integrated waste management system, but larger-scale centralised anaerobic digesters also exist, which use feedstocks imported from different sources. The larger schemes usually have a better return on investment and shorter payback times which justifies the initial capital cost required for the system. AD systems often require bulk inputs to be economically viable, but this can be challenging when sourcing material from dispersed (rural) locations. Once built, ADs are often linked to on-farm processes, energy supply, and the grid. The figure below shows an example of an AD plant configured to produce energy and bio-fertiliser from biowaste feedstock.

[299] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284612/pb14130-energy-waste-201402.pdf

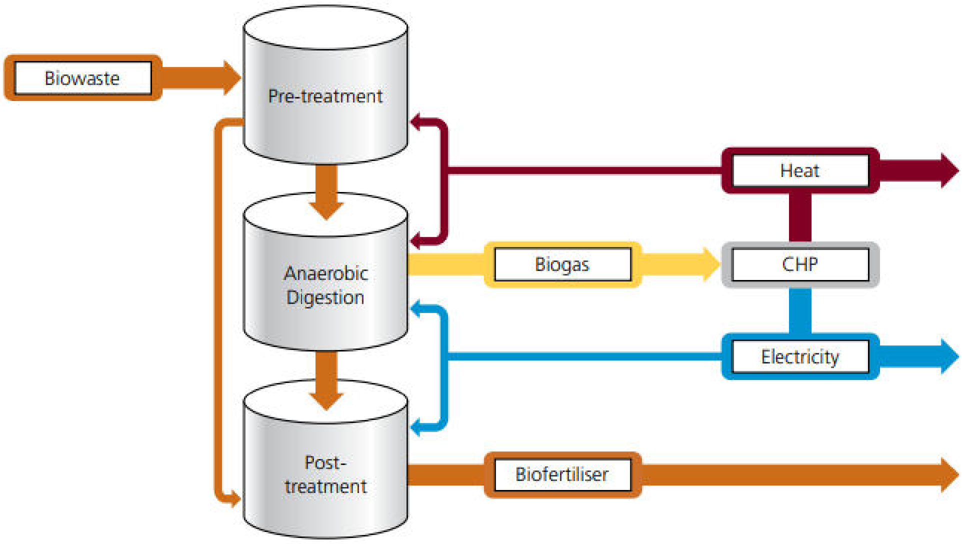


Figure 121: Example of an Anaerobic Digestion (AD) System from Feedstock to Final Use[300]

Incineration (Energy from Waste)

Incineration can be defined as controlled thermal treatment of waste by burning. Energy recovered from waste through this method can be used in the following ways:

1. Generation of Power (electricity),
2. Generation of Heat,
3. Generation of Heat and Power (this is referred to as CHP)[301].

However, EfW is almost always from a bespoke plant that produces both power and heat. The system could generate heat from sources including waste wood, municipal waste and industrial and commercial waste. The selection of energy generation option is dictated by end-user requirements and their utilisation of the heat and/or power.

Option three above includes a CHP for simultaneous generation of heat and power. The power can be consumed on-site or exported and sold to the national grid. Local heat demand and a dedicated heat network is required for the generated heat unless all the available heat can be used in the generating facility. For more information on CHP, see Section 8.1.1.

If waste (used as the fuel) includes materials that are not capable of degradation by plants and animals, the fraction of heat output generated due to incineration of these wastes is considered low carbon. It should be noted that this fraction of waste could include plastics, which may impact the low carbon status of the heat generated.

Any new centralised electricity plant is likely to be required to have a higher thermal efficiency and linked in with some process to use heat (e.g. steam, waste treatment, etc.).

There are issues linked with incineration, including:

- Greater focus on circularity will mean a diminishing resource;
- EfW plants must comply with strict emissions requirements;

[300] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69400/anaerobic-digestion-strat-action-plan.pdf
[301] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf

Landfill Gas

Landfill Gas is the methane-rich gas released from biodegradable waste as it decomposes. Landfill gas can be captured through vertical pipes drilled into a capped site.

Landfill Gas can be to generate electricity that can be exported to the electricity grid.

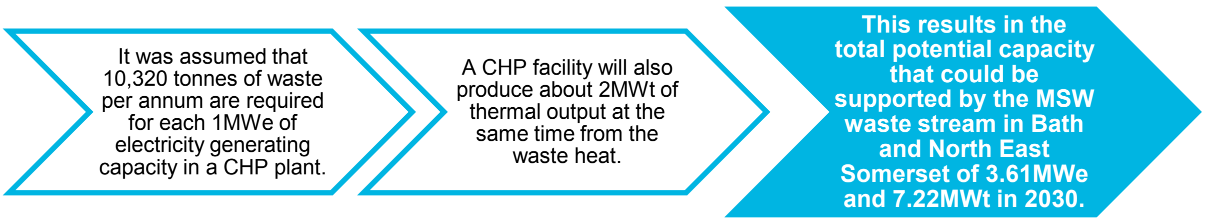
O.2 Municipal Solid Waste

By utilising current MSW data and the B&NES waste prediction model to understand trends, levels of MSW in B&NES were projected to 2030. This includes an increase of about 15.1% from total MSW collected in 2019/20

The B&NES Resources, Waste and Litter Strategy 2020 to 2030 (consultation version[302]) confirms a 68% recycling rate and zero waste to landfill by 2030. Therefore, to avoid conflict with existing recycling targets, it was assumed that only 32% of this waste stream would be available for energy recovery.

Thus, the total predicted MSW waste that could be used for energy recovery across B&NES area in 2030 is 37,240 tonnes.

Energy from Waste facilities that generate electricity typically have gross efficiencies of about 27%[303]. However, England's waste and resource strategy confirm the Government will seek greater efficiency of EfW plants by encouraging the use of the heat the plants produce. Many plants are already CHP-enabled and can utilise the generated heat if they can find a customer for it. Therefore, it was assumed that MSW waste would be burnt in facilities that produce Combined Heat and Power with higher efficiency levels (typically of around 40%) where the heat is usefully employed[304].



However, only the Biodegradable (BD) fraction of energy generation from waste would be classified as renewable energy[305].

The current Renewables Obligation guidance[306] includes a minimum level of the biodegradable fraction of MSW of 50%. However, the UK Government consultation on the re-banding of the Renewables Obligation suggested that high rates of recycling could result in residual biomass energy content in the range 30–38%[307, 308].

[302] https://beta.bathnes.gov.uk/waste-strategy-consultation
[303] Our Waste, Our Resources: A Strategy for England, HM Government, 2018
[304] This assumes an electricity generation efficiency of 25%, based on a net calorific value of the fuel of 11MJ/kg, and a capacity factor of 0.9. This assumed calorific value of the fuel is a rough average as the actual value can vary widely depending on the composition of the waste, the extent to which recyclables and wet biodegradable waste has been removed or source separated, and whether the fuel has already been processed into RDF pellets.
[305] Directive 2009/28/EC of the European Parliament and of the Council; on the promotion of the use of energy from renewable sources and amending the subsequently repealing Directives 2001/77/EC and 2003/30/EC, 2009
[306] Renewables Obligation: Fuel Measurement and Sampling, OFGEM, April 2020
[307] See Annex E: Analysis on Deeming the Fossil Fuel Fraction of Waste of the Government Response to the Statutory Consultation on the Renewables Obligation Order 2009, December
[308] Reform of the Renewables Obligation, DECC, December 2008

It was assumed that 35% of the power and energy output of any waste facility count as renewable

The renewable electricity and heat capacity across Bath and North East Somerset for MSW waste would be 1.26MWe and 2.53MWt for 2030

Table 71: Municipal Solid Waste Resource for the B&NES Area in 2030

MSW Resource in 2030	
Total waste (tonnes)	116,376
Total residual waste (tonnes)	37,240
Required wet tonnes per 1MWe	10,320
Potential installed capacity (MWe)	3.61
Total renewable element	35%
Potential installed capacity (MWe)	1.26
Heat to power ratio	2:1
Potential installed capacity (MWt)	2.53

Currently, MSW is exported to EfW and landfill sites outside B&NES. It is understood that the existing arrangement will be in place in 2030 and therefore it is assumed no energy generation using this resource in 2030.

O.3 Commercial and Industrial Waste

The potential for generating energy using C&I waste streams is challenging to assess as there is no central data holding, and this would need to be explored through regional intelligence on producers and managers of C&I waste. The collection of C&I waste is outside the remit of B&NES, although the Council collects a small amount of waste from commercial buildings such as schools.

The Environment Agency's Waste Data Interrogator (WDI) was used to calculate the total C&I waste arising across B&NES[309]. The dataset is designed primarily to provide data for waste management professionals. It contains details of all waste received and removed from permitted waste facilities in England, including hazardous waste, but not from exempted facilities.

The amount MSW collected by the Council was subtracted from the total collected waste figure reported in WDI for B&NES to calculate the arising C&I waste within the planning area. The figure amounts to 216,802 tonnes of waste in 2019. It should be noted this figure includes waste streams such as concrete, bricks, tiles and ceramics from construction and demolition (C&D) waste which will not be suitable for incineration. Therefore, the inert C&D waste proportion was subtracted further from the C&I waste arising figure. Inert waste is waste that does not undergo any significant physical, chemical or biological transformations[310].

The arising C&I waste suitable for incineration was 55,145 tonnes in 2019

In order to calculate the predicted C&I waste across B&NES in 2030, targets from the “Sustainability Turn” scenario of the “Scenario-Building for Future Waste Policy” report were utilised[311]. The research was commissioned and funded by Defra, and the “Sustainability Turn” assumes an overall sustainability turn by society, industry, and politics whilst focusing on the principle of avoiding waste. The scenario predicts a 7% reduction in C&I Waste Arisings between 2020 and 2030.

309 https://data.gov.uk/dataset/d409b2ba-796c-4436-82c7-eb1831a9ef25/2019-waste-data-interrogator
310 https://www.gov.uk/guidance/landfill-operators-environmental-permits/landfills-for-inert-waste
311 http://sciencesearch.defra.gov.uk/Document.aspx?Document=WR1508_FutureWasteScen_FinalReport_FORPUBLICATION.pdf

The arising C&I waste suitable for incineration was 55,145 tonnes in 2019.

The "Sustainability Turn" predicts a 7% reduction in C&I Waste arisings between 2020 and 2030.

The arising C&I waste (excluding inert construction and demolition waste) in Bath and North East Somerset in 2030 is 51,523 tonnes

However, to avoid conflict with existing recycling targets, it was assumed that only 32% of this waste stream would be available for energy recovery.

The B&NES Resource, Waste and Litter Strategy confirms a 68% recycling rate and zero waste to landfill by 2030

The total predicted C&I waste for energy recovery across Bath and North East Somerset is 15,457 tonnes in 2030

It was assumed that C&I waste will be burnt in facilities that produce CHP with higher efficiency levels (typically of around 40%) where the heat is usefully employed, as per England's Waste and Resource Strategy[312].

It was assumed that 10,320 tonnes of waste per annum are required for each 1MWe of electricity generating capacity in a CHP plant.

A CHP facility will also produce about 2MWt of thermal output at the same time from the waste heat.

This results in the total potential capacity that could be supported by the C&I waste stream in Bath and North East Somerset is 1.50MWe and 3.00MWt in 2030

However, only the Biodegradable (BD) fraction of energy generation from waste can be considered as renewable energy[313].

The current Renewables Obligation guidance[314] includes a minimum level of the biodegradable fraction of 50%. However, the UK Government consultation on the Renewables Obligation's re-banding suggested that high rates of recycling could result in residual biomass energy content in the range 30–38%[315] [316].

It was assumed that 35% of the power and energy output of any waste facility count as renewable

The renewable electricity and heat capacity across Bath and North East Somerset for C&I waste would be 0.52MWe and 1.05MWt in 2030

Table 72: Commercial and Industrial waste resource in B&NES in 2030

Commercial and Industrial Waste Resource in 2030	
Total waste (tonnes)	51,523

312 This assumes an electricity generation efficiency of 25%, based on a net calorific value of the fuel of 11MJ/kg, and a capacity factor of 0.9. This assumed calorific value of the fuel is a rough average as the actual value can vary widely depending on the composition of the waste, the extent to which recyclables and wet biodegradable waste has been removed or source separated, and whether the fuel has already been processed into RDF pellets.
313 Directive 2009/28/EC of the European Parliament and of the Council; on the promotion of the use of energy from renewable sources and amending the subsequently repealing Directives 2001/77/EC and 2003/30/EC, 2009
314 Renewables Obligation: Fuel Measurement and Sampling, OFGEM, April 2020
315 Reform of the Renewables Obligation, DECC, December 2008
316 See Annex E: Analysis on Deeming the Fossil Fuel Fraction of Waste of the Government Response to the Statutory Consultation on the Renewables Obligation Order 2009, December

Commercial and Industrial Waste Resource in 2030

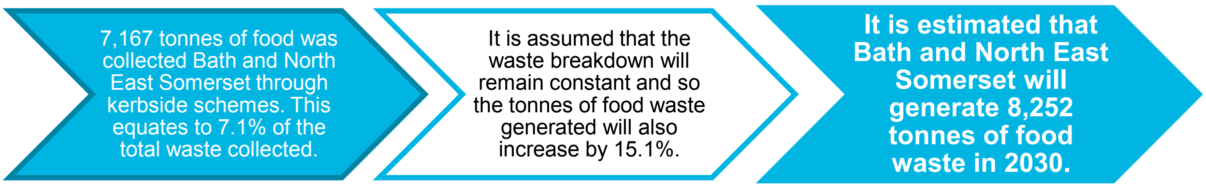
Total residual waste (tonnes)	15,457
Required wet tonnes per 1MWe	10,320
Potential installed capacity (MWe)	1.50
Total renewable element	35%
Potential installed capacity (MWe)	0.52
Heat to power ratio	2:1
Potential installed capacity (MWt)	1.05

Based on the WDI data, the bulk of residual waste is currently is exported to facilities outside B&NES. It is unknown if the existing arrangement will be in place until 2030. For the purposes of this study, no energy generation using this resource is assumed for 2030.

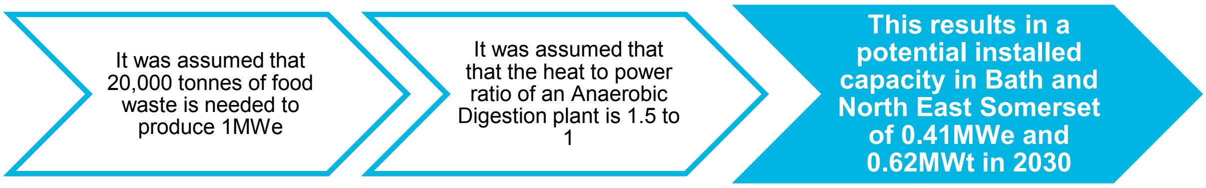
O.4 Food Waste

The data for the tonnes of food waste collected in B&NES in 2019/20 was collected from DEFRA data.

As the population of B&NES rises, from 193,282, in 2019, to a projected 210,848[317], in 2030, it is expected that the amount of household waste produced will also increase. As it was shown in Section O.2, predicted MSW across B&NES in 2030 is assumed to be 116,376 tonnes that includes an increase of about 15.1% from total MSW collected in 2019/20.



Food waste can be anaerobically digested to produce a gas that is suitable for combustion and, if the plant is suitably enabled, generate both electric and heat[318,319].



The figures are shown below in Table 73.

Table 73: Potential Installed Capacity from Total Available Food Waste Resource in the B&NES in 2030

Resource from Food Waste in 2030

MSW food waste (tonnes)	8,252
Required tonnes per MWe	20,000
Potential installed capacity (MWe)	0.41
Heat to Power Ratio	1.5:1
Potential installed capacity (MWt)	0.62

[317] Office for National Statistics – Population Projections for Local Authorities: Table 2 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2
[318] This assumes the following: : 1 tonne of wet food waste produces 140m^3 of biogas (Dealing with Food Waste in the UK, Eunomia, March 2007 - Table 10 - https://www.yumpu.com/en/document/read/24424418/dealing-with-food-waste-in-the-uk-march-2007-wrap); 1m^3 of biogas has an energy content of 5.8kWh; an electrical generating efficiency of 30% and a capacity factor of 0.9
[319] Combine Heat and Power, Technologies A detailed guide for CHP developers, BEIS, February 2021

Decisions on how to deal with the food waste produced within B&NES needs to reflect a combination of factors, including marketing dynamics, capacity and economies of scale. Currently, food waste from B&NES is treated outside of the B&NES area. Therefore, no energy generation from food waste is assumed in B&NES for 2030.

O.5 Agricultural Waste

Agricultural emissions accounted for 10% of all greenhouse gas emissions in 2017[320]. These emissions come from the following sources:

- Livestock rearing
- Energy use from the farm vehicles and buildings
- Waste produced through the farming process
- Disturbance of soils

Improved farming practices and livestock management could see a reduction in the agricultural emissions. There is a push for improved manure management, including an uptake in the use of anaerobic digestion to treat cattle, pig and poultry waste[321].

The following analysis is undertaken in the context of free-range farming in which the cattle and pigs are only kept undercover in the winter months to shield them from the weather conditions.

Animal Manure

It was assumed that the farming mix will not change significantly in B&NES over the time period to 2030 and therefore to potential for energy generated from agricultural waste will be the same as the current scenario.

Utilising the latest statistics (2016), the total numbers of cattle and pigs across B&NES was determined[322,323].

Utilising the latest statistics (2016), the total numbers of cattle and pigs across Bath and North East Somerset is 21,279 and 5,352 respectively

The total annual tonnage of available manure across Bath and North East Somerset is 130,885 tonnes.

It is assumed that that slurry is only collected for 6 months of the year

It is assumed that each cattle produces 1 tonne of slurry a month and each pig produces 0.1 tonnes per month.

In practice, it is unlikely to be possible or practical to collect all of the potential resource. This is because many farms will not use a slurry system but will collect the excreta as solid manure mixed with bedding which is then spread on the fields.

Furthermore, it will not be practical to collect the slurry from some of the farms, because they may be too small or too dispersed for this to be economically viable[324].

[320] Agricultural Statistics and Climate Change, DEFRA, September 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835762/agriclimate-9edition-02oct19.pdf
[321] Land Use: Reducing Emissions and Preparing for Climate Change, CCC, November 2018; https://www.theccc.org.uk/wp-content/uploads/2018/11/Land-use-Reducing-emissions-and-preparing-for-climate-change-CCC-2018.pdf
[322] Structure of the agricultural industry in England and the UK at June - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672730/structure-june-eng-localauthority-09jan18.xls
[323] Typical Average figure – DEFRA - http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=1QQUSGMWSS.0LHA1QS0A3E5TV, Accessed 17th February 2021
[324] Renewable and Low-carbon Energy Capacity Methodology – DECC - 2010

The total available resource across Bath and North East Somerset of animal manure is 104,708 tonnes/ annum

This study assumes that 80% of the animal waste resource is practically viable

An Anaerobic Digestion plant would be suitable to treat animal slurry and be CHP enabled to generate both electricity and heat.[325,326,327]

The total potential installed capacity from animal manure across Bath and North East Somerset is 0.465MWe and 0.698MWt

It is assumed that the heat to power ratio of an Anaerobic Digestion plant is 1.5 to 1

It is assumed 37,000 tonnes of feedstock is required to generate 1 MWe, however, this represents a high calorific value feedstock (food waste for example) and so an amended value of 225,000 tonnes was used

Table 74: Potential Installed Capacity from Total Available Animal Slurry Resource in B&NES in 2030

Animal Slurry Resource in 2030	
Total livestock (Cattle & Pigs)	26,631
Total slurry (tonnes)	130,885
Usable slurry (tonnes)	104,708
Required wet tonnes per MWe	225,000
Potential installed capacity (MWe)	0.465
Heat to power ratio	1.5:1
Potential installed capacity (MWt*)*	**0.698**

There is currently 2.45MW of installed capacity in B&NES for animal slurry. Therefore, it is assumed that all economic opportunities have already been exploited and therefore there is no additional potential for energy generation from animal slurry in 2030

Poultry Litter

It is assumed that the farming mix in B&NES will not change over the time period to 2030 and that the potential energy generated from agricultural waste will be the same as the current scenario.

Utilising the latest statistics (2016), the total number of poultry recorded across Bath and North East Somerset was calculated as 331,876

DEFRA provides information on the amount of excreta produced by different types of poultry[328, 329, 330].

DEFRA data suggests a figure of 42 tonnes of litter per year per 1,000 birds

For mass-producing farms, it was assumed that 75% of the litter produced can be utilised for conversion into energy.

The total annual tonnage of available poultry litter across Bath and North East Somerset is 10,454 tonnes.

325 Renewable and Low-carbon Energy Capacity Methodology, DECC , January 2010; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf
326 East of England Renewable and Low Carbon Energy Capacity Study, AECOM, May 2011
327 Combine Heat and Power, Technologies A detailed guide for CHP developers, BEIS, February 2021
328 See the DEFRA leaflets on guidance to famers in Nitrate Vulnerable Zones, Leaflet 3, Table 3
329 Based on the figure for laying hens, which is 3.5 tonnes per month
330 Renewable and Low-carbon Energy Capacity Methodology, DECC, January 2010 *See above link*

A bespoke CHP plant would need to be used to facilitate the poultry litter resource.

It can be assumed that 11,000 tonnes of litter per annum are needed to produce 1MWe

It can be assumed that the heat to power ratio of a bespoke plant with CHP is 2 to 1

The total potential installed capacity from poultry litter across Bath and North East Somerset is 0.95MWe and 1.90MWt

Table 75: Potential Installed Capacity from Poultry Litter in the B&NES in 2030

Poultry Litter Resource in 2030	
Total poultry	331,876
Accessible Poultry (75%)	248,907
Total litter (tonnes)	10,454
Required tonnes of litter per MWe	11,000
Potential installed capacity (MWe)	0.950
Heat to power ratio	2 :1
Potential installed capacity (MWt)	1.901

In practice, as the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant.

Given the total combined resource from animal slurry and poultry litter is 1.42MWe and 2.60MWt, the resource could be combined with animal slurry to support an anaerobic digestion facility of 1.42MWe, especially in partnership with neighbouring authorities

Given the total combined resource from animal slurry and poultry litter is 1.42MWe and 2.60MWt, the resource could be combined with animal slurry to support an anaerobic digestion facility

O.6 Sewage Sludge

The predicted population of B&NES in 2030, based on the Office for National Statistics population projections for England[331], is 210,484.

Assuming that the average amount of sewage produced per person per year is 0.03tonnes (t), the total sewage sludge across B&NES in 2030 equates to circa 6,325 tonnes

The predicted population of Bath and North East Somerset in 2030, based on the Office for National Statistics population projections for England, is 210,484

It is assumed that the average amount of sewage produced per person per year is 0.03tonnes (t),

The total sewage sludge across Bath and North East Somerset in 2030 equates to circa 6,325 tonnes.

An Anaerobic Digestion plant would be suitable for utilising sewage sludge to produce both electric and heat[332,333].

[331] Office for National Statistics – Population Projections for Local Authorities: Table 2 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2

[332] The biogas production figure was provided by AECOM engineers who are specialists in designing AD plants for the water industry

[333] Combine Heat and Power, Technologies A detailed guide for CHP developers, BEIS, February 2021

The total potential installed capacity from sewage sludge across Bath and North East Somerset is 0.38MWe and 0.57MWt

It is assumed that the heat to power ratio of an Anaerobic Digestion plant is 1.5 to 1

It was assumed that 13,000t of dry solids are needed to produce 1MWe

Table 76: Potential Installed Capacity from Total Available Sewage Sludge Resource in B&NES in 2030

Sewage Sludge	2030
B&NES population	210,848
Sewage per person (tonnes)	0.03
Total sewage (tonnes)	6,325
Required tonnes of sewage per MWe	13,000
Potential installed capacity (MWe) less 0.11MWe already generated	0.377
Heat to Power Ratio	1.5:1
Potential installed capacity (MWt)	0.565

Given that there is existing installed capacity of 0.63MWe it is concluded that this resource is already utilised with no further resource for further generation.

O.7 Waste Summary

A summary of the potential energy generation from utilising the waste resource in B&NES is provided below. There are a number of key issues which would impact on whether the resource can be exploited as follows:

- Viability of any investment in plant;
- Existing arrangements and contracts;
- Origin and price/gate fees of the resource.

High level consideration is given to the likelihood of the resource being exploited.

Although there is available MSW resource in the area, Waste is taken to facilities in Ashton Gate, Bristol where it is segregated into constituent materials and sent for onward processing. Waste unsuitable for EfW is landfilled in sites outside B&NES.

Given that there is already recovery of landfill gas as well as AD plant utilising sewage and other resources, it is assumed that all economic opportunities have already been exploited and there is no further potential for generation from these resources in B&NES in 2030.

When considering all of the above, the final potential for renewable energy from the waste resource is shown in Table 77 below.

Table 77: Summary of Energy from Waste

	Prior to Consideration of Likelihood of Utilisation for RE Generation			Reason for Adjustment / Change of Technology	Post Consideration of Likelihood of Utilisation for RE Generation 2030		
Resource	**Technology**	**2030**			**Technology**		
		MWe	**MWt**			**MWe**	**MWt**
C&I Waste	EfW with CHP	0.52	1.05	Currently the residual waste that is sent for landfill or incineration is exported to facilities outside B&NES. Therefore, counted as existing generation elsewhere.	None	-	-
MSW	EfW with CHP	1.26	2.53	Currently, the waste is exported to EfW and landfill sites outside of B&NES. It has been assumed that the existing arrangement are likely to be in place until the end of 2030 therefore the resource is counted as generation elsewhere.	None	-	-
Food Waste	AD with CHP	0.41	0.62	Food waste from B&NES is currently exported out of the council area. Assuming the arrangement stays in place until 2030, the resource is counted as existing generation elsewhere	None	-	-
Animal Slurry	AD with CHP	0.47	0.69 8	RHI database confirms 2.45MW of installed capacity. It is assumed that all economic opportunities have already been exploited	None		
Poultry Litter	Bespoke plant with CHP	0.95	1.90	Not likely to be enough resource for bespoke plant. A bespoke CHP plant would need to be used to facilitate the poultry litter resource. However, in practice, as the potential capacity is less than 10MWe, it is unlikely that this would be enough to support a dedicated poultry litter power plant.	None	-	-
Sewage Sludge	AD with CHP	0.38	0.57	There is a 0.63MWe installed capacity, it is assumed that all economic opportunities have already been exploited	None		
Landfill Gas	Landfill gas recovery engine			There is a 1.60MWe installed capacity, it is assumed that all economic opportunities have already been exploited.	None		
Potential installed capacity		**3.99**	**8.69**			0	0

Appendix P : Future Energy Scenarios

The National Grid Electricity Systems Operator's (ESO) produces Future Energy Scenarios (FES) annually[334], containing in-depth analysis of different future scenarios in the energy system within the UK (see Section 14). The 2020 FES have been updated to reflect the UK Governments net zero by 2050 targets. It should be noted that the 'Steady Progression' scenario would not meet the 2050 net zero target. The four scenarios are described below:

1. Steady Progression
    - Low levels of decarbonisation and societal change.
    - Not compliant with the 2050 net zero emissions target.
2. System Transformation
    - High level of decarbonisation with lower societal change. Larger, more centralised solutions are developed. This scenario has the highest levels of hydrogen deployment.
3. Consumer Transformation
    - High levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and more decentralised solutions are developed. This scenario has significant electrification of domestic heat.
4. Leading the Way
    - Very high levels of decarbonisation and societal change. Consumers adopt new technologies rapidly, and a mix of solutions are developed. This scenario aims for the "fastest credible" decarbonisation pathway

The UK FES total annual energy (end consumer) and the consumption for residential, industrial and commercial and road transport sectors for each scenario can be seen below in Figure 122 to Figure 125. The figures outline the projected consumption by fuel type within each of the 4 FES scenarios at the UK wide level.

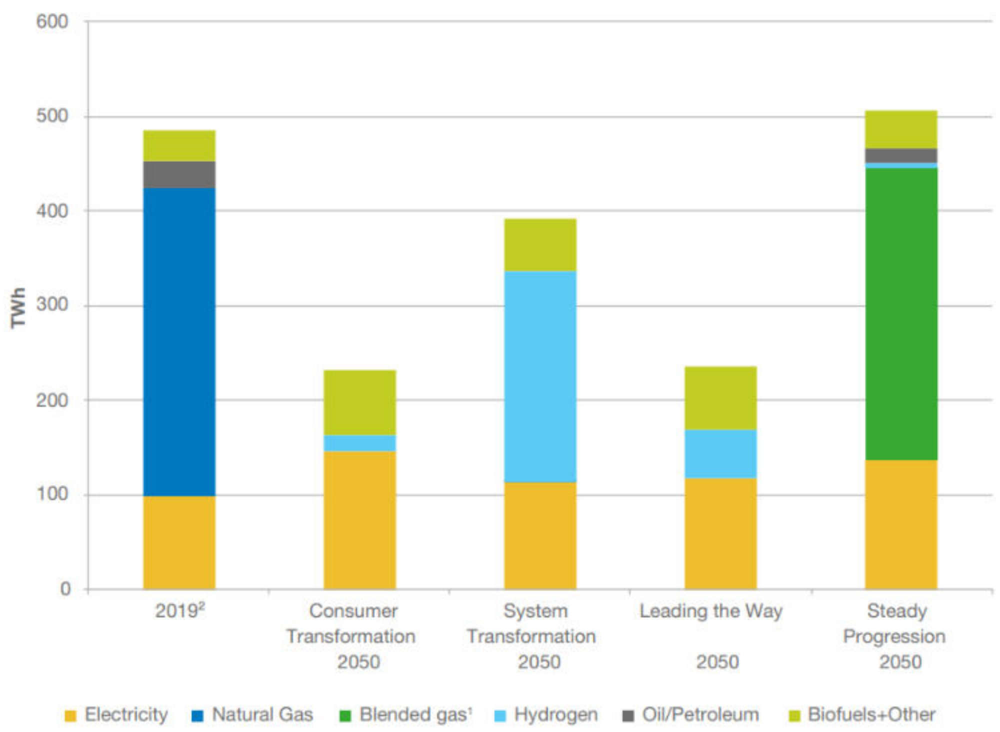


Figure 122: UK 2019 and Projected Annual Residential Energy Consumption (for Heat and Appliances) in the UK[335]

[334] Future Energy Scenarios, National Grid ESO, July 2020; https://www.nationalgrideso.com/document/173821/download
[335] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download

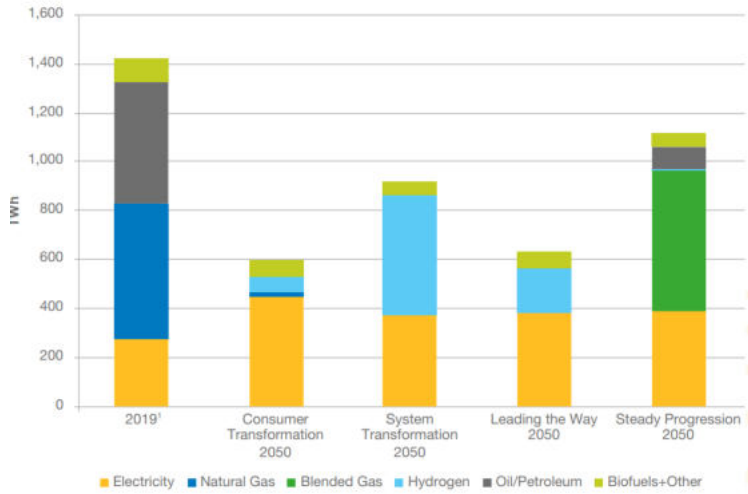


Figure 123: UK 2019 and Projected Annual End Consumer Energy Consumption in the UK[336]

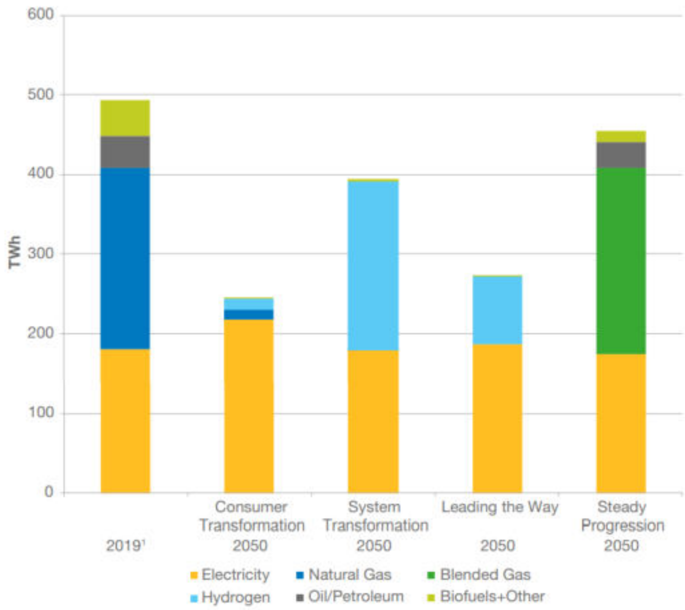


Figure 124: UK 2019 and Projected Annual Industrial and Commercial Energy Consumption in 2050[337]

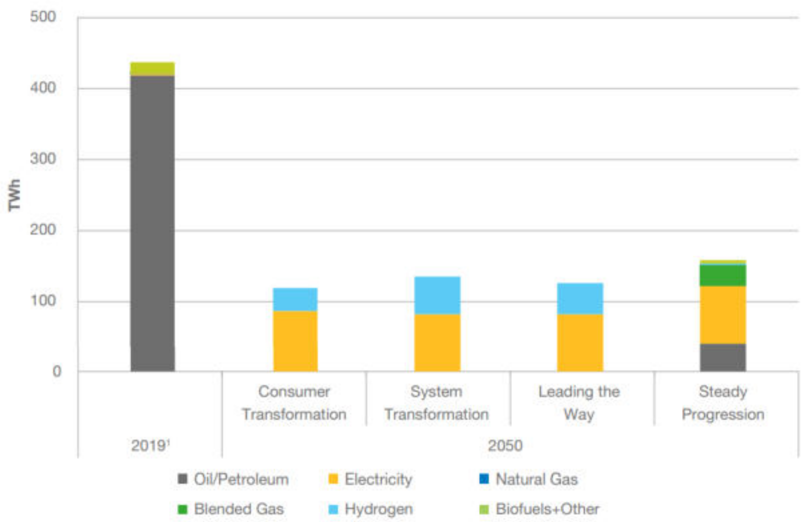


Figure 125: UK Total Annual Consumption for Road Transport in 2050[338]

As shown in Figure 125 above, the use of a low amount of natural gas is still projected in the commercial and industrial sectors in 2050 under the Consumer Transformation scenario in an industrial and commercial setting.

Table 78 below details the predicted UK 2050 greenhouse gas emissions for each scenario under the FES, highlighting residual emission in industry, power generation and “Other” category. The ‘Other’ category includes Agriculture, Land Use and Land Use Change and Forestry (LULUCF), Waste, F-gases, Aviation and shipping

The data shows the fundamental use of Bioenergy with Carbon Capture and Storage (BECCS) in achieving net zero emissions. BECCS is the combination of bioenergy with carbon capture and storage to capture any CO2 released during combustion, and the FES assumes that the greenhouse gases released in each scenario will be mainly offset by using BECCS.

Table 78: UK 2050 Greenhouse Gas Emissions by Category[339,340]

$MtCO_2$ equivalent	2019	CT 2050	ST 2050	LW 2050	SP 2050
Heat for buildings	87	0	0	0	78
Electricity before BECCS	57	3	2	2	30
BECCS in power sector	0	-52	-49	-61	0
Industry	102	4	4	4	55
Road transport	113	0	0	0	16
Hydrogen production	0	0	-1	0	0
Other	121	45	45	45	79
Total	**480**	**0**	**0**	**-10**	**258**

[336] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download
[337] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download
[338] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download
[339] National Grid ESO, Future Energy Scenarios, July 2020; https://www.nationalgrideso.com/document/173821/download
[340] Note that some of these figures do not add up exactly due to rounding.

Appendix Q : Renewable Energy Generation Load Factors

The area-wide resource assessment results indicate the potential installed capacity for different technologies (in MW) that the available resource can support. A well-established and straightforward way of estimating how much energy the potential capacity might generate is to use capacity factors (as load factors).

These factors, which vary by technology, measure how much energy a generating station will typically produce in a year for any given installed capacity. A summary of the different capacity factors for different technologies are given below.

Technology	Load Factors	Comments and Sources
Onshore Wind	0.25	Average of the five previous years' regional standard load factors published by BEIS.[341]
Biomass (Electricity)	0.75	Average of the five previous years' regional standard load factors. DUKES 2020.
Biomass (Heat)	0.40	This allows for the fact that not all of the waste heat can be usefully used 100% of the time.
Hydropower	0.29	Average of the five previous years' regional standard load factors published by BEIS.[292]
Energy from Waste (Electricity)	0.90	Typical for gas and coal fired power stations[342]. It should be noted in this study, calculation is based on only biodegradable waste capacity.
Energy from Waste (Heat)	0.50	This allows for the fact that not all of the waste heat can be usefully used 100% of the time
Landfill Gas (Electricity)	0.46	Average of the five previous years' regional standard load factors published by BEIS.[292]
Landfill Gas (Heat)	0.30	This allows for the fact that not all of the waste heat can be usefully used 100% of the time
Anaerobic Digestion Utilising including Food Waste, Animal Slurry, Poultry Litter, Sewage Sludge and Sewage Gas. (AD with CHP)	0.43	Average of the five previous years' regional standard load factors published by BEIS.[292]
Anaerobic Digestion Utilising Food Waste, Animal Slurry, Poultry Litter, Sewage Sludge and Sewage Gas. (Heat)	0.5	This allows for the fact that not all of the waste heat can be usefully used 100% of the time
Solar Farm	0.11	Average of the five previous years' regional standard load factors published by BEIS.[292]
Domestic and Non-Domestic Renewable Electricity Technologies Such as Rooftop Solar PV (electricity)	0.10	This is an average for PV and micro and small wind

[341] https://www.gov.uk/government/statistics/regional-renewable-statistics
[342] https://www.gov.uk/government/statistics/regional-renewable-statistics

Domestic and Non-Domestic Renewable Thermal Technologies (Thermal)	0.20	This is an average across a range of technologies, covering heat pumps, wood chip and pellet boilers and solar water heating.

Appendix R : Future Energy Demand Building Integrated Renewables Projections Data Source

This section includes details of the key data sources that are used in calculation of future energy demand and building integrated renewable technologies projections.

Source	Use	Description	Link
National Grid ESO FES 2020	Projections and scenario framework	National Grid ESO's Future Energy Scenarios (FES) represent a range of different ways to decarbonise the GB energy system. Represented as four scenarios, three of them meet net zero by 2050 at a national level.	Link.
Western Power Distribution (WPD) and Regen DFES	Technology baseline and projections	The Distribution Future Energy Scenarios (DFES) outline the range of credible futures for the growth of the distribution network. Broadly aligning with the National Grid ESO's FES, these encompass the growth of demand, storage and distributed generation, also low carbon technologies such as Electric Vehicles and Heat Pumps at a local level.	Link.
Ministry of Housing, Communities & Local Government (MHCLG) EPC data	Technology baseline	MHCLG publish Energy Performance Certificates and Display Energy Certificates data for buildings in England and Wales down to the granularity of individual houses. This provides highly detailed information on energy related information for buildings in a local area.	Link.
BEIS Sub-national energy consumption statistics	Energy baseline	BEIS publish local data on energy consumption, including at local authority level, for different fuels and consumption sectors.	Link.

Appendix S : Potential Hydropower Sites

The Win-Win (schemes that both provide a good hydropower opportunity and increase the status of the associated fish population beneficial both in terms of hydropower generation and environmental impact[343]) sites have been highlighted below[344]..

OBSTRUCT ID	Feature	Power	Power Category	Sensitivity	Location
828	Weir	2.9200000000	0 - 10 kW	Medium	Avon & Frome
835	Weir	1.0100000000	0 - 10 kW	High	Avon & Frome
850	Weir	2.9800000000	0 - 10 kW	Medium	Avon & Frome
852	Weir	3.0900000000	0 - 10 kW	Medium	Avon & Frome
886	Weir	42.3000000000	20 - 50 kW	High	Avon & Frome
957	Weir	2.1400000000	0 - 10 kW	High	Avon & Frome
959	Weir	0.7720000000	0 - 10 kW	High	Avon & Frome
993	Weir	1.7700000000	0 - 10 kW	High	Avon & Frome
1002	Weir	23.3000000000	20 - 50 kW	High	Avon & Frome
1028	Weir	6.8800000000	0 - 10 kW	High	Avon & Frome
1034	Weir	2.8600000000	0 - 10 kW	High	Avon & Frome
1041	Weir	2.8800000000	0 - 10 kW	High	Avon & Frome
1054	Weir	32.9000000000	20 - 50 kW	High	Avon & Frome
1080	Weir	26.6000000000	20 - 50 kW		Avon & Frome
1082	Weir	5.6000000000	0 - 10 kW	High	Avon & Frome
1085	Weir	4.1600000000	0 - 10 kW	Medium	Avon & Frome
1129	Weir	4.4300000000	0 - 10 kW	Medium	Avon & Frome
1132	Weir	5.3300000000	0 - 10 kW	Medium	Avon & Frome
1178	Weir	247.0000000000	100 - 500 kW	High	Avon & Frome
1183	Weir	0.6860000000	0 - 10 kW	Medium	Avon & Frome
1195	Weir	45.6000000000	20 - 50 kW	High	Avon & Frome
1203	Weir	21.2000000000	20 - 50 kW	High	Avon & Frome
1215	Weir	5.6400000000	0 - 10 kW	Medium	Avon & Frome
1254	Weir	4.3200000000	0 - 10 kW	High	Avon & Frome
1271	Weir	6.6700000000	0 - 10 kW	High	Avon & Frome
1279	Weir	3.3600000000	0 - 10 kW	High	Avon & Frome
1316	Weir	2.4700000000	0 - 10 kW	High	Avon & Frome
1320	Weir	1.9500000000	0 - 10 kW	High	Avon & Frome
1321	Weir	3.8700000000	0 - 10 kW		Avon & Frome
1350	Weir	0.6470000000	0 - 10 kW	High	Avon & Frome
1363	Weir	4.7300000000	0 - 10 kW	Medium	Avon & Frome
1381	Weir	4.6300000000	0 - 10 kW	Medium	Avon & Frome
1391	Weir	2.2100000000	0 - 10 kW		Avon & Frome
1400	Weir	8.9800000000	0 - 10 kW	High	Avon & Frome
1417	Weir	8.2000000000	0 - 10 kW	High	Avon & Frome

343 The Environmental Agency's judgement on whether the site is a potential "win-win" for both hydropower and the environment, Page 11

344 Potential Sites of Hydropower Opportunity, Environment Agency, revised 2020; https://data.gov.uk/dataset/cda61957-f48b-4b75-b855-a18060302ed1/potential-sites-of-hydropower-opportunity

1427	Weir	5.3000000000	0 - 10 kW	Medium	Avon & Frome
1475	Weir	0.0126000000	0 - 10 kW		Avon & Frome
1476	Weir	2.4600000000	0 - 10 kW	High	Avon & Frome
1549	Weir	5.1300000000	0 - 10 kW		Avon & Frome
1565	Weir	3.5600000000	0 - 10 kW	Medium	Avon & Frome
1587	Weir	8.5000000000	0 - 10 kW	Medium	Avon & Frome
1591	Weir	21.3000000000	20 - 50 kW		Avon & Frome
1644	Weir	2.1500000000	0 - 10 kW	Medium	Avon & Frome
1667	Weir	5.1500000000	0 - 10 kW	High	Avon & Frome
1672	Weir	10.3000000000	10 - 20 kW	High	Avon & Frome
1685	Weir	14.5000000000	10 - 20 kW	Medium	Avon & Frome
1694	Weir	0.0208000000	0 - 10 kW		Avon & Frome
1739	Weir	3.9300000000	0 - 10 kW	High	Avon & Frome
1742	Weir	3.1000000000	0 - 10 kW	Medium	Avon & Frome
1758	Weir	2.3700000000	0 - 10 kW	Medium	Avon & Frome
1760	Weir	2.0200000000	0 - 10 kW	Medium	Avon & Frome
1769	Weir	6.1300000000	0 - 10 kW	High	Avon & Frome
1773	Weir	55.0000000000	50 - 100 kW	High	Avon & Frome
1774	Weir	1.0500000000	0 - 10 kW	High	Avon & Frome
1781	Weir	0.9150000000	0 - 10 kW	Medium	Avon & Frome
1784	Weir	2.5100000000	0 - 10 kW	High	Avon & Frome
1816	Weir	0.8170000000	0 - 10 kW	Medium	Avon & Frome
1817	Weir	1.4400000000	0 - 10 kW		Parrett, Axe & Sheppy
1830	Weir	25.6000000000	20 - 50 kW		Avon & Frome
1899	Weir	1.3000000000	0 - 10 kW	High	Avon & Frome
1903	Weir	5.2500000000	0 - 10 kW	Medium	Avon & Frome
1921	Weir	2.6900000000	0 - 10 kW	High	Avon & Frome
1934	Weir	14.8000000000	10 - 20 kW	Medium	Avon & Frome
1950	Weir	3.6900000000	0 - 10 kW		Avon & Frome
2007	Weir	12.0000000000	10 - 20 kW	High	Avon & Frome
2010	Weir	5.4200000000	0 - 10 kW	High	Avon & Frome
2013	Weir	9.5200000000	0 - 10 kW	Medium	Avon & Frome
2026	Weir	4.0800000000	0 - 10 kW		Avon & Frome
2034	Weir	11.6000000000	10 - 20 kW		Avon & Frome
2061	Weir	8.3000000000	0 - 10 kW	Medium	Avon & Frome
2064	Weir	2.6700000000	0 - 10 kW	High	Avon & Frome
2120	Weir	0.0187000000	0 - 10 kW		Avon & Frome
2134	Weir	4.5800000000	0 - 10 kW	High	Avon & Frome
2149	Weir	6.7200000000	0 - 10 kW	Medium	Avon & Frome
2154	Weir	7.0800000000	0 - 10 kW	Medium	Avon & Frome
2201	Weir	5.1000000000	0 - 10 kW	Medium	Avon & Frome
2220	Weir	1.9900000000	0 - 10 kW	Medium	Avon & Frome
2226	Weir	3.3700000000	0 - 10 kW	Medium	Avon & Frome

2239	Weir	1.6800000000	0 - 10 kW	High	Avon & Frome
2247	Weir	2.7500000000	0 - 10 kW	Medium	Avon & Frome
2251	Weir	5.1500000000	0 - 10 kW	High	Avon & Frome
2266	Weirs	6.5800000000	0 - 10 kW	High	Avon & Frome
2273	Weirs	4.1600000000	0 - 10 kW	High	Avon & Frome
2307	Weirs	59.2000000000	50 - 100 kW		Avon & Frome
2308	Weirs	38.1000000000	20 - 50 kW		Avon & Frome
2328	Weirs	0.0190000000	0 - 10 kW		Avon & Frome
2329	Weirs	0.0208000000	0 - 10 kW		Avon & Frome
2369	Waterfall	3.4900000000	0 - 10 kW	Medium	Avon & Frome
2377	Waterfall	2.7200000000	0 - 10 kW	Medium	Avon & Frome
2412	Lock	341.0000000000	100 - 500 kW	High	Avon & Frome
2415	Lock	311.0000000000	100 - 500 kW	High	Avon & Frome
2431	Lock	399.0000000000	100 - 500 kW	High	Avon & Frome
2434	Lock	6.9700000000	0 - 10 kW	Medium	Avon & Frome
2435	Lock	7.7900000000	0 - 10 kW	Medium	Avon & Frome
2443	Lock	4.9000000000	0 - 10 kW	Medium	Avon & Frome
2450	Lock	4.1100000000	0 - 10 kW	High	Avon & Frome
2451	Lock	7.5300000000	0 - 10 kW	Medium	Avon & Frome
2455	Lock	3.0700000000	0 - 10 kW	High	Avon & Frome
2468	Lower Lock	3.0900000000	0 - 10 kW	High	Avon & Frome
2470	Weston Lock	373.0000000000	100 - 500 kW	High	Avon & Frome
2473	Bridge Lock	6.5700000000	0 - 10 kW	High	Avon & Frome
2587	Weir	25.2000000000	20 - 50 kW	High	Avon & Frome
2601	Weir	6.8500000000	0 - 10 kW	Medium	Avon & Frome
2606	Weir	23.4000000000	20 - 50 kW	High	Avon & Frome
2616	Twerton Sluice	558.0000000000	500 - 1500 kW	High	Avon & Frome
2647	Weir	0.1250000000	0 - 10 kW		Avon & Frome
2648		0.0519000000	0 - 10 kW		Avon & Frome
2655	Weir	25.0000000000	20 - 50 kW	High	Avon & Frome
2659	Weir	209.0000000000	100 - 500 kW	High	Avon & Frome
2660		3.7300000000	0 - 10 kW		Avon & Frome
2667	Sluice	32.7000000000	20 - 50 kW	High	Avon & Frome
2668		5.7300000000	0 - 10 kW	Medium	Avon & Frome
2683		3.2500000000	0 - 10 kW		Avon & Frome
2684	Weir	4.0200000000	0 - 10 kW		Avon & Frome
2686	Weir	40.6000000000	20 - 50 kW	Medium	Avon & Frome
2687	Weir	33.3000000000	20 - 50 kW	Medium	Avon & Frome
2699	Weir	290.0000000000	100 - 500 kW	High	Avon & Frome
2710	Weir	26.7000000000	20 - 50 kW		Avon & Frome
2711		0.0621000000	0 - 10 kW		Avon & Frome
2712		2.4100000000	0 - 10 kW		Avon & Frome
2714	Weir	0.0791000000	0 - 10 kW		Avon & Frome
2719	Weir	313.0000000000	100 - 500 kW	High	Avon & Frome

2722	Weir	209.0000000000	100 - 500 kW	High	Avon & Frome
2726	Weirs	338.0000000000	100 - 500 kW		Avon & Frome
2754	Weir	44.9000000000	20 - 50 kW	High	Avon & Frome
2755	Weir	363.0000000000	100 - 500 kW	High	Avon & Frome
2793	Sluice	47.3000000000	20 - 50 kW	High	Avon & Frome
2794	Weir	9.4500000000	0 - 10 kW	Medium	Avon & Frome

Appendix T : Accelerating DFES 2050 Projections to 2030

Technology	Existing Installations (MWe)	Existing Generation (MWh/annum)	2050 DFES Projection	2030 Projection for Bath and North East Somerset	Total Generation Required to meet 2030 DFES Projection (MWh/annum)	Additional Capacity required to meet DFES (MWe)	Additional Generation required to meet DFES (MWh)	Number of 5MW Wind Farms/ 5MW Solar Farms Required
Onshore Wind <1MW	0.105	91.98	4.22	4.22	3,699.47	4.12	3,607.49	4.42
Onshore Wind >=1MW	0.00	0.00	18.00	18.00	39,178.96	18.00	39,178.96	
Onshore Wind <=0.006 MW	0.0060	5.26	0.088	0.088	76.97	0.082	71.71	
Commercial solar rooftop (10kW - 1MW)	7.00	6,132.0	46.7	46.71	40,917.96	39.71	34,785.96	
Ground mounted solar (>1MW)	5.8670	5,690.61	57.37	57.37	55,642.32	51.50	49,951.71	1.03
Domestic solar rooftop (<10kW)	7.3260	6,417.59	71.3	71.27	62,428.76	63.94	56,011.17	
Domestic solar rooftop (>10kW)	0.00	0.00	20.0	2.28	1,994.57	2.28	1,994.57	
Landfill Gas, Sewage Gas, Biogas	4.680	18,195.68	2.52	2.52	9,889.04	-2.16	-8506.33	
Hydropower	0.16	404.45	0.162	0.16	404.45	0.00	0.00	
Large Scale Biomass	2.0320	13,438.95	2.032	2.03	13,438.95	0.00	0.00	
Waste Incineration (EfW)	0.057	445.92	0.057	0.06	445.92	0.00	0.00	
Total	27.234	**50,822**			**228,117**	177.46	**177,095**	
Percentage of 2030 Demand		**4.77%**			**21.40%**		**16.61%**	

Appendix U : Installation of Maximum Potential

This option assumes a 100% uptake of the potential installed capacity identified through the study for solar PV farms and wind farms and the installation of other technologies, such as heat pumps, as set out in the DFES. It also assumes that projected energy consumption in 2050 occurs in 2030, excluding demand from any new dwellings, which has stayed consistent with the current 2030 projection.

It should be noted the lack of grid connection opportunities may affect the ability of the Council to meet the 2030 aim under this scenario; therefore, more investment in the grid would be required to support a greater number of renewables than currently assumed needed from DFES.

This Option assumes that the majority of homes are primarily heated by heat pumps (circa 73% of homes in the South West of England as per the DFES), and there will be an overall decrease in the number of dwellings with direct electric heating in B&NES.

This Option assumes that there will be circa 270 times more electric vehicles than in 2020, in the South West, as per the DFES[345].

This Option could deliver a potential maximum energy of 5,668.8GWh$_e$ and 82.03GWh$_t$ in B&NES.

This option is the most ambitious and least realistic option due to the amount of new wind and solar development required. Further constrains such as competing land uses would need to be considered and a balance between other local objectives would need to be considered prior to any development.

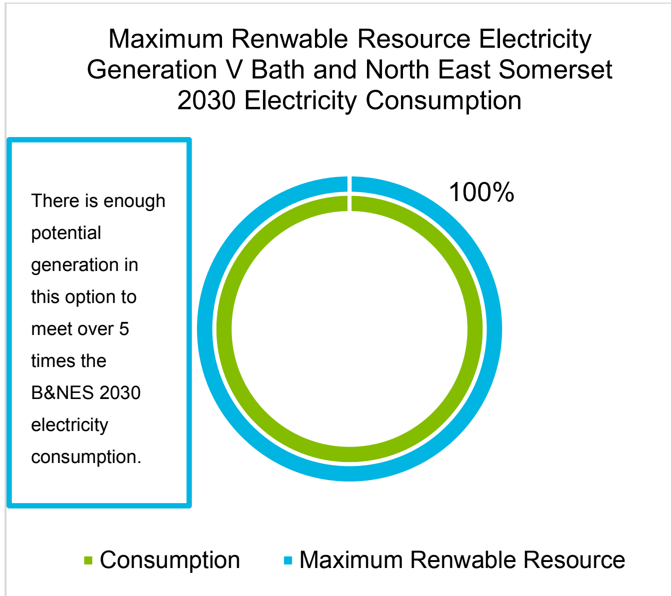


Figure 126: Comparison of 2030 Electricity Generation in this option and Bath and North East Somerset's 2030 Consumption

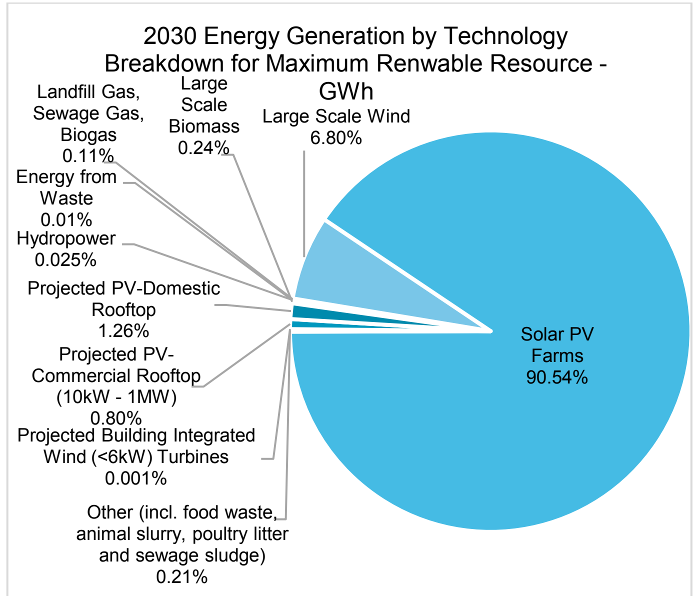


Figure 127: 2030 Energy Generation by Technology Breakdown in this option - GWh

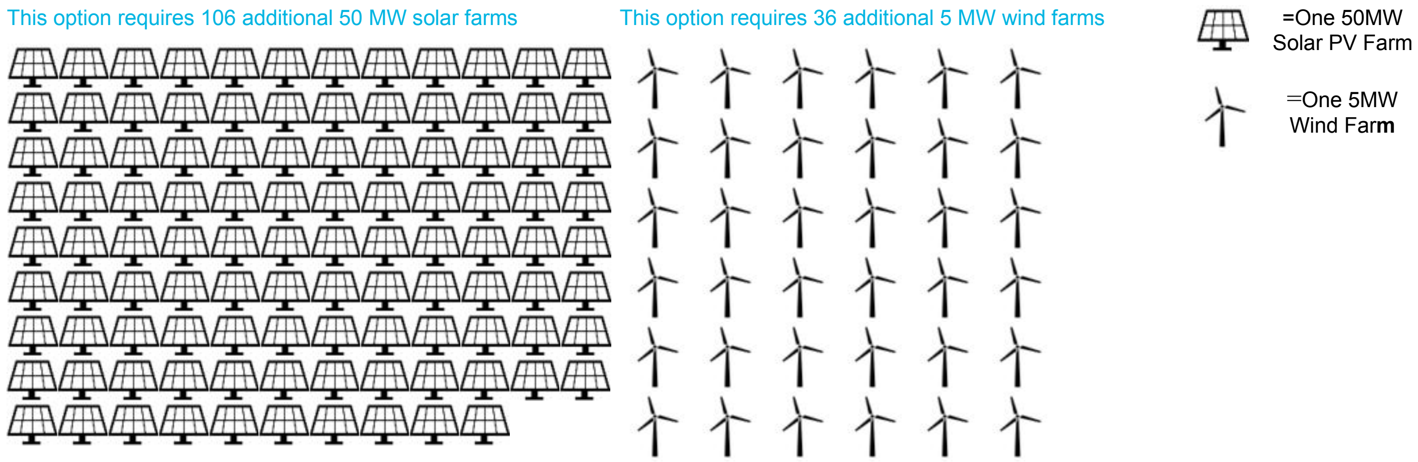


Figure 128: Pictogram of Number of Additional 50MW Solar Farms and 5MW Wind Farms Required in this option[346]

Table 79: Potential Maximum Electricity Generation (GWh)

Technology	Potential Maximum Electricity Generation (GWh)
Large Scale Biomass	13.4
Energy from Waste	0.45
Hydropower	1.41
Landfill Gas	6.48
Large Scale Wind	392.3
Solar PV Farms	5,126.56
Other (incl. food waste, animal slurry, poultry litter and sewage sludge biogas biomass)	11.71
Projected Building Integrated Wind Turbines	0.08
Projected PV - Rooftop	116.6

[345] 7,000 EVs in baseline year and 1,894,000 EVs in 2030 in the South West licence area in Consumer Transformation scenario. https://www.regen.co.uk/wp-content/uploads/WPD-DFES-2020-technology-summary-report-South-West.pdf

[346] Each solar panel icon is equivalent to one 50MW solar farm. Each wind turbine icon is equivalent to one 5MW wind farm