Sewage gas production

- All plants currently operational will be in operation by 2025.
- The gas captured from sewage gas sites is used for electricity generation only.
- A capacity factor of 42% has been assumed to estimate the annual electrical output.

A.10.2 Technically accessible resource

It has been assumed that 80% of the slurry resource can be collected for energy generation.

To account for competing uses, it has been assumed that only 50% of the food and drink waste resource is available for energy generation.

It has been assumed that all of the dry organic waste resource will be available for energy generation.

It has been assumed that 25% of the MSW resource and 50% of the C&I resource will be available for energy recovery by 2020.

No further constraints have been applied to calculate the technically accessible resource from landfill gas production and sewage gas production.

A.10.3 Physically accessible resource

The DECC methodology does not identify further constraints that could be applied to calculate the physically accessible resource.

A.10.4 Economically viable resource

The DECC methodology does not identify further constraints that could be applied to calculate the economically viable resource.

A.11 Solar energy

A.11.1 Natural resource and assumptions for energy generation

The sun's energy arrives at the earth's surface either as 'direct', from the sun's beam, or 'diffuse' from clouds and sky. The total or 'global' irradiation is the sum of these two components and, across the UK, the daily annual mean varies between 2.2kWh/m^2 to 3.0kWh/m^2 as measured on the horizontal plane. There is a very significant variation around this average value due to both seasonal and daily weather patterns.

A capacity factor of 9% has been assumed to calculate annual output, based on figures provided in DUKES (2009).

A.11.2 Technically accessible resource

The technically accessible, solar resource has been assessed based on the number of roofs across the region. Table 42 and Table 43 show the proportions of building types will be able to accommodate a solar water heating or solar PV system, in accordance with the DECC methodology

Suitable building types	Existing stock	New build development
Domestic (houses and flats)	25%	50%
Commercial	40%	5% from 2010-2013 * 10% from 2013-2018 * 30% from 2019 (PV) * 10% from 2019 (SWH)
Industrial	80%	5% from 2010-2013 * 10% from 2013-2018 * 30% from 2019 (PV) * 10% from 2019 (SWH)

Table 42 Suitable building types for solar panel installation. Assumptions taken from other sources than the DECC methodology are denoted with *.

Installed capacity	Solar PV	SWH
Domestic	2 kW	2kW
Commercial	5 kW	10 kW *
Industrial	10 kW *	10 kW *

Table 43 Installed capacities modelled for solar installations. Assumptions taken from other sources than the DECC methodology are denoted with *.

A.11.3 Physically accessible resource

It has been assumed that the physically accessible resource is the same as the technically accessible resource.

A.11.4 Economically viable resource

The assumptions for solar uptake in the existing stock are described in section A.3.

Assumptions for solar uptake in the new build stock are shown in Table 44 to Table 45.

Year of construction	Flats	Houses	Non domestic
2010	24%	40%	5%
2013	20%	45%	10%
2016 onwards	18%	45%	30%

Table 44 Modelled solar PV uptake in new build stock.

Year of construction	Flats	Houses	Non domestic
2010	24%	39%	5%
2013	19%	15%	10%
2016 onwards	0%	5%	10%

Table 45 Solar water heating uptake in new build stock.

A.12 Heat pumps

A.12.1 Natural resource and assumptions for energy generation

The assessment of the potential for heat pumps is based on the premise that most buildings (existing stock and new build) are suitable for the deployment of a heat pump.

A seasonal performance factor (SPF) of 320% and 250% has been applied to ground source heat pumps and air source heat pumps respectively, in order to calculate the renewable proportion of the total usable heat from the heat pump, Q_{usable}, based on the following formula [62]:

$$Renewable\ energy\ output\ = Qusable * (1 - (\frac{1}{SPF})$$

A capacity factor of 30% has been used to calculate the annual energy output from both types of heat pumps.

A.12.2 Technically accessible resource

It has been assumed that the following proportions of building types will be able to accommodate a heat pump (Table 46). It is considered unlikely that industrial buildings will have significant potential for heat pumps, as most are sheds with limited space heating and cooling demand.

	Existing stock (off grid properties)	Existing stock	New build development
Detached/semi detached homes	100%	75%	50%
Terraced homes	100%	50%	50%
Flats	100%	25%	50%
Commercial	100%	100%	100%
Industrial	0% *	0% *	0% *

Table 46 Suitable building types for heat pump installation. Assumptions taken from other sources than the DECC methodology are denoted with *.

	Size of heat pumps
Domestic	5 kW
Commercial	100 kW
Industrial	n/a

Table 47 Installed capacities modelled for heat pumps

A.12.3 Physically accessible resource

It has been assumed that the physically accessible resource is the same as the technically accessible resource.

A.12.4 Economically viable resource

The assumptions for heat pump uptake in the existing stock are described in section A.3. At the time of modelling, it was thought that air source heat pumps would be included within the renewable heat incentive, therefore this has been included in the modelling parameters.

Assumptions for heat pump uptake in the new build stock are shown in Table 48 to Table 49.

Year of construction	Flats	Houses	Non domestic
2010	0%	0%	3%
2013	0%	5%	3%
2016 onwards	0%	8%	10%

Table 48 Modelled ASHP uptake in new build stock.

Year of construction	Flats	Houses	Non domestic
2010	25%	5%	3%
2013	25%	8%	5%
2016 onwards	30%	10%	10%

Table 49 Modelled GSHP uptake in new build stock.

[62] Annex VII Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

A.13 Small scale wind energy

A.13.1 Natural resource and assumptions for energy generation

The natural resource for small scale wind energy generation is based on the wind speed.

A.13.2 Technically accessible resource

The technically accessible resource refers to the potential for energy generation based on the performance of the generating equipment. A standard turbine size of 6kW has been assumed.

A capacity factor has been assumed of 5% has been assumed for renewable electricity generation in urban and suburban areas and 15% in rural areas.

A.13.3 Physically accessible resource

The physically accessible resource has been identified using GIS mapping and the DECC methodology, based on the constraints shown in Table 51 below. This suggests that a wind "scaling factor" should be applied to the wind speeds, to take into account obstruction effects in built up areas that will reduce the wind speed. It should be noted these constraints do not take into account site-specific constraints such as actual building height and roof shape, neighbouring buildings, high trees and other physical obstacles. Such detailed analysis is only possible at the local authority level and is outside the scope of this study.

A.13.4 Economically viable resource

The assumptions for small wind turbine uptake in the existing stock are described in section A.3. Assumptions for small wind turbine uptake in the new build stock are shown in Table 50.

Year of construction	Flats	Houses	Non domestic
2010	1%	1%	1%
2013	1%	2%	2%
2016 onwards	2%	5%	5%

Table 50 Small wind turbine uptake in new build stock.

Constraint on physically accessible resource	Justification for applying constraint	Source of dataset
Wind speeds below 4.5 m/s	The DECC methodology states that this represents the wind speed below which small scale wind turbines are not viable.	UK wind speed database (NOABL)
Address points.	It has been assumed that all address points could accommodate one small scale wind turbine, in accordance with the DECC methodology. This is an extremely simplistic assumption. In practice, this number is likely to be substantially lower due to site-specific constraints. Of particular concern is the issue that many buildings will be linked to multiple address points, for example, shopping malls, office buildings and blocks of flats.	Ordnance Survey ADDRESS-POINT dataset
44% reduction in wind speed in urban areas	Applied in accordance with the DECC methodology.	UK wind speed database (NOABL) Defra Rural-Definition dataset
33% reduction in wind speed in suburban areas	Applied in accordance with the DECC methodology.	UK wind speed database (NOABL) Defra Rural-Definition dataset
Zero reduction in wind speed in rural areas	Applied in accordance with the DECC methodology.	UK wind speed database (NOABL) Defra Rural-Definition dataset

Table 51 Issues constraining physically accessible resource for small scale wind energy generation

Appendix B: Renewable energy resource by local authority

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Appendix B Renewable energy resource by local authority

A description of the renewable energy resource for each local authority in Yorkshire and Humber has been provided in this appendix. These should be considered a high level summary of the resource and only facilities above 1 MW are discussed.

A detailed description of the resource at local authority level is beyond the scope of this study, but the Energy Opportunities Plans produced can be used to provide an evidence base for local development framework documents. Appendix B contains a copy of the Energy Opportunities Plan for each local authority and a summary of the maximum, economically viable resource by technology for each local authority. The technologies have been categorised as follows.

- Commercial scale wind energy;
- Hydro energy (small scale, low head);
- Biomass (including energy crops, managed woodland, industrial wood waste and agricultural arisings, or straw);
- Energy from waste (including AD from slurry, food and drinks waste, poultry litter, municipal solid waste, commercial and industrial waste arisings, landfill gas production and sewage gas production);
- Microgeneration (including small scale wind energy, solar, heat pumps and small scale biomass boilers).

All figures are rounded to the nearest MW. The resource is described in terms of capacity in MW, annual generation potential in GWh and in terms of the energy demand of a typical dwelling. For the purposes of comparison, an average home has been assumed to have an annual energy demand of 0.015 GWh.

The following technologies are not included in the resource tables:

- Co-firing resource
- Offshore technologies.

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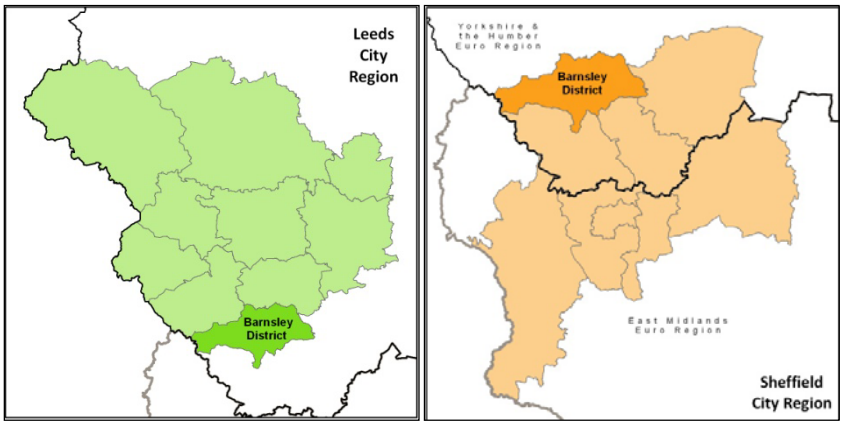
B.1 Barnsley

Population: 225,900

Land area (km^2): 329



The borough of Barnsley is located in both the Leeds City sub-region and the South Yorkshire/Sheffield City sub-region. It is mainly rural to the west and urban/industrial to the east.

The town of Barnsley is the main urban centre and has sufficient heat density to support district heating networks. Recognising the Borough's district heating potential, Barnsley has implemented a program to connect buildings to a biomass heating scheme. The Council initiated the program with a number of its own public buildings. It has also established a local biomass supply chain from which to source its biomass heat supply.

In the more rural parts of the Borough, wind holds the greatest promise. Four wind farms are in operation or have been consented in the west of the district; Blackstone Edge, Hazlehead, Royd Moor, and Spicer Hill.

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Barnsley	Current capacity (MW)	Current capacity (GWh)	Potential resource - heat (MW)	Potential resource - electricity (MW)	Potential resource (GWh)	Potential resource (No of existing homes equivalent energy demand)	Potential resource (Proportion of regional resource)
Commercial wind	26	68	0	86	225	0	0%
Small scale wind	0	0	0	1	2	0	7%
Hydro	0	0	0	0	1	0	0%
Solar PV	1	1	0	11	9	0	0%
Solar thermal	0	0	17	0	11	1163	5%
Air source heat pumps	0	0	9	0	14	576	3%
Ground source heat pumps	0	0	1	0	2	87	1%
Biomass energy crops	0	0	9	5	78	629	2%
Biomass woodfuel	2	5	27	0	72	1821	8%
Biomass agricultural arisings (straw)	0	0	3	1	20	168	1%
Biomass waste wood	0	0	2	1	12	102	3%
Energy from waste wet	0	0	1	1	8	61	1%
Energy from waste poultry litter	0	0	0	0	0	0	0%
Energy from waste MSW	0	0	2	1	18	151	3%
Energy from waste C&I	0	0	3	2	26	216	2%
Energy from waste landfill gas	0	0	0	0	0	0	0%
Energy from waste sewage gas	0	1	0	0	5	0	0%
Total	29	75	92	110	578	6,131	

Table 52 Current capacity and renewable energy resource in Barnsley. Current" refers to facilities that are operational or have planning consent

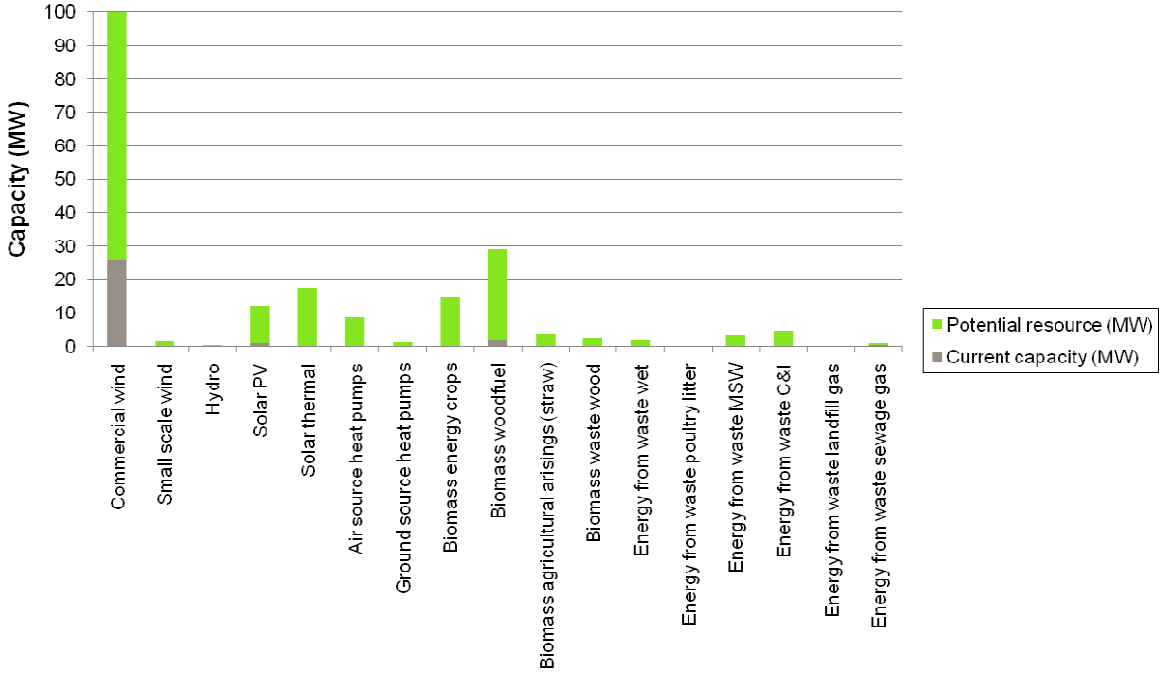

Figure 60 Current capacity and renewable energy resource in Barnsley. Current" refers to facilities that are operational or have planning consent

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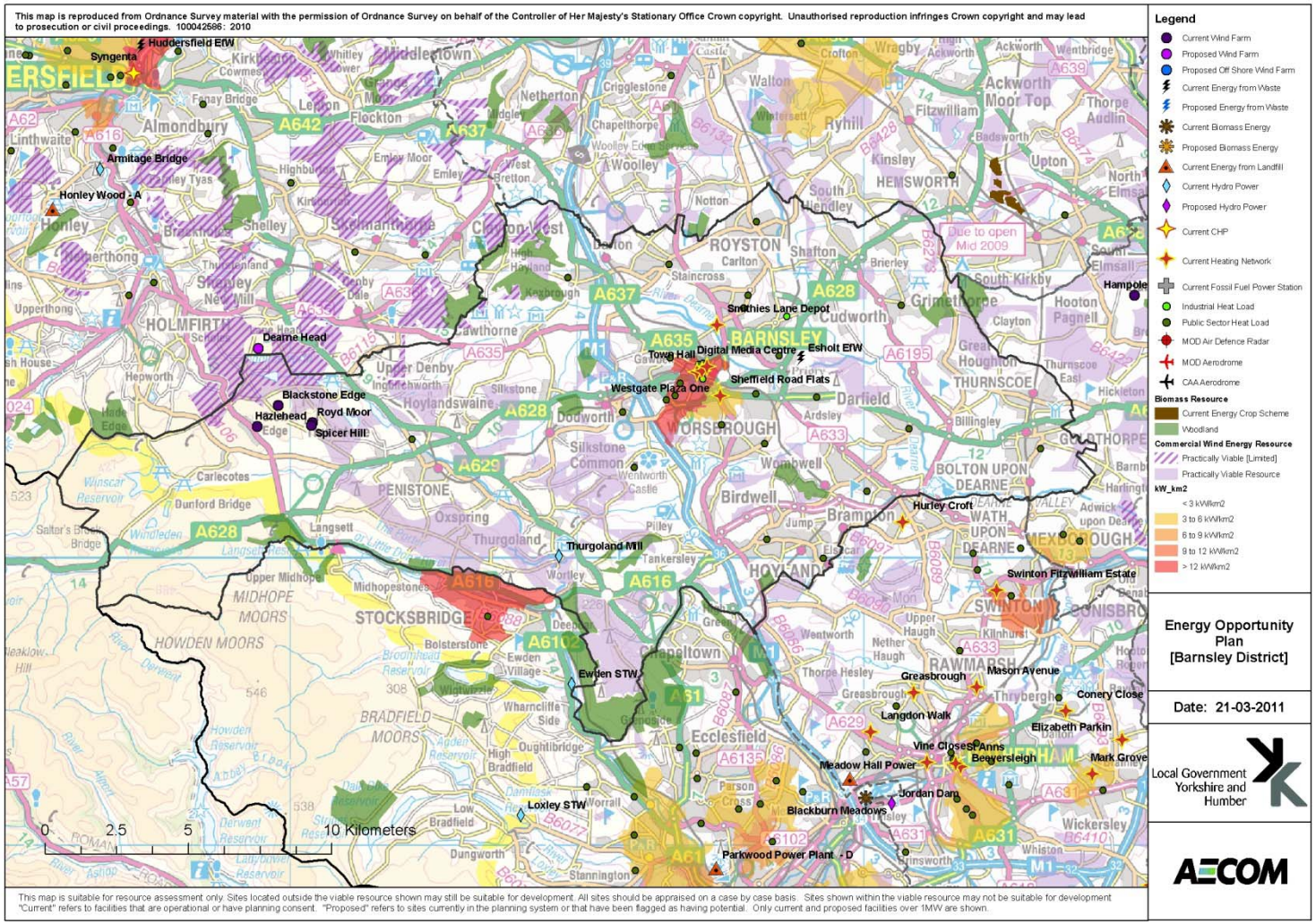

Figure 61 Energy opportunities plan for Barnsley. “Current” refers to facilities that are operational or have planning consent. “Proposed” refers to facilities currently in the planning system or sites that have been flagged as having potential. Only current and proposed facilities over 1MW are shown. The areas with purple hatched shading described as “Practically viable [Limited]” represent areas where commercial scale wind energy development should be viable but the number of turbines may be restricted due to environmental constraints. Please refer to section 5.15 and appendix A for more details.

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B.2 Bradford

Population: 501,700

Land area (km^2): 370

Bradford is located in the eastern part of the South Pennines, in the Leeds City Region. Although it is the fourth largest district in the country in terms of populations, around two-thirds of the district is rural with the majority of the population living in the urban centres of Bradford, Shipley, Bingley, Keighley and Ilkley.

The city of Bradford has the density necessary to support district heating networks. The Energy Opportunities Plan shows that there are many public buildings in the city that could provide anchor loads for such networks.

Other renewable energy opportunities in the district include wind and hydro opportunities. There is currently one hydro generation plant operating in Esholt, and a potential site identified at Greenholme Mills on the border with Harrogate district. Bradford's hydro potential is among the best in the region and their installation should be sought and supported wherever feasible.

Planning permission was granted to BioGen Power in April 2010, to build the world's largest gasification based Energy Recovery Facility to be fuelled by residual waste in Bradford, capable of processing 160,000 tonnes of residual waste.

Capabilities on project:
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Bradford	Current capacity (MW)	Current capacity (GWh)	Potential resource - heat (MW)	Potential resource - electricity (MW)	Potential resource (GWh)	Potential resource (No of existing homes equivalent energy demand)	Potential resource (Proportion of regional resource)
Commercial wind	0	0	0	70	183	0	0%
Small scale wind	0	0	0	2	3	0	13%
Hydro	1	2	0	4	14	0	0%
Solar PV	0	0	0	28	21	0	0%
Solar thermal	0	0	37	0	22	2440	10%
Air source heat pumps	0	0	25	0	40	1694	10%
Ground source heat pumps	0	0	2	0	4	131	1%
Biomass energy crops	0	0	4	2	35	284	1%
Biomass woodfuel	1	3	24	0	63	1603	7%
Biomass agricultural arisings (straw)	0	0	0	0	0	0	0%
Biomass waste wood	0	0	4	2	32	270	8%
Energy from waste wet	0	0	2	2	16	124	2%
Energy from waste poultry litter	0	0	0	0	0	0	0%
Energy from waste MSW	15	104	5	3	43	363	6%
Energy from waste C&I	0	0	10	5	78	659	6%
Energy from waste landfill gas	2	10	0	0	0	0	0%
Energy from waste sewage gas	2	6	0	1	14	0	0%
Total	21	126	139	120	682	9,269	

Table 53 Current capacity and renewable energy resource in Bradford. Current" refers to facilities that are operational or have planning consent

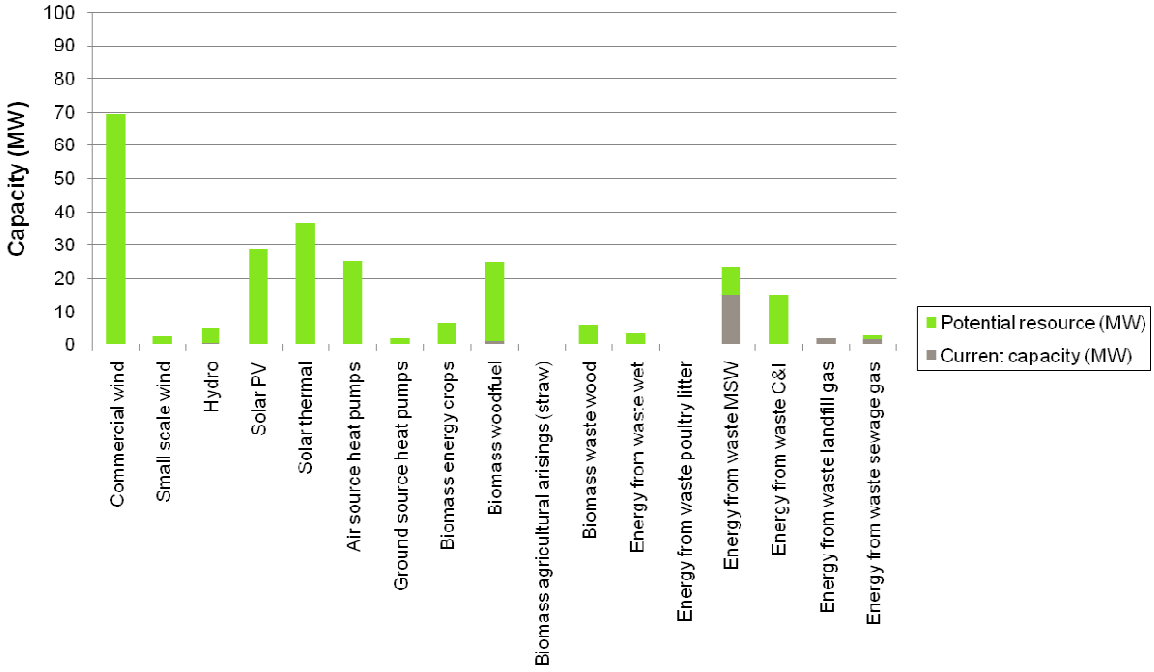

Figure 62 Current capacity and renewable energy resource in Bradford. Current" refers to facilities that are operational or have planning consent

Capabilities on project:
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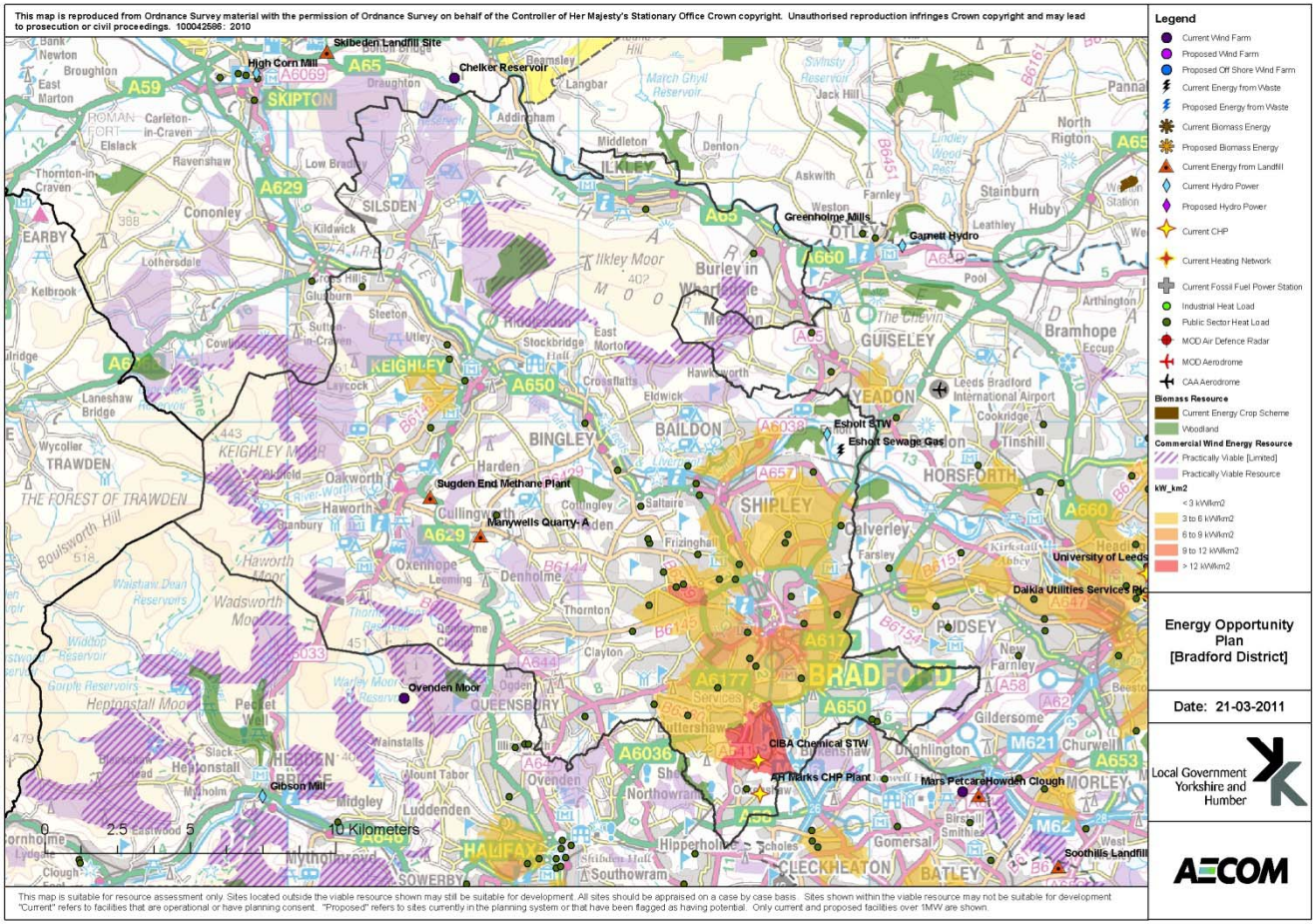

Figure 63 Energy opportunities plan for Bradford. “Current” refers to facilities that are operational or have planning consent. “Proposed” refers to facilities currently in the planning system or sites that have been flagged as having potential. Only current and proposed facilities over 1MW are shown. The areas with purple hatched shading described as “Practically viable [Limited]” represent areas where commercial scale wind energy development should be viable but the number of turbines may be restricted due to environmental constraints. Please refer to section 5.15 and appendix A for more details.

Capabilities on project:
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B.3 Calderdale

Population: 200,100

Land area (km^2): 364

Calderdale is located on the western edge of Leeds City Region. Halifax is the largest urban area, containing heat density capable of supporting a heating network, and many public buildings that could provide anchor loads for a network. This is a prime example of a heating network which the Council can initiate and lead, encouraging other developments and buildings to connect to. Within the high heat density areas is a CHP plant located at Sonoco in the South.

Wind also has strong potential in the borough, although sites may have limited viability due to environmental reasons such as high sensitivity to birds (these areas are shown with purple hatching on the Energy Opportunities Plan). This conclusion was supported by the Landscape Capacity Study prepared by Julie Martin Associates on behalf of a number of South Pennine Authorities.[63] As part of developing their evidence base, Calderdale undertook a renewable energy and low carbon energy study with surrounding local authorities, which also suggested that wind is Calderdale's largest opportunity for renewable energy. Two wind farms have been granted planning permission: Todmorden Moor and Crook Hill in the west. A planning application has also been submitted for the repowering of the 9.2MW Ovenden Moor Wind Farm with larger turbines.

Calderdale Council has given planning consent to at least over 40 small wind turbines, representing over 0.5 MW_e of renewable energy capacity.

Biomass and microgeneration could also play a role in increasing the capacity of renewable energy. Hydro is also a promising renewable energy in the Borough, ranking among the top five in the region. There is currently only one hydro scheme, Hebden Bridge, operating in the centre of the Borough. With the potential to be a hydro leader in the Region, other hydro options should be explored.

[63] Landscape Capacity Study for Wind Energy Developments in the South Pennines, Julie Martin Associates, January 2010

Capabilities on project:
Building Engineering - Sustainability

Calderdale	Current capacity (MW)	Current capacity (GWh)	Potential resource - heat (MW)	Potential resource - electricity (MW)	Potential resource (GWh)	Potential resource (No of existing homes equivalent energy demand)	Potential resource (Proportion of regional resource)
Commercial wind	37	96	0	110	290	0	0%
Small scale wind	1	1	0	1	1	0	3%
Hydro	0	0	0	2	8	0	0%
Solar PV	0	0	0	7	6	0	0%
Solar thermal	0	0	12	0	8	822	3%
Air source heat pumps	0	0	12	0	20	831	5%
Ground source heat pumps	0	0	1	0	2	87	1%
Biomass energy crops	0	0	5	3	41	333	1%
Biomass woodfuel	0	0	10	0	27	694	3%
Biomass agricultural arisings (straw)	0	0	0	0	2	17	0%
Biomass waste wood	0	0	1	1	8	67	2%
Energy from waste wet	0	0	1	1	10	79	1%
Energy from waste poultry litter	0	0	0	0	1	0	0%
Energy from waste MSW	0	0	2	1	14	114	2%
Energy from waste C&I	0	0	4	2	30	258	2%
Energy from waste landfill gas	1	6	0	0	0	0	0%
Energy from waste sewage gas	0	0	0	0	4	0	0%
Total	39	104	62	128	527	4,154	

Table 54 Current capacity and renewable energy resource in Calderdale. Current" refers to facilities that are operational or have planning consent

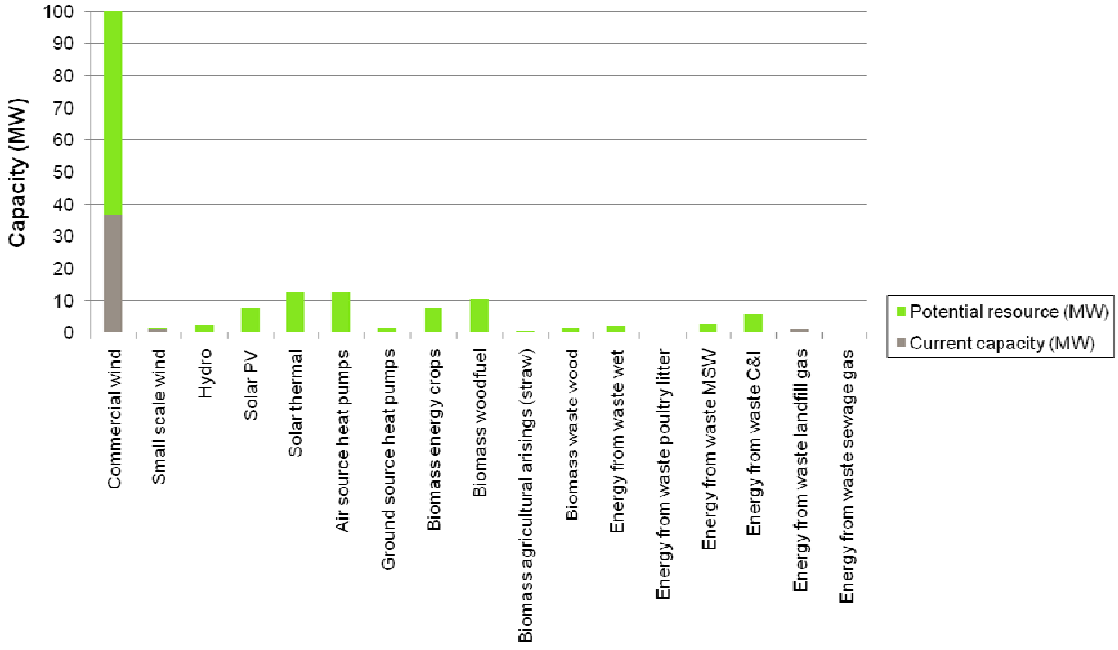

Figure 64 Current capacity and renewable energy resource in Calderdale. Current" refers to facilities that are operational or have planning consent

Capabilities on project:
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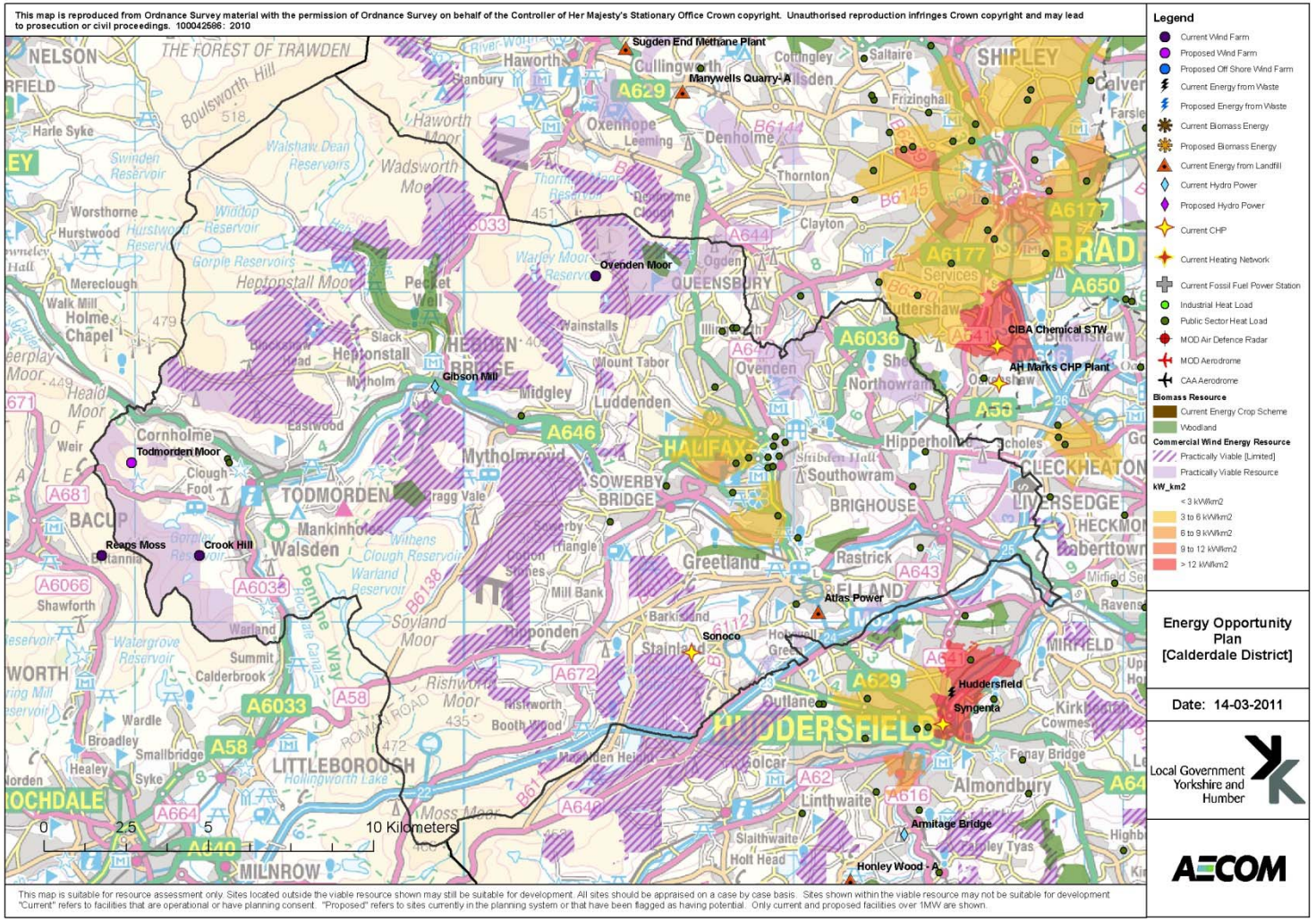

Figure 65 Energy opportunities plan for Calderdale. “Current” refers to facilities that are operational or have planning consent. “Proposed” refers to facilities currently in the planning system or sites that have been flagged as having potential. Only current and proposed facilities over 1MW are shown. The areas with purple hatched shading described as “Practically viable [Limited]” represent areas where commercial scale wind energy development should be viable but the number of turbines may be restricted due to environmental constraints. Please refer to section 5.15 and appendix A for more details.

Capabilities on project:
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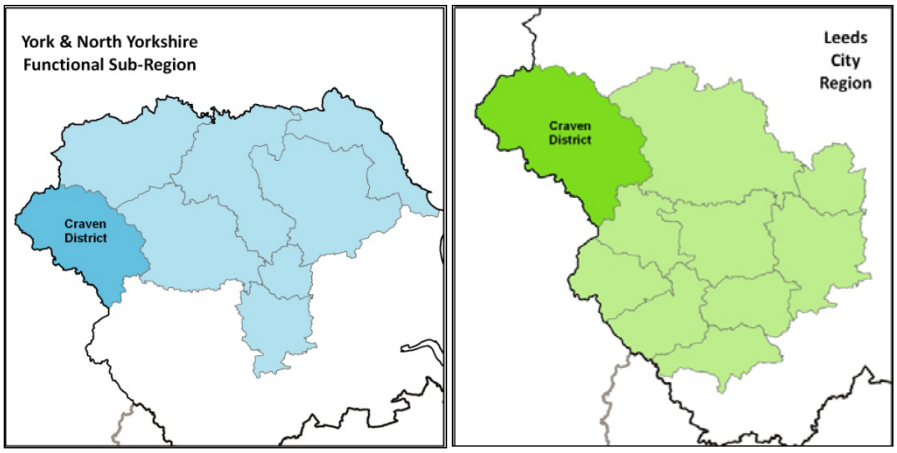
B.4 Craven

Population: 56,200

Land area (km^2): 1,177



Almost all of Craven district is located within the Yorkshire Dales National Park and consequently the potential for deployment of larger scale renewable energy technologies is severely restricted.

There are currently four wind turbines at Chelker Reservoir, and a planning application has been submitted to replace these with three larger turbines. Electricity is also generated at the 0.8 MW Skibeden Landfill site.

Craven is a rural district with limited potential for district heating. However, there are several areas of woodland which, with the development of an appropriate supply chain, could supply biomass to individual biomass boilers within the district and to the wider region.

There is some potential for hydro energy generation in Craven, with three schemes already operational or with planning permission; Settle Bridge End Mill, Grassington and High Corn Mill and a potential scheme identified at Halton Gill. There is also a commercial wind scheme called Windy Hill currently in the planning system. There is potential for microgeneration technologies throughout the district.

Capabilities on project:
Building Engineering - Sustainability

Craven	Current capacity (MW)	Current capacity (GWh)	Potential resource - heat (MW)	Potential resource - electricity (MW)	Potential resource (GWh)	Potential resource (No of existing homes equivalent energy demand)	Potential resource (Proportion of regional resource)
Commercial wind	1	3	0	36	95	0	0%
Small scale wind	0	0	0	1	1	0	3%
Hydro	0	0	0	5	18	0	0%
Solar PV	0	0	0	2	2	0	0%
Solar thermal	0	0	4	0	2	245	1%
Air source heat pumps	0	0	6	0	9	378	2%
Ground source heat pumps	0	0	4	0	7	256	2%
Biomass energy crops	0	0	23	12	186	1506	4%
Biomass woodfuel	0	1	7	0	18	456	2%
Biomass agricultural arisings (straw)	0	0	1	0	7	56	0%
Biomass waste wood	0	0	0	0	3	25	1%
Energy from waste wet	0	0	3	3	30	230	4%
Energy from waste poultry litter	0	0	0	2	11	0	0%
Energy from waste MSW	0	0	1	0	6	49	1%
Energy from waste C&I	0	0	1	1	11	89	1%
Energy from waste landfill gas	1	6	0	0	0	0	0%
Energy from waste sewage gas	0	0	0	0	1	0	0%
Total	3	11	78	64	532	5,189	

Table 55 Current capacity and renewable energy resource in Craven. Current" refers to facilities that are operational or have planning consent

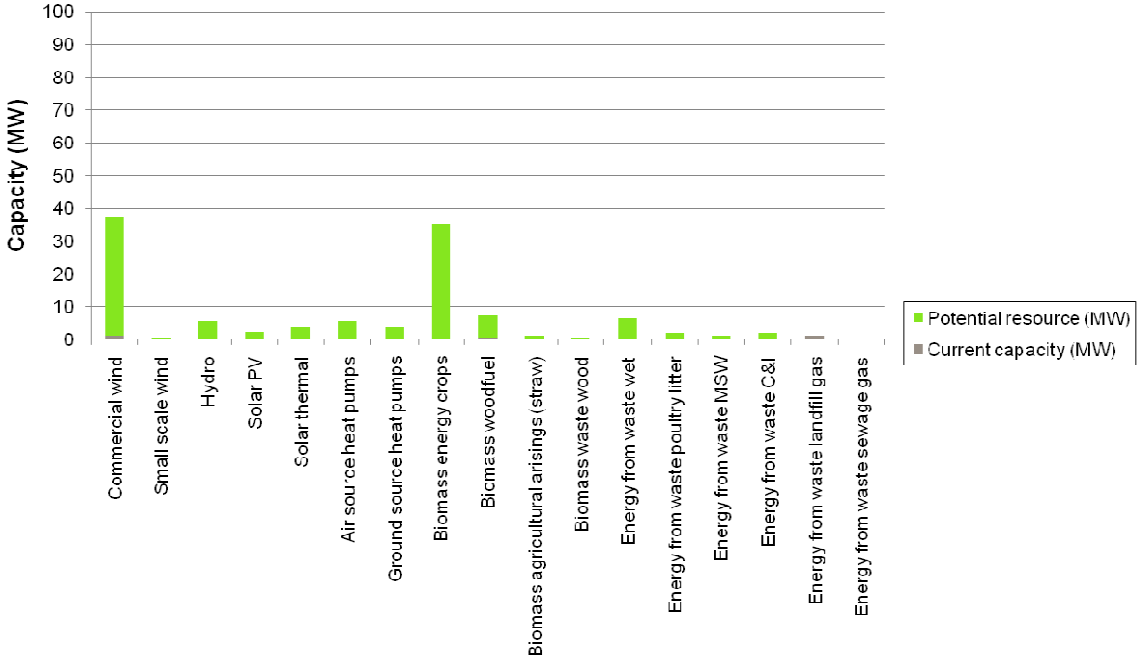


Figure 66 Current capacity and renewable energy resource in Craven. Current" refers to facilities that are operational or have planning consent.