Capabilities on project:
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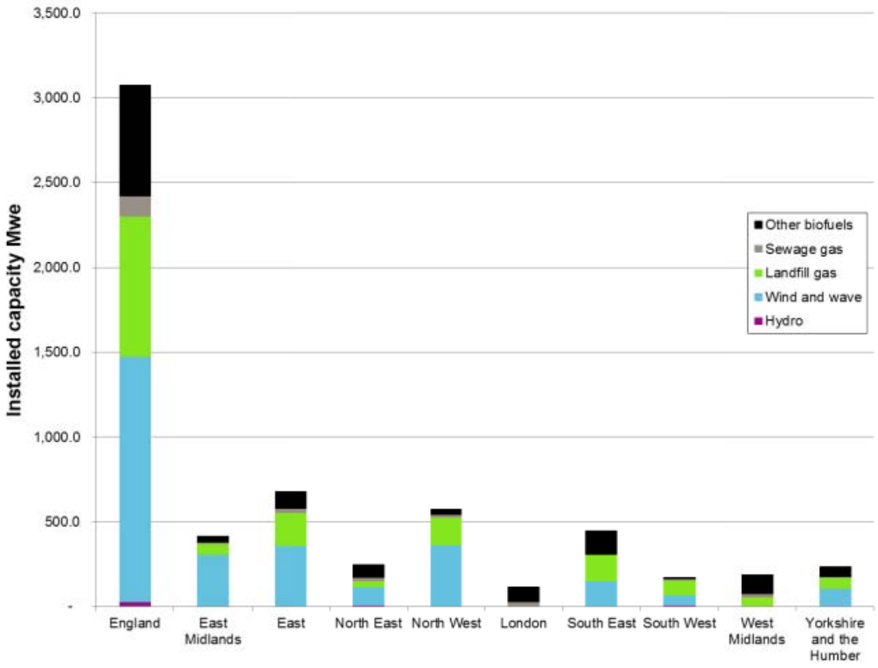

Figure 15 Installed renewable energy capacity in the Yorkshire and Humber region in 2009, relative to the other English regions (Source: DUKES 2009, DECC website, accessed November 2010)

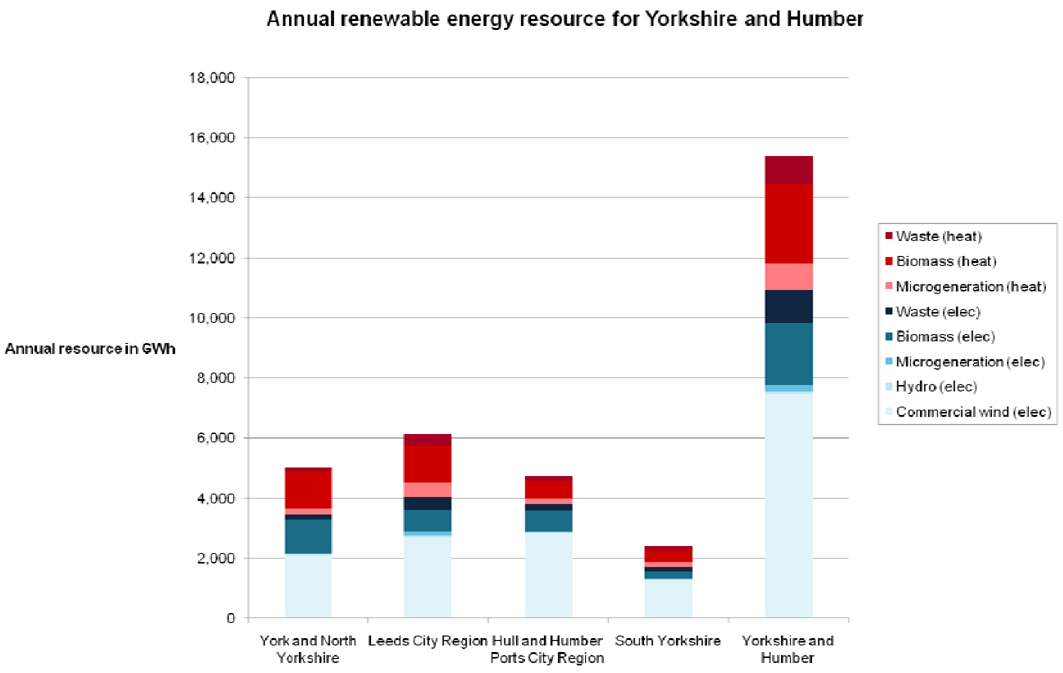

Figure 16 Renewable energy resource in Yorkshire and Humber, in terms of annual GWh of heat and electricity generation (excludes district heating resource).

5.7 Resource tables

The following tables show the current capacity and potential resource for renewable energy in the Yorkshire and Humber region by technology and by local authority.

Current capacity (MW)	District heating	Commercial wind	Small scale wind	Hydro	Solar PV	SWH	ASHP	GSHP	Biomass energy crops	Biomass woodfuel	Biomass agricultural arisings (straw)	Biomass waste wood	EfW wet	EfW poultry litter	EfW MSW	EfW C&I	EfW landfill gas	EfW sewage gas
Barnsley	0.0	25.8	0.1	0.0	0.8	0.0	0.0	0.0		1.7	0.0		0.0	0.0	0.0		0.0	0.4
Bradford	0.0	0.0	0.3	0.6	0.2	0.0	0.0	0.0		1.1	0.0		0.0	0.0	14.9		2.0	1.5
Calderdale	0.0	36.7	0.9	0.0	0.2	0.0	0.0	0.0		0.1	0.0		0.0	0.0	0.0		1.1	0.0
Craven	0.0	1.3	0.1	0.1	0.0	0.0	0.0	0.0		0.3	0.0		0.0	0.0	0.0		1.1	0.0
Doncaster	0.0	91.0	0.1	0.0	0.7	0.0	0.0	0.0		0.2	8.0		2.0	0.0	9.5		9.7	0.5
East Riding of Yorkshire	0.0	240.0	0.1	0.0	0.2	0.3	0.0	0.1		0.0	30.2		2.0	0.0	0.0		3.5	1.6
Hambleton	0.0	16.0	0.1	1.1	0.1	0.0	0.0	0.1		0.0	0.0		0.0	0.0	0.0		0.3	0.0
Harrogate	0.0	16.0	0.3	0.1	0.1	0.0	0.0	0.2		0.8	0.0		0.0	0.0	0.0		1.0	0.0
Kingston Upon Hull, City of	0.0	2.0	0.1	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	20.0		0.0	0.0
Kirklees	0.0	0.0	0.3	0.0	1.4	0.1	0.0	0.0		0.0	0.0		0.3	0.0	10.0		3.9	1.3
Leeds	0.0	0.0	0.1	0.2	0.5	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0		8.6	0.0
North East Lincolnshire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	6.0		1.0	0.7
North Lincolnshire	0.0	105.0	0.1	0.0	0.2	0.0	0.0	0.0		0.1	0.0		0.0	14.0	0.0		5.4	0.6
Richmondshire	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0		0.8	0.1
Rotherham	0.0	26.3	0.0	0.0	0.8	0.0	0.0	0.0		0.6	0.0		0.0	0.0	0.0		1.1	0.5
Ryedale	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0		0.8	8.0		0.0	0.0	0.0		0.3	0.1
Scarborough	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0		10.0	0.0
Selby	0.0	36.0	0.1	0.0	0.1	0.0	0.0	0.0		0.0	4.7		8.0	0.0	0.0		1.4	0.0
Sheffield	39.0	0.0	0.0	0.5	1.0	0.1	0.0	0.0		2.0	25.0		0.0	0.0	20.0		11.1	0.3
Wakefield	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0		0.9	0.0		0.0	0.0	0.0		14.6	0.3
York	0.0	0.0	0.2	0.0	0.2	0.1	0.0	0.0		2.8	2.5		0.0	0.0	0.0		6.6	0.6
York and North Yorkshire	0	69	1	1	1	0	0	0		5	15	0	8	0	0		22	1
Leeds City Region	0	116	2	1	4	0	0	0		8	7	0	8	0	25		40	4
Hull and Humber Ports	0	347	0	0	0	0	0	0		0	30	0	2	14	26		10	3
South Yorkshire	39	143	0	1	3	0	0	0		4	33	0	2	0	30		22	2
Yorkshire and Humber	39	596	3	3	7	1	0	1		12	78	0	12	14	80		83	9
Regional biomass schemes	**65**	**(this comprises the 65MW$_e$ consented biomass Stallingborough, EON scheme in North East Lincolnshire)**																
Co-firing schemes	**548**																	

Table 5 Current renewable energy capacity in the Yorkshire and Humber region, in terms of MW. “Current” refers to facilities that are operational or have planning consent. It has been assumed that all current biomass schemes contribute to the “Biomass woodfuel” capacity and all current EfW schemes contribute to the “EfW MSW” capacity. SWH refers to “Solar Water Heating,” ASHP refers to “Air Source Heat Pumps,” and GSHP refers to “Ground Source Heat Pumps.” Some local authorities are in more than one sub-region, therefore the capacity in Yorkshire and Humber is not equivalent to the sum of the capacity of the sub-regions.

Capabilities on project:
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Potential resource, Electricity capacity (MW)	District heating	Commercial wind	Small scale wind	Hydro	Solar PV	SWH	ASHP	GSHP	Biomass energy crops	Biomass woodfuel	Biomass agricultural arisings (straw)	Biomass waste wood	EfW wet	EfW poultry litter	EfW MSW	EfW C&I	EfW Landfill gas	EfW sewage gas
Barnsley		86	1.3	0.2	11				5.2		1.3	0.8	0.8	0.0	1.1	1.6		0.4
Bradford		70	2.5	4.3	28				2.3		0.0	2.0	1.6	0.0	2.7	4.9		1.4
Calderdale		110	0.6	2.3	7				2.7		0.1	0.5	1.0	0.2	0.9	1.9		0.0
Craven		36	0.6	5.4	2				12.4		0.4	0.2	3.0	2.2	0.4	0.7		0.0
Doncaster		298	1.3	0.3	13				6.5		3.9	0.9	1.2	0.0	1.8	2.5		0.5
East Riding of Yorkshire		652	2.9	0.0	11				26.7		36.0	0.9	4.7	3.9	2.2	2.5		1.6
Hambleton		226	1.3	0.1	3				23.0		7.4	0.2	3.4	2.4	0.6	1.3		0.0
Harrogate		126	0.8	0.8	4				17.1		4.6	0.3	3.4	2.3	1.0	2.2		0.0
Kingston Upon Hull, City of		12	0.5	0.0	9				0.0		0.0	0.7	2.4	0.0	1.5	2.9		0.0
Kirklees		129	1.5	2.3	16				4.0		0.5	1.3	1.4	0.2	2.3	3.9		1.3
Leeds		80	3.0	2.7	44				5.7		1.3	3.2	2.8	0.0	3.5	9.4		0.0
North East Lincolnshire		235	0.3	0.0	5				3.0		2.5	0.4	0.5	2.5	1.0	1.6		0.7
North Lincolnshire		188	1.8	0.0	7				8.9		12.9	0.6	1.1	13.4	1.0	1.8		0.6
Richmondshire		85	0.7	2.4	2				13.7		2.5	0.2	3.3	2.4	0.3	0.3		0.1
Rotherham		91	0.9	0.9	12				3.9		2.4	0.9	1.1	0.0	1.2	2.2		0.5
Ryedale		10	0.6	0.2	2				26.0		6.6	0.2	3.7	2.6	0.3	0.6		0.1
Scarborough		10	0.5	0.3	5				11.2		2.3	0.4	2.0	1.4	0.8	1.0		0.0
Selby		271	0.9	0.9	4				5.4		4.1	0.3	3.4	1.1	0.5	0.8		0.0
Sheffield		14	1.4	1.6	21				0.1		0.0	1.1	1.7	0.0	2.2	4.9		0.3
Wakefield		79	1.7	1.4	16				3.6		1.6	1.2	2.5	0.2	1.8	3.6		0.3
York		35	0.8	0.0	10				3.0		2.3	0.6	0.4	0.0	1.2	2.1		0.6
York and North Yorkshire		799	6	10	31				112		30	2	23	14	5	9		1
Leeds City Region		1,023	14	20	144				62		16	10	20	6	15	31		4
Hull and Humber Ports		1,087	6	0	33				39		51	2	9	20	6	9		3
South Yorkshire		489	5	3	58				16		8	4	5	0	6	11		2
Yorkshire and Humber		2,843	26	26	235				185		93	17	45	35	28	53		8

Table 6 Potential renewable energy electricity generation capacity in the Yorkshire and Humber region, in terms of MW. SWH refers to “Solar Water Heating,” ASHP refers to “Air Source Heat Pumps,” and GSHP refers to “Ground Source Heat Pumps.” Some local authorities are in more than one sub-region, therefore the resource in Yorkshire and Humber is not equivalent to the sum of the resource of the sub-regions.

Capabilities on project:
Building Engineering - Sustainability

Potential resource, Heat capacity (MW)	District heating	Commercial wind	Small scale wind	Hydro	Solar PV	SWH	ASHP	GSHP	Biomass energy crops	Biomass woodfuel	Biomass agricultural arisings (straw)	Biomass waste wood	EfW wet	EfW poultry litter	EfW MSW	EfW C&I	EfW Landfill gas	EfW sewage gas
Barnsley						17	9	1	9.4	27.3	2.5	1.5	0.9		2.3	3.2		
Bradford						37	25	2	4.3	24.0	0.0	4.1	1.9		5.4	9.9		
Calderdale						12	12	1	5.0	10.4	0.3	1.0	1.2		1.7	3.9		
Craven						4	6	4	22.6	6.8	0.8	0.4	3.4		0.7	1.3		
Doncaster						20	11	7	11.8	23.5	7.8	1.8	1.4		3.5	4.9		
East Riding of Yorkshire						20	15	3	48.5	55.3	72.0	1.7	5.4		4.4	4.9		
Hambleton						5	7	2	41.9	13.8	14.7	0.4	4.0		1.1	2.6		
Harrogate						8	9	3	31.2	10.0	9.2	0.6	4.0		2.0	4.5		
Kingston Upon Hull, City of						16	10	20	0.0	2.0	0.0	1.3	2.8		3.0	5.7		
Kirklees						26	21	31	7.3	17.7	1.0	2.6	1.6		4.6	7.9		
Leeds						60	31	4	10.4	33.3	2.6	6.5	3.2		7.0	18.8		
North East Lincolnshire						9	7	12	5.5	3.4	5.0	0.8	0.6		1.9	3.2		
North Lincolnshire						11	8	11	16.1	29.5	25.8	1.1	1.2		2.0	3.5		
Richmondshire						3	6	8	24.8	7.5	4.9	0.3	3.8		0.6	0.6		
Rotherham						18	10	6	7.1	13.6	4.8	1.7	1.3		2.5	4.4		
Ryedale						3	6	5	47.2	6.5	13.3	0.3	4.2		0.7	1.2		
Scarborough						7	12	4	20.3	10.5	4.5	0.8	2.2		1.6	1.9		
Selby						6	3	7	9.9	12.7	8.2	0.7	3.9		1.0	1.6		
Sheffield						34	21	9	0.2	8.9	0.0	2.1	2.0		4.5	9.7		
Wakefield						25	13	12	6.6	40.1	3.2	2.4	2.9		3.7	7.1		
York						13	9	9	5.4	7.2	4.6	1.3	0.4		2.4	4.1		
York and North Yorkshire						48	57	41	203	75	60	5	26		10	18		
Leeds City Region						207	138	74	112	190	32	21	23		31	62		
Hull and Humber Ports						56	39	45	70	90	103	5	10		11	17		
South Yorkshire						89	50	22	29	73	15	7	6		13	22		
Yorkshire and Humber						353	249	159	335	364	185	33	52		57	105		

Table 7 Potential renewable energy heat generation capacity in the Yorkshire and Humber region, in terms of MW. SWH refers to “Solar Water Heating,” ASHP refers to “Air Source Heat Pumps,” and GSHP refers to “Ground Source Heat Pumps.” Some local authorities are in more than one sub-region, therefore the resource in Yorkshire and Humber is not equivalent to the sum of the resource of the sub-regions. The district heating resource has already been included within the potential heat figures from other technologies.

Total resource (GWh)	District heating	Commercial wind	Small scale wind	Hydro	Solar PV	Solar thermal	Air source heat pumps	Ground source heat pumps	Biomass energy crops	Biomass managed woodfuel	Biomass agricultural arisings (straw)	Biomass waste wood	EfW wet	EfW poultry litter	EfW MSW	EfW C&I	EfW Biogas	EfW sewage gas
Barnsley	0	225	2	1	9	11	14	2	78	72	20	12	8	0	18	26	0	5
Bradford	0	183	3	14	21	22	40	4	35	63	0	32	16	0	43	78	0	14
Calderdale	0	290	1	8	6	8	20	2	41	27	2	8	10	1	14	30	0	4
Craven	0	95	1	18	2	2	9	7	186	18	7	3	30	11	6	11	0	1
Doncaster	0	784	2	1	9	12	17	12	98	62	61	15	13	0	28	39	0	6
East Riding of Yorkshire	0	1,714	4	0	9	12	23	5	399	145	568	14	47	20	34	39	0	6
Hambleton	0	594	2	0	2	3	10	3	345	36	116	3	35	12	9	20	0	1
Harrogate	0	331	1	3	3	5	15	5	257	26	72	5	35	12	16	35	0	2
Kingston Upon Hull, City of	0	32	1	0	7	10	16	37	0	5	0	10	25	0	23	45	0	5
Kirklees	0	339	2	8	12	16	33	56	60	47	8	20	14	1	37	62	0	9
Leeds	0	211	4	9	33	37	49	8	85	87	20	51	28	0	55	148	0	23
North East Lincolnshire	0	618	0	0	4	6	10	21	45	9	39	6	5	13	15	25	0	3
North Lincolnshire	0	493	2	0	5	7	12	19	133	78	203	9	11	69	16	28	0	4
Richmondshire	0	223	1	8	1	2	10	14	204	20	39	2	34	12	5	5	0	1
Rotherham	0	239	1	3	9	11	15	11	59	36	38	14	11	0	20	35	0	6
Ryedale	0	26	1	1	1	2	9	9	389	17	105	2	37	14	5	9	0	1
Scarborough	0	26	1	1	3	4	20	8	167	28	36	7	20	7	12	15	0	3
Selby	0	712	1	3	3	3	4	13	81	33	65	5	34	6	8	13	0	2
Sheffield	0	36	2	5	16	21	32	16	1	23	0	17	18	0	35	77	0	7
Wakefield	0	208	2	5	12	15	20	22	54	105	25	19	26	1	29	56	0	8
York	0	92	1	0	7	8	14	16	45	19	36	10	4	0	19	32	0	4
York and North Yorkshire	0	2,101	8	34	24	29	91	73	1,674	197	475	38	229	74	80	140	0	17
Leeds City Region	0	2,687	18	68	109	127	218	133	922	498	255	165	206	32	244	491	0	73
Hull and Humber Ports	0	2,856	7	0	25	34	62	81	577	237	811	39	88	102	89	137	0	17
South Yorkshire	0	1,284	6	10	44	55	78	41	236	193	119	57	49	0	100	176	0	25
Yorkshire and Humber	0	7,472	34	88	177	217	393	286	2,762	957	1,461	264	461	179	447	828	0	117

Table 8 Potential annual renewable energy generation capacity in the Yorkshire and Humber region by 2025, in terms of GWh. SWH refers to "Solar Water Heating," ASHP refers to "Air Source Heat Pumps," and GSHP refers to "Ground Source Heat Pumps." Some local authorities are in more than one sub-region, therefore the resource in Yorkshire and Humber is not equivalent to the sum of the resource of the sub-regions. The district heating resource has already been included within the potential heat figures from other technologies in Table 7.

5.8 District heating networks and CHP

5.8.1 Introduction

Energy demand has traditionally been met by electricity supplied by the national grid, heating supplied with individual boilers and cooling supplied through chillers. District heating is an alternative method of supplying heat to buildings using a network of pipes to deliver heat to multiple buildings from a central heat source. Building systems are usually connected to the network via a heat exchanger, which replaces individual boilers for space heating and hot water. This is a more efficient method of supplying heat than individual boilers and consequently, district heating is considered to be a low carbon technology that can contribute towards renewable targets.

The traditional method of generating electricity at power stations is inefficient, with at least 50% of the energy in the fuel being wasted. A CHP plant is essentially a localised power station but makes use of the heat that would normally be wasted through cooling towers. This heat can be pumped through district heating networks for use in buildings. Since it is generated closer to where it is needed, electricity losses in transmission are reduced.

The economics of district heating networks and CHP are determined by technical factors including the size of the CHP engine and annual hours of operation (or base load). Ideally, a system would run for at least 4,500 hours per year for a reasonable return on investment which is around 17.5 hours per day, five days per week, or 12.5 hours every day of the year. CHP is therefore most effective when serving a mixture of uses, to guarantee a relatively constant heat load. High energy demand facilities such as hospitals, leisure centres, public buildings and schools can act as anchor loads to form the starting point for a district heating and CHP scheme. These also use most heat during the day, at a time when domestic demand is lower.

The potential for establishing networks to supply electricity and heat at a community scale from local sources is discussed in this section.

5.8.2 Existing heat networks and CHP

The study has not identified many existing district heating networks across the region (Appendix E Table 82). For the most part, these are small scale networks associated with local authority owned housing estates. Rotherham in particular has a number of small networks served by communal boiler houses.

The most well-known network in the region in the Sheffield district heating network, which provides more than 130 buildings around the city centre with energy generated from residual waste. Buildings connected to the network range from offices and public buildings to hotels and residential premises.

5.8.3 Potential for heat networks with CHP

The potential to supply low carbon heat through district heating networks with CHP has been assessed and mapped using a methodology developed by AECOM, as the DECC methodology does not provide an approach for this. Details of the AECOM mapping methodology are provided in Appendix A.2.

The heat mapping exercise has identified areas where there may be sufficient heat demand from existing buildings to support a commercially viable district heating or CHP system and the results are shown in Figure 17. The relative viability of areas in the region for district heating is shown through colours of increasing intensity, from yellow to orange to red.

Due to its largely rural nature and relatively low density of development, the potential for district heating and CHP in the region is limited. Most of the potential is located within or around the major urban centres – Leeds, Sheffield, Doncaster, York and Hull. There are also some smaller areas of potential in Harrogate District, Scarborough, Scunthorpe and around the ports in Immingham.

Numerous buildings within urban centres in the Yorkshire and Humber region could act as anchor loads to reduce risk for investment in district heating networks. These include public buildings, hospitals, leisure centres and new, mixed use development sites and are shown on Figure 17.

There are also a number of “mini-networks” in the region, where electricity is generated at a dedicated power plant and used to serve a nearby industrial load. Examples include the straw burning, energy generation plant at the Tesco Distribution Centre in Goole. There is potential to use these networks to deliver waste heat as well.

5.8.4 Conclusions from heat networks potential assessment

Where there is potential and based on the current grid mix, district heating with biomass CHP is the most cost-effective solution for the supply of low carbon heat in terms of cost per amount of carbon saved.[15] Once networks are in place they can be made flexible in that they have the potential to be served by a range of low carbon fuel sources, which could change over time in response to available incentives and the availability of fuel supply.

Although there is some potential for district heating networks as shown in Figure 17, delivering district heating networks at scale has proved difficult to date and there are a range of timing, planning, financial and technical hurdles to overcome. The barriers include:

- Lack of scale, diversity and security of load to create a viable network. A strategic approach to the planning and phasing of district heating infrastructure and plant is crucial for success;
- Phasing and timing issues, including lack of committed and secure base-loads to attract investment in required infrastructure. Uncertainty around timing and delivery of networks, preventing developers from committing to solutions outside the red line boundary of their own site;
- Varying local authority capacity and commitment to lead and enable delivery. Even where loads can be aggregated there may be reluctance for the private or public sector to invest unless loads can be guaranteed;
- Lack of evidence base required for decision making at a community scale.

[15] The potential and costs of district heating networks, Faber Maunsell and Poyry, April 2009

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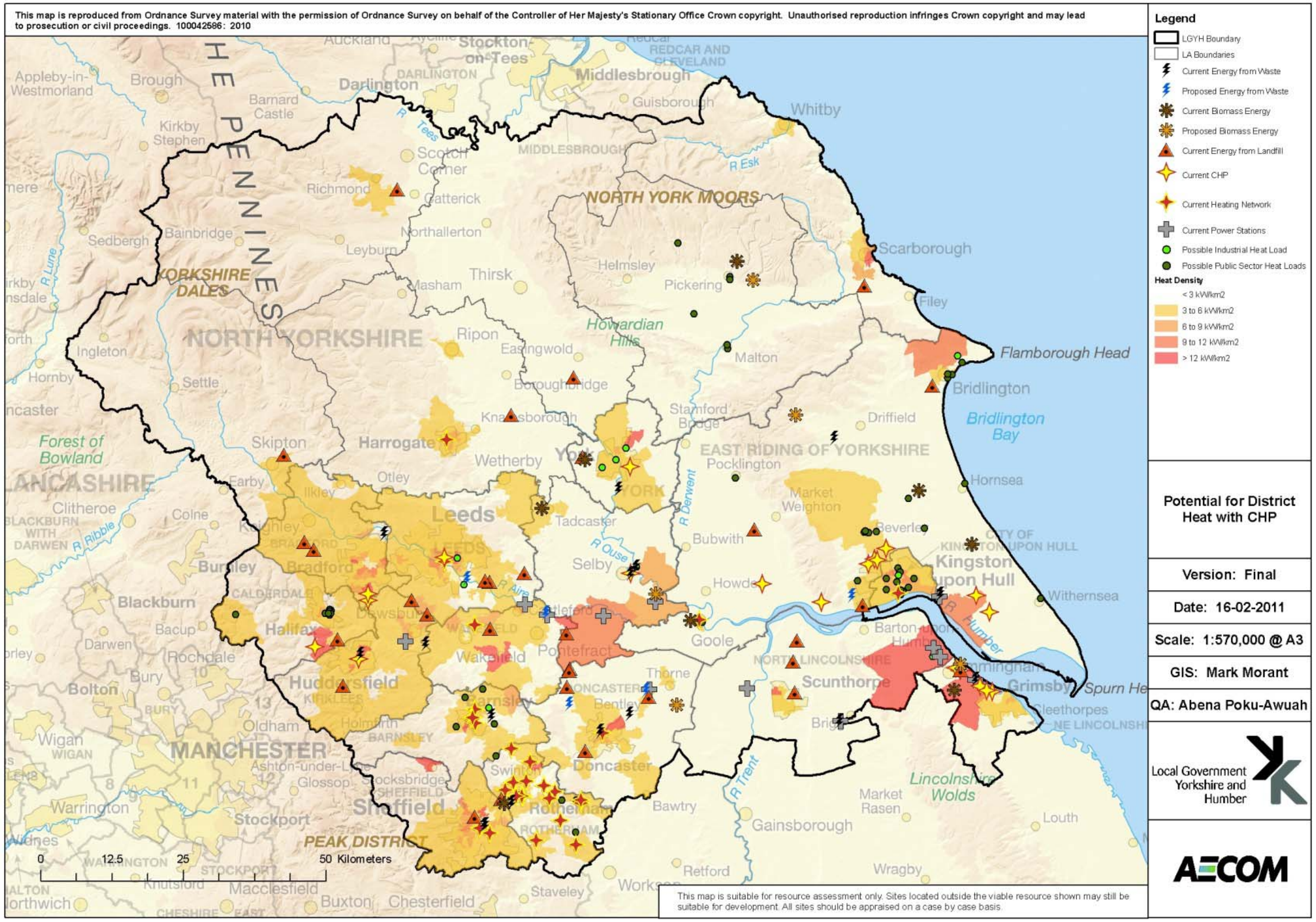

Figure 17 Potential for district heating with CHP, based on heat density. The areas with most potential are shown in red, areas with least potential are shown in yellow.

5.9 Wind energy resource

5.9.1 Introduction

Wind turbines convert the energy contained in the wind into electricity. Large scale, free standing wind turbines have the potential to generate significant amounts of renewable energy.

The potential for renewable energy generation from large scale, onshore wind turbines for commercial energy and supply is described in this section. The potential for offshore wind energy generation has not been included in this assessment.

5.9.2 Existing wind energy capacity

Installed or consented commercial scale, wind energy capacity in the region is around 592 MW. The greatest deployment of wind energy has been in East Riding of Yorkshire, followed by North Lincolnshire. The locations of the wind farms above 1MW capacity are shown as purple dots on Figure 23.

Figure 18 shows the progress of installed wind against the RSS target. Barnsley, Calderdale, Doncaster, East Riding of Yorkshire, Harrogate, Leeds, North Lincolnshire, Rotherham and Selby have exceeded their targets for commercial scale wind.

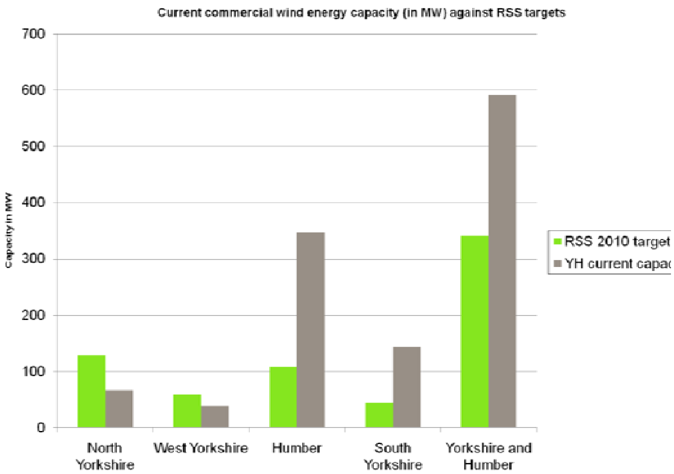

Figure 18 Progress of current commercial wind energy capacity against 2010 RSS targets. “Current” refers to facilities that are operational or have planning consent.

Most new wind farms are in the 10 MW to 50 MW range. Major wind farms include the 85 MW Keadby site in North Lincolnshire and the 66 MW wind farm at Tween Bridge in Doncaster. There are very few wind farms in the north of the region due to the presence of the National Parks and AONBs and the four MoD aerodromes.

There are four offshore wind farms proposed off the Humber, Dogger Bank, Hornsea, Westernmost Rough and the Humber Gateway, which could result in installed capacities of up to 13,000 MW, 4,000 MW, 245 MW and 300 MW respectively.

Figure 19 The 9 MW, 23 turbine, Ovenden Moor Wind Farm in Calderdale. This wind farm has been operational since 1993 and an application has been submitted to planning for repowering of the site with larger turbines. (Source: Nigel Homer, March 2005, retrieved from Wikimedia website, accessed November 2010)

5.9.3 Potential wind energy resource

The UK Wind Speed database shows that wind speeds across the region range from 5 m/s in the lower lying areas to 9 m/s on the North York Moors and Yorkshire Dales National Parks (Figure 22). Wind speeds of at least 6m/s are necessary for commercial viability. Most of the region therefore has sufficient wind speed for commercial scale wind energy generation and the constraints on development tend to come from large areas of high landscape and environmental sensitivity and the presence of a number of MOD sites.

The economically viable capacity of the region for commercial scale wind energy is around 2,800 MW. This has the potential to generate just under 7,500 GWh electricity annually, equivalent to over 6% of regional energy demand in 2008 and the energy use of around 510,000 homes.

Most of the economically viable wind energy resource lies in a band through the centre of the region from Teeside Airport just north of the regional boundary to Scunthorpe in the south, and along the east coast of the region in East Riding of Yorkshire. The local authority with the most potential is East Riding of

Yorkshire. There is relatively little potential in Kingston upon Hull, Scarborough and Sheffield.

5.9.4 Financial implications of wind energy

Wind turbines, when located appropriately in areas of high wind speeds, are one of the most cost effective renewable energy technologies currently available in the UK. Generally the capital cost of wind turbines reduces as the size of the turbine increases. As of February 2009, large scale wind power is projected to cost around £800 per kilowatt installed[16]. A typical cost breakdown is provided in Figure 20. The biggest influence on the cost of projects is the cost of the turbine, which is influenced by the cost of steel (for turbine components) and the exchange rate. The cost of grid connection is around 10% of total project costs.

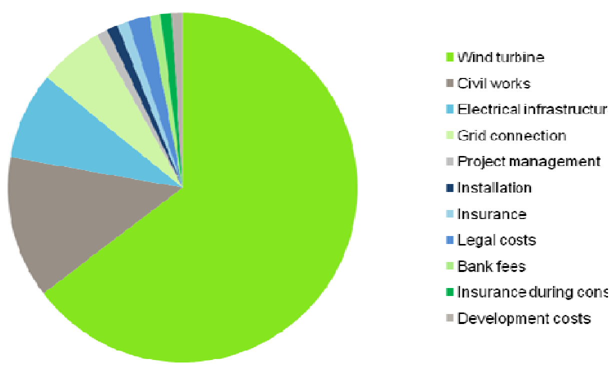

Figure 20 Capital cost breakdown for a large scale wind turbine. (Source: The economics of onshore wind energy; wind energy fact sheet 3, DTI)17

5.9.5 Conclusions from wind energy resource assessment

Commercial scale wind energy generation represents one of the most cost effective renewable energy technologies. The relatively high installed capacity and number of planning applications for wind farms across the region shows that the opportunity is being exploited.

This study has applied a number of assumptions to the technically accessible wind energy resource to deduce the resource that is economically viable. Although this can provide a high level indication of the potential, many of the constraints on wind energy development are subjective and have evolved over time. Figure 23 shows that there are wind farms located in areas with characteristics that have been ruled out in other areas. For example, Knabs Ridge Wind Farm is located on the boundary of the Nidderdale AONB. This is encouraging and implies that each site is being assessed on its individual merits.

Discussion with wind farm developers undertaken as part of this study has suggested that the overwhelming barrier to delivery of projects in the region is delays within the planning system. Obtaining planning permission for new sites is taking approximately 2 years. Stakeholders have commented on lack of consistency in decisions by consultees and a lack of knowledge of the technicalities of delivery in planning departments.

Further activity to encourage wider understanding of renewable energy through education and awareness raising has been suggested as a key recommendation to increase deployment of wind energy. Region wide or sub-regional guidance for planning officers on the interpretation of visual information such as zone of visual influence maps would be welcomed by developers. It was also suggested that adopting design principles, such as those produced by Scottish Natural Heritage on the cumulative effect of wind farms[18], would encourage consistency in assessing applications.

The effect of large wind turbines on landscape amenity remains an emotive issue. This study has reduced the economically viable potential for wind energy due to landscape constraints, on the basis of discussion with Natural England and other relevant stakeholders. An assessment of landscape sensitivity was outside of the scope of this study and the studies that have been already out (such as the South Pennines study[19]) were extremely useful. It is recommended that an assessment of the sensitivity of the landscape to objects such as large wind turbines is carried out for the whole region, either at a sub-regional or local level.

The cumulative impact of wind farms in relatively close proximity will become an important visual amenity issue for the region, particularly in areas such as East Riding of Yorkshire or Hull, where there are already many turbines. The methodology for this study has considered cumulative impact to be a specific constraint on development (separate to development in visually

[16] BWEA Small Wind Turbine FAQ (BWEA website, accessed September 2009)
[17] The economics of onshore wind energy; wind energy fact sheet 3 (DTI, June 2001)
[18] Cumulative effect of wind farms, Scottish Natural Heritage, April 2005
[19] Landscape Capacity Study for Wind Energy Developments in the South Pennines, Julie Martin Associates, January 2010

sensitive landscapes) and has reduced the economically viable potential accordingly.

The possible detrimental effect of large scale wind farms on military and aviation radar operation has also been a constraint for wind energy development in the region, as with the rest of the country. In 2008, around 47% of wind farm applications in the UK were rejected on radar grounds.[20] Turbines within line of sight of the radar will generally have the most effect, which can be a major issue for military air defence radar such as the instrument at Staxton Wold, which can have a range over large swathes of the region, up to 200 km in some cases.

Discussion with stakeholders has suggested that there are mitigation solutions available that are currently at the research stage but are likely to come forward in the short to medium term. These include the “Raytheon” solution which can be applied to NATs equipment, a 3D holographic solution proposed by Cambridge Consultants[21] and “Verifye” developed by Qinetiq.[22] AECOM is aware of one solution due to be implemented at Robin Hood airport in Doncaster, which should open up the area in the vicinity of the airport to commercial wind energy generation. Requirements for mitigation can also be included within the conditions for planning approval.

In our judgement, whilst radar mitigation has been a significant issue in the past, major issues should be resolved within 5-10 years. Consequently we have not reduced the economically viable potential because of radar concerns.

The capacity of the electrical network may also become a constraint on commercial scale wind energy development. Wind farms typically connect into the 33kV network. The cumulative impact of clustering of wind farms may become an issue, particularly in East Riding which is a light load area.

[20] Resolution of radar operation objections to wind farm developments W/45/00663/00/0, BERR, 2008
[21] “Wind farms vs. radar – seeing through the clutter”, presentation by Cambridge Consultants, October 2008
[22] Vertical radar speeds up planning applications, Qinetiq website, accessed January 2011 http://www.qinetiq.com/home/markets/energy_environment/wind_energy/maximum_radar_coverage.html

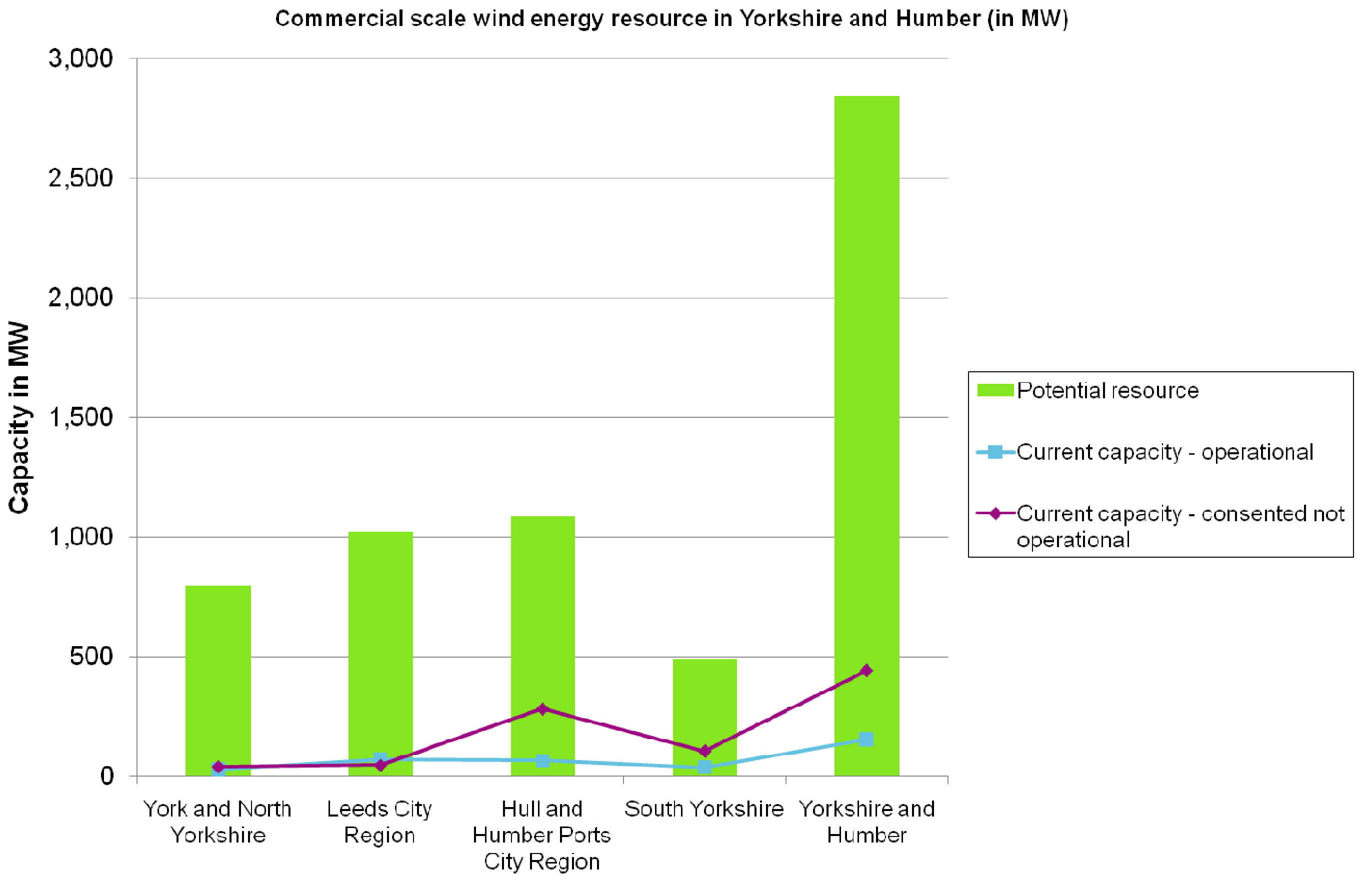

Figure 21 Commercial scale wind energy resource in Yorkshire and Humber, by sub region, in terms of potential MW.

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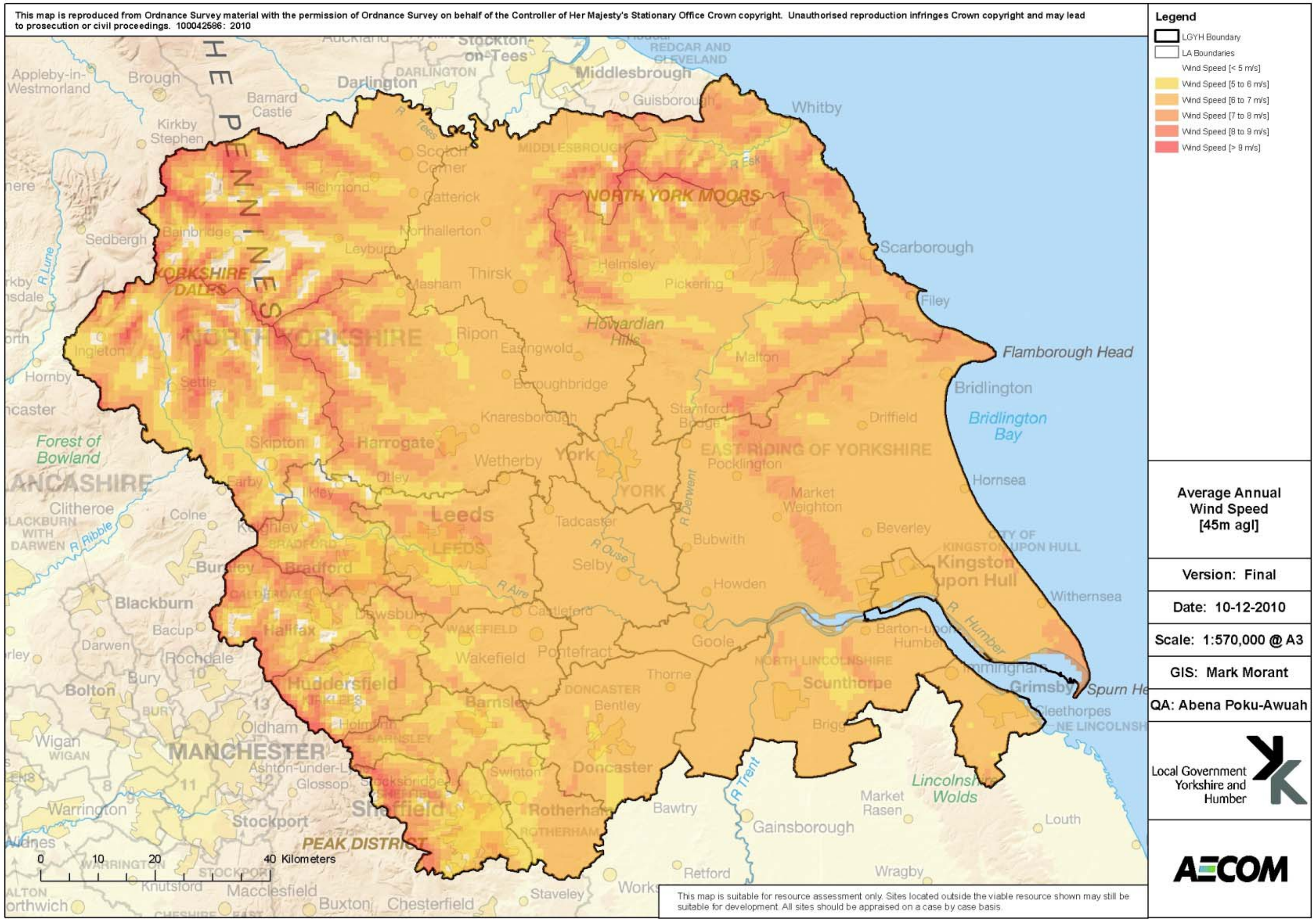

Figure 22 Annual average wind speed in Yorkshire and Humber in m/s, at 45 m height above ground level (Source: UK Wind Speed Database, accessed November 2010).

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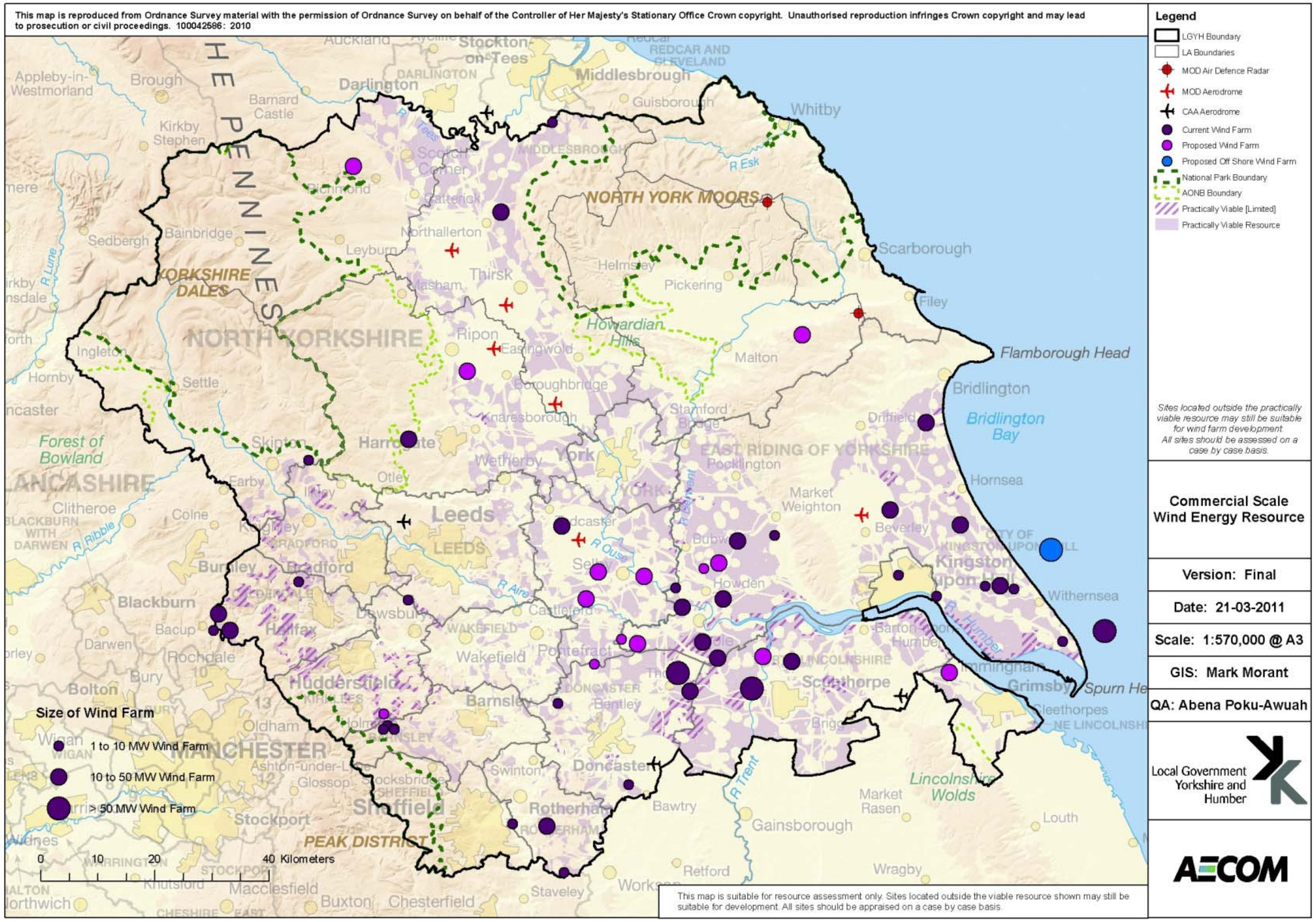

Figure 23 Commercial scale wind energy resource in Yorkshire and Humber. There are two further offshore wind farms in planning off the east coast (beyond boundary of map), Dogger Bank and Hornsea. “Current Wind Farm” refers to facilities that are operational or have planning consent. “Proposed Wind Farm” 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 shaded 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 appendix A.2.3 for more details.

5.10 Hydro resource

5.10.1 Introduction

Hydro power involves the generation of electricity from passing water (from rivers, or stored in reservoirs) through turbines. The energy extracted from the water depends on the flow rate and on the vertical drop through which the water falls at the site, the head.

5.10.2 Existing hydro energy capacity

Analysis of the British Hydro Association database and installed installations under the FIT scheme shows that there is around 3 MW of hydro energy capacity consented or installed in the region as of 2010. This is primarily located in the Hambleton district, which has a third of the region's capacity and is home to the largest consented scheme in the region, the 1MW Linton Lock facility. It should be noted that although it has been granted planning consent, the Linton Lock scheme has yet to be constructed (Figure 25).

Figure 24 Bonfield Ghyll hydro facility in the North York Moors National Park (Source: Case study, Mann Power Consulting Ltd)

Figure 25 Linton Lock hydro energy site (Source: Our heritage and the changing climate: Yorkshire and the Humber, Natural England, 2008)

Figure 26 shows the progress of installed and consented hydro schemes against the RSS targets. It shows that if the consented schemes are actually built then the majority of local authorities in the region will have exceeded the targets set in the RSS for hydro power.

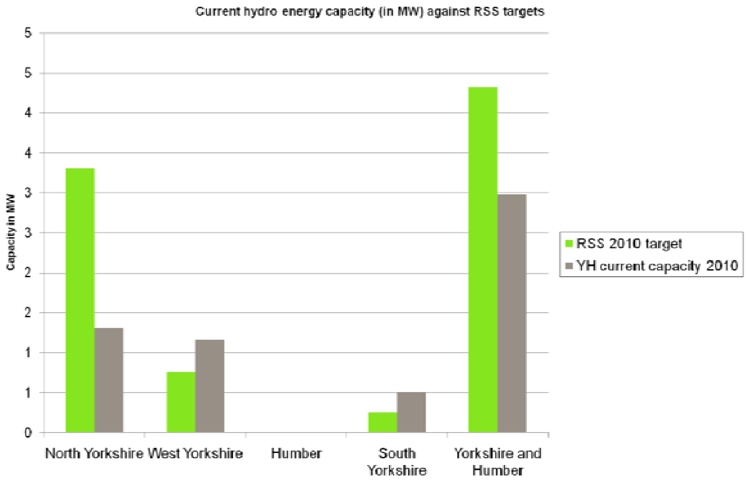

Figure 26 Progress of current hydro power schemes against 2010 RSS target. "Current" refers to facilities that are operational or have planning consent.

5.10.3 Potential hydro resource

The hydro energy resource has been identified through engagement with the Environment Agency. This identified all existing barriers within rivers in England and Wales. These represented sites where there is sufficient height in river level to provide a hydropower opportunity. These sites are mostly weirs, but could be other man-made structures, or natural features such as a waterfall.

Sites with high environmental sensitivity or where the power output would be less than 10kW were then removed from further consideration. The remaining sites are shown spatially on Figure 30. We then reduced the overall resource by 75%, to represent the constraints that typically arise at the feasibility study stage.

The economically viable capacity for hydro energy is around 26 MW, primarily located in the west within the Leeds City Region. This has the potential to generate around 88 GWh electricity annually, equivalent to the energy use of 6,000 homes, or the output from 13 commercial scale wind turbines. The Hull and Humber Ports sub-region has practically no potential for hydro energy generation.

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5.10.4 Financial implications of hydro energy

The most important parameter in dictating the overall viability of a low-head scheme is the available head. Generally, the lower the head, the higher the cost per kW of the scheme. Expert opinion within the hydro industry suggests that sites where the head is below 2 metres and/or below 100kW in size are difficult to make cost-effective using standard methods and consequently only projects offering installed capacities greater than 15kW are likely to be developed[23].

The cost of developing a hydro scheme is currently around £7,000 per kW installed, although the constraints on individual sites can cause the cost to vary greatly between sites.

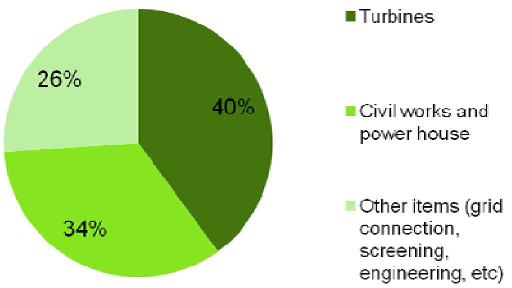

Figure 27 Typical cost breakdown for a hydro energy scheme (Source: Sustainability at the Cutting Edge, Smith, F, 2007)

5.11 Conclusions from hydro resource assessment

The assessment of the hydro resource suggests that small-scale hydropower has an important but limited role to play in renewable energy generation. Whilst not particularly cost-effective in comparison to other renewable energy technologies, hydro schemes could play a useful role in education and increasing awareness of the benefit of renewables. Yorkshire has a rich heritage of hydro schemes, used to power mills before coal. Although many of the original buildings, weirs and mill ponds have fallen into various states of disrepair, the many derelict mill sites that once captured the energy in water for operating machinery could be revitalised as micro and small-scale electricity generators.

Ideally, hydro development should not impact rivers in a negative way - small-scale schemes, which do not involve collecting water behind dams or in reservoirs, have very little impact on the environment. Hydro schemes do not necessarily have to be detrimental to the environment and there are “win win sites” where connectivity of rivers and ecology can be improved with hydro schemes.

High level feasibility studies are good for whetting the appetite of local authorities. However, it is not really possible to assess feasibility at a lower level without expensive site visits. Bureaucracy and regulations are also a barrier to development at the moment, i.e. the process of obtaining Environment Agency consents, construction licences, river consents, fish pass consents, etc. The Environment Agency is actively trying to streamline this process and is also in the midst of a follow up study on UK hydro schemes which should filter out sites that are probably unviable.

[23] Low Head Hydro Power in the South-East of England –A Review of the Resource and Associated Technical, Environmental and Socio-Economic Issues, TV Energy and MWH, February 2004

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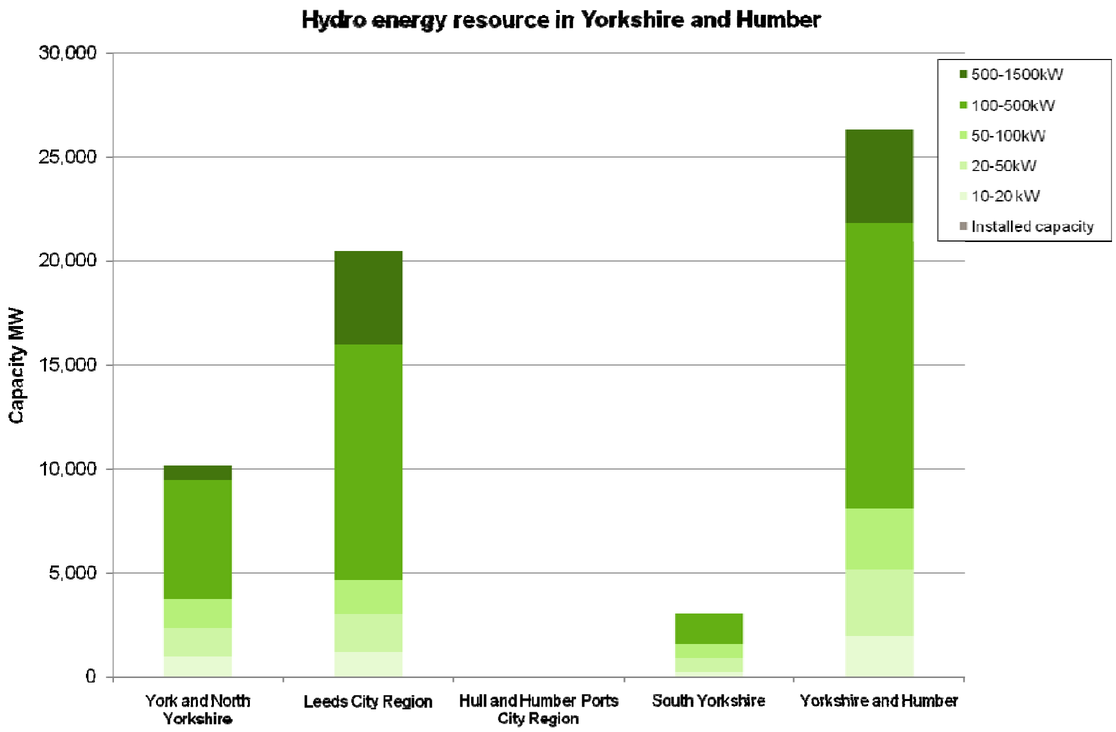

Figure 28 Hydro energy resource in Yorkshire and Humber by sub-region, in terms of potential MW. “Current” refers to facilities that are operational or have planning consent.

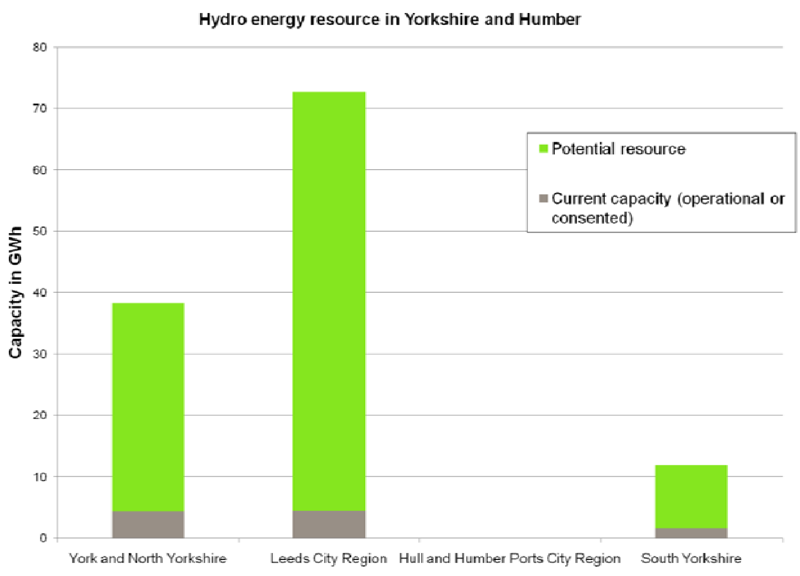

Figure 29 Hydro energy resource in Yorkshire and Humber, in terms of potential annual energy generation in GWh. “Current” refers to facilities that are operational or have planning consent.

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Figure 30 Hydro energy resource in Yorkshire and Humber. “Current Hydro Energy” refers to facilities that are operational or have planning consent. “Proposed Wind Farm” refers to facilities currently in the planning system.

5.12 Biomass resource

5.12.1 Introduction

Biomass is a collective term for all plant and animal material. It is normally considered to be a renewable fuel, as the carbon emissions emitted during combustion have been (relatively) recently absorbed from the atmosphere by photosynthesis.

The potential for energy generation from dedicated energy crops, managed woodland, industrial woody waste and agricultural arisings (straw) is described in this section.

Arboricultural arisings from the pruning of trees have not been included in the assessment since this resource is difficult to quantify and logistically difficult to source.

The potential for energy generation from other animal waste products (such as poultry litter) is described in section 5.13.

5.12.2 Co-firing of biomass

Under the Renewables Obligation, co-firing of biomass with coal or oil in large scale power generation is encouraged.

In order to stimulate the development of a supply chain, large scale power generators receive twice the level of support if they co-fire with energy crops rather than other forms of biomass. There is a limit on electricity suppliers for how much of their obligation they can meet from purchasing or claiming ROCs from co-firing from non-energy crops biomass, without CHP. However, this limit does not apply to co-firing from energy crops or to co-firing with CHP and there are no restrictions on whether the biomass crops have to be sourced locally.

All three major coal-fired power stations in the region are currently co-firing with biomass. The main factors affecting the level of cofiring are the cost of fuel and whether the fuel is physically compatible with the rest of the fuel stream.

Prior to 2010, Drax had about 100MW of co-firing capacity, up to about 2.5% of installed capacity, based on putting biomass through the same mills as the coal. In 2010, the plant installed 400MW of biomass direct injection plant which enables a greater proportion of biomass to be used. This brings the current installed co-firing capacity to 500MW, or 12.5% of total capacity, with the potential to co-fire up to 1.5 million tonnes of biomass per year. Drax believes that this now makes them the largest co-firing facility in the world.[24] A range of fuels are being used, both from the UK and imported, including energy crops, wood and tall oil. Drax has built a straw pelleting plant in Goole which became operational in 2009, and can process 100,000 tonnes of pellets per annum. Drax also secured planning consent in 2010 to build a second straw pelting plant, with a capacity of 150,000 tonnes per annum, at Somerby Park in Gainsborough, Lincolnshire.

Imported olive pellets are used as biomass co-firing material at Ferrybridge “C” power station. The biomass capacity of the plant peaked at about 2.9%, or 58MW, in 2005/6, but fell to 1.3% (26MW) in 2007/8. Ferrybridge did invest in some dedicated biomass burners in 2006, but with the financial incentives currently available, their operation is not economically viable at present. Currently the plant is limited to the maximum amount of biomass it can put through the coal mills, without causing clogging of the mills. This limit is about 3% by mass, or about 1.5% of output. However, this amount will halve from 2016 when a proportion of Ferrybridge’s generating capacity (1 GW) is scheduled to close under the LCPD (see section 4.4 for details).

Olive pellets are the main source of biomass co-firing material at Eggborough power station. Almost 18,000 tonnes are used annually.[25] Analysis of ROC data shows that in 2008/9 about 1.1% (22MW) of the output of the plant came from co-firing. Eggborough is not planning to reduce any of its coal fired capacity and all of its capacity will be LCPD compliant.

5.12.3 Existing biomass capacity (non co-firing)

There are only a few examples of operational biomass power or CHP schemes in the region. These are:

- The 4.7MW_e facility at John Smith’s brewery, Tadcaster in Selby district. This is fuelled by spent grain and locally sourced wood chip and supplies steam and electricity for process use;
- The 2.5MW_e biomass facility at Sandfield Heat and Power in Brandesburton, in East Riding. This is fuelled by waste wood. This scheme was developed by Bioflame, who are based in Pickering, Ryedale. Bioflame also have a 0.5MWe demonstration scheme at their Pickering site;
- The 2MW_e biomass facility operated at Bioflame at South View Farm in Ryedale.

However, there are a significant number of other schemes that have either received planning consent or are currently in

[24] Biomass Growth Strategy, Drax group PLC, October 2008

[25] Sustainability Report on biomass fuelled generating stations, Ofgem,

planning. These are covered under the “potential” section 5.12.4 below.

In terms of current biomass heating (wood fuel) installations, these, along with their potential uptake, are considered under the microgeneration section later in this report (section 5.14.2).

Figure 31 Delivery of biomass at Sheffield Road flats, Barnsley (Source: Case study – Sheffield Road – Barnsley MBC)

5.12.4 Potential biomass resource

Straw

The resource assessment showed that there were about 0.56 million tonnes of straw per annum available for energy generation in the region, after allowing for 50% of the resource being left on the fields for fertiliser. The majority of this resource is in East Riding and North Lincolnshire, with a significant contribution also from North Yorkshire districts. This could support $93MW_e$ of installed capacity, equivalent to the energy use of around 43,300 homes.

Given the size of this resource, it is perhaps surprising that there are currently no operational straw combustion facilities in the region. However, there are three straw burning CHP schemes that have been granted planning consent in recent years, all in East Riding district, with a total capacity of $30MW_e$. These are:

- Tansterne straw burning plant in Flinton, developed by GB-Bio, 10MWe, which will supply heat and CO_2 to glasshouses;
- Tesco distribution centre in Goole, $5MW_e$, where some of the heat will be used for buildings;
- Gameslack farm, Wetwang, $15MW_e$.

As mentioned under the co-firing section 5.12.2, some of this resource is likely to also be pelletised for use in co-firing, at the pellet mill in Goole, for example.

A planning application was also submitted in 2009 for a $40MW_e$ straw burning plant at the former British Sugar works in Brigg, North Lincolnshire. This was refused planning consent in 2010, but at the time of writing was due to go to appeal in Spring 2011.

Energy crops

The resource assessment showed that for the medium scenario defined within the DECC methodology, where energy crops are only grown on land not used for arable crops (see appendix A.9.2), there is the potential for planting about 64,000 ha of energy crops, which could yield about 1.1 million oven dried tonnes of fuel per annum by 2020. The analysis found that this was made up of 8,339 ha of short rotation coppice (SRC) and 55,832 ha of miscanthus.

The majority of this resource is in North Yorkshire, but there is also significant potential in East Riding and North Lincolnshire. If all of this were to be used for biomass electricity generation and CHP facilities, this could support an installed capacity of about 185 MW_e, equivalent to the energy use of around 86,200 homes. In practice, a significant proportion of this resource may be used for co-firing. It may also be grown for wood fuel, particular on farms and estates where they have installed their own wood fuel boilers.

Currently, there is just under 1800 ha of energy crops planted in the region[26], i.e. just under 3% of this resource. There are areas of the region with fertile, peaty soil that should be beneficial for growing short rotation coppice (SRC), especially with impact of higher temperatures expected from climate change. On the other hand, these crops may be more at risk of flood damage. Natural England has advised that they would expect schemes that avoid peaty soils as advised in the Best Practice Guide to growing Short Rotation Coppice.[27]

Imported biomass

Over the last few years there has been considerable interest in developing large scale biomass power stations on the Humber that would be fuelled mainly by biomass imported by sea. Drax has announced plans for a 290MW facility at Immingham, North Lincolnshire. A section 36 application was lodged with the Department for Energy and Climate Change towards the

[26] Based on data from the UK Government Energy Crop Scheme
[27] Growing Short Rotation Coppice, DEFRA, August 2004

end of 2009. Able UK has also announced plans for a 300MW_e biomass facility for the south bank of the Humber, although it is not clear if a formal application has yet been lodged. In addition, Drax also lodged a section 36 application for a second 290MW_e facility in Selby. At the time of writing, it is unclear whether or not DECC has approved the Drax applications, nor whether Drax intend to continue developing them. In early 2010, Dong Energy also announced plans for a biomass power station at Queen Elizabeth dock in East Hull. However, they subsequently withdrew these proposals later in 2010.

A proposed 65MW_e scheme at Stallingborough, on the south side of the Humber, was granted planning consent by the Secretary of State in 2008, under a section 36 application. Formerly this was owned by Helius Energy, but has since been bought by RWE. The scheme has yet to be built.

Waste wood

Based on the DECC methodology, the amount of wood waste that could be available in the region from the construction sector by 2020 was estimated to be about 100,000 odt per annum. This assumes that only 50% of the resource would be available due to competing uses. If all of this went to electricity production, or CHP, this could support 17MW_e of biomass generation capacity, equivalent to the energy use of around 7,800 homes.

It is acknowledged that there are also potentially significant additional volumes of wood waste within the commercial and industrial mixed waste stream. A 2009 study for Resource Efficiency Yorkshire[28] found that there was potentially up to 318,000 tonnes per annum of wood waste being produced by the commercial and industrial sectors in the region.

However, for this study, we have considered this resource as part of the biodegradable proportion of the potential for energy generation from waste, which is covered later in this report (section 5.13.1).

As mentioned above, there are already a few (pioneering) operating examples of energy generation from wood waste in the region, in Ryedale and East Riding. A proposal by EON for a 25MW_e scheme at Blackburn Meadows in Sheffield also received planning consent in 2008, but this has yet to be built. Futhermore, Dalkia has submitted proposals to the Secretary of State (under section 36) for a 56MW_e scheme located at Pollington airfield, in Selby. The wood waste would be transported to the site via the Aire and Calder canal. At the time of writing, it is not known whether the scheme has received approval.

It is worth noting that not all of the wood waste would necessarily be used for dedicated electricity generation or CHP plants. Clean wood waste may be pelleted to be used as wood fuel or for co-firing. In 2010, Dalkia commissioned a waste wood pelleting facility at Pollington airfield in Selby which can produce up to 50,000 tonnes per year of pellets.

Figure 32 Woodpile at Smithies Depot, Barnsley where waste wood is collected. (Source: Climate Change Case Study: Barnsley Metropolitan Borough Council, Efficiency North)

Managed woodland

Data from the Forestry Commission suggests that there could be only a fairly limited amount of 22,000 odt of wood fuel available per annum from thinnings and fellings from woodland management in the region, by 2020. This would be from both Forestry Commission and private sector woodland over 2 ha in size. This estimate is an upper limit as it does not take account of whether it would be economically viable to extract timber or thinnings from all of this woodland.

This figure is based on only stemwood of 14cm in diameter or less going into the woodfuel market, as larger sizes would tend to go into the sawn timber market where they would receive a higher price. The figure also assumes that only conifer residues would go for chipped wood fuel, as broadleaf residues would tend to be used for logs.

The Forestry Commission for the region already has a contract to supply 100,000 tonnes of forestry residues per year (which presumably also includes stemwood with a diameter greater than 14cm) to the 30MW_e Wilton biomass power scheme run by Sembcorp in the Tees Valley. This is a ten year contract

[28] Calculation of the Wood Fraction of C&I waste in Yorkshire & Humber, July 2009, Urban Mines

which began in 2008. Therefore, this may preclude the Forestry Commission from entering into any other large scale wood fuel supply contracts in the region for the next ten years.

5.12.5 Financial implications of biomass

Forest residues, whilst abundant, are produced at a cost which varies depending upon market conditions, type of plantation, size, and location. Typical production costs for a range of products is £30 - £45 per tonne, this includes £5/per tonne for transport costs for local supply.

Establishment of energy crops is estimated to cost approximately £2000/hectare (Table 9), which equates to around £1,200 per kilowatt of electricity generated by CHP. Details on grants available for establishing crops are presented in Appendix D.17. A recent analysis of the potential income from both willow SRC and miscanthus suggested that for medium yield land (i.e. Grade 3), the average annual income would be £187 to £360 per hectare. Energy crops are relatively expensive compared to some other biomass fuels but do have the potential to provide very significant volumes of fuel.

Activity	Cost per hectare
Ground preparation (herbicides, labour, ploughing and power harrowing)	£133
Planting (15,000 cuttings, hire of planter and team)	£1,068
Pre-emergence spraying (herbicide and labour)	£107
Year 1 management costs (cut back, herbicides, labour)	£112
Harvesting	£170
Local use (production, bale shredder, tractor and trailer)	£378
Total	**£1,968**

Table 9 Indicative costs of establishing willow SRC energy crops, exclusive of payments from grants or growing on set aside land. Costs for miscanthus SRC are expected to be broadly comparable (Source: Energy Crops, CALU and Economics of Short Rotation Coppice, Willow for Wales) 29, 30

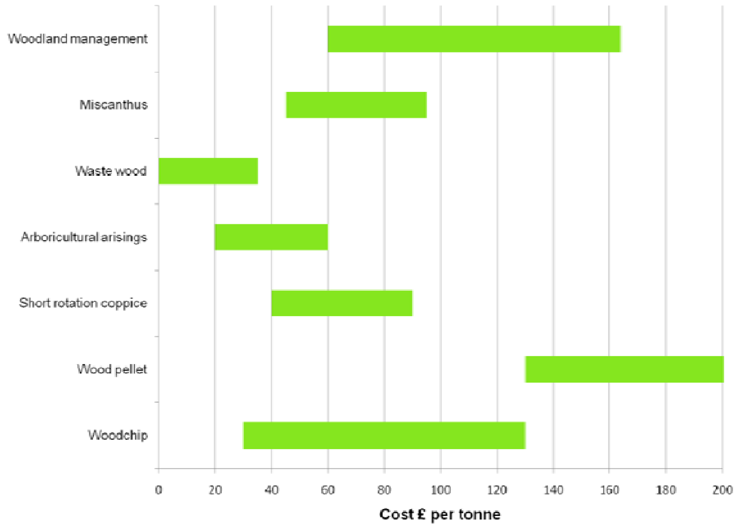

Figure 33 Guideline costs for different biomass fuels. (Source: Biomass heating, A practical guide for potential users CTG012, Carbon Trust, January 2009)

[29] Economics of short rotation coppice (Willow for Wales, July 2007)
[30] Energy Crops, Economics of miscanthus and SRC production (CALU, November 2006)

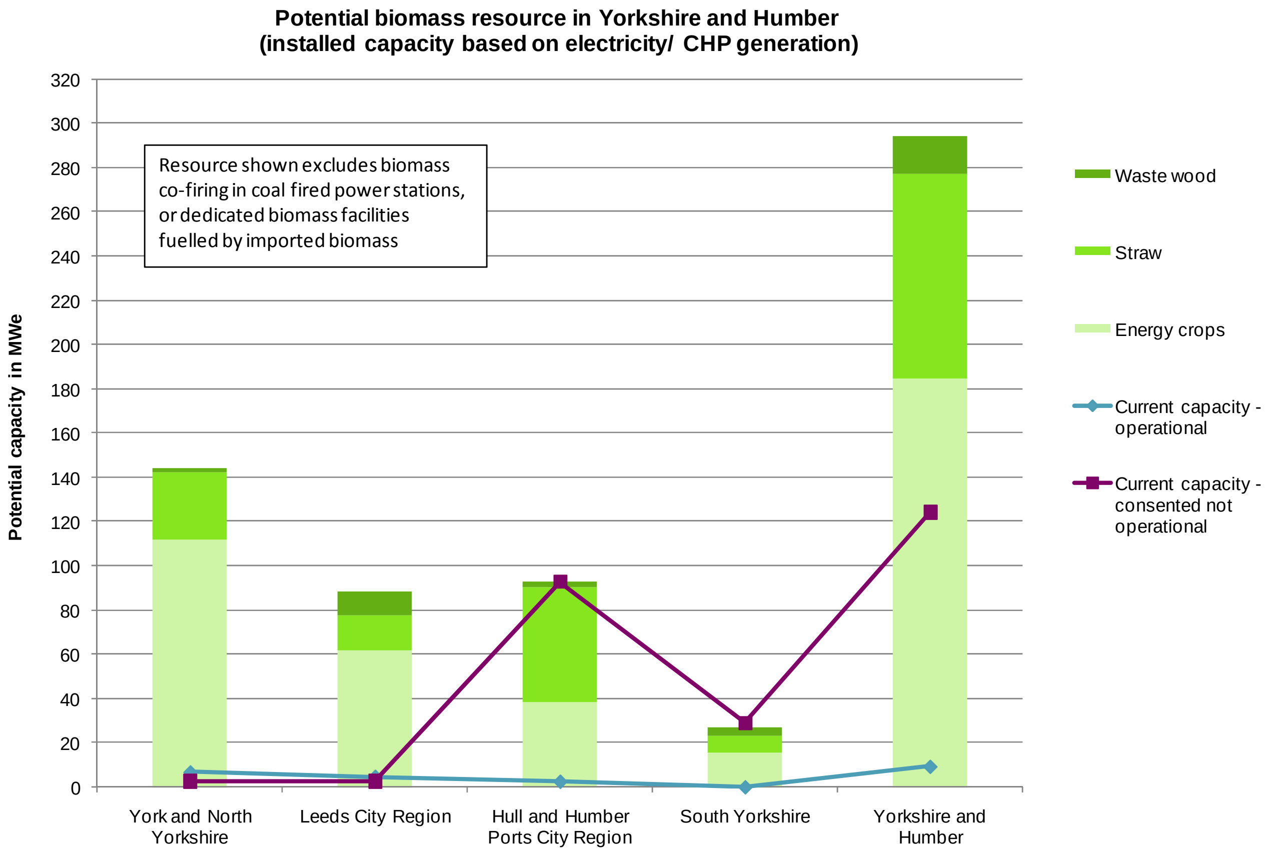

Figure 34 Biomass resource in Yorkshire and Humber, by sub region, in terms of potential MW. "Current" refers to facilities that are operational or have planning consent. The 129MWe of consented schemes for the region includes the 65MWe Stallingborough scheme, on the Humber which would run off imported biomass, and the 25MWe Blackburn Meadows waste wood scheme in Sheffield.

5.12.6 Conclusions from biomass resource assessment

This study has identified biomass as a significant resource for renewable energy generation in the region. At the large and medium plant scale, there are few physical environmental or planning factors that could seriously constrain the deployment of biomass. Biomass boilers for large scale use such as in district heating networks are an option but district heating schemes are still relatively rare in UK.

The majority of the biomass energy resource is located in the largely rural sub-region of York and North Yorkshire, where there are particular opportunities for energy crops grown on land no longer needed for food production, animal waste and straw.

The biomass fuel supply chain in the Yorkshire and Humber region is currently in its infancy and the market conditions are extremely variable. This makes the long-term forecasting of biomass system costs extremely difficult. For example, biomass fuel, particularly waste wood, has in the past been either free of charge or attracted a gate fee (where the supplier pays the user a fee which is lower than the alternative disposal cost). However, as the market for biomass increases with additional biomass electricity, heat, and CHP capacity being installed, the demand will increase and the fuel will command a higher premium. It will be important to consider the longer term potential market conditions for new developments and there is a potential role for local authorities to collaborate with the sub-regional bodies to establish a supply chain to provide some degree of long term stability.

The major constraint to the use of locally sourced biomass is likely to be financial. Feedback received as part of this study suggests that the economically viable potential for growing energy crops in the region will ultimately depend on the price of wheat. There is potential to use the region's relatively large straw resource for biomass energy generation.

At present, the biomass heating sector is quite separate from the co-firing sector and there is no real competition for resources between the heat and co-firing markets.

Securing finance for schemes has been suggested as a major barrier. Stakeholders have highlighted that uncertainty over incentive mechanisms is significantly affecting the viability of new biomass plants and that grandfathering provisions are needed to provide certainty for investment decisions. ROC bands are subject to review every four years and there is no clarity on the level of ROC support that plants accredited after April 2013 (the date of implementation of the next ROC bands) will receive. The commercial viability of using biomass boilers is likely to depend upon the introduction of the Renewable Heat Incentive.

Other constraints on biomass energy production include the amount of land available for crop production and the need to consider environmental issues such as biodiversity issues, for example, if substantial areas of set aside or temporary grassland are used for energy crops.

Greater use of biomass as fuel raises some considerations about increased CO_2 emissions associated with transport of material. A recent report by the Environment Agency provides data which suggests an increase in CO_2 emissions of between 5% (wood chip) and 18% (wood pellets) for European imports. The data is not clear for transport within the UK, but the overall carbon savings are likely to outweigh the transport energy costs, particularly where water borne transport is used. The costs for water borne transport were also shown to be substantially reduced, although these costs would clearly be dependent on the number of transfers required between modes. [31]

In addition, major growth in the use of biomass fuel could have implications for air quality. Planning should ensure that this is considered for areas where Air Quality Management Areas (AQMAs) have been defined.

[31] Feasibility Study into the Potential for Non-Building Integrated Wind and Biomass Plants in London: Final Biomass Report, February 2006.

Capabilities on project:
Building Engineering - Sustainability

Figure 35 Biomass resource in Yorkshire and Humber.

5.13 Potential for energy generation from waste

5.13.1 Introduction

The organic fraction in waste streams can be used to generate energy through direct combustion, anaerobic digestion, pyrolysis or gasification. The potential for energy generation from waste is described in this section. It covers the following renewable energy resources. A full list of the energy from waste facilities in the region larger than $1MW_e$ is provided in Appendix E.

- *Animal manures or slurry from pigs and cattle* - This wet organic waste can be treated using anaerobic digestion (AD) to produce biogas. The biogas can then either be burnt directly to produce heat, or burnt in a gas engine to produce electricity and heat.
- *Food waste* - This can stem directly from waste from the food and drinks processing industry or it could be food waste from the general household and commercial waste stream. If this waste is separated, it can be treated using AD, as described above. If it is not separated, then it instead forms part of the general waste stream described below.
- *Poultry litter* - This is a drier from of organic waste and can be burnt to raise steam to drive a steam turbine to generate electricity and potentially useful heat if there is a use for the latter.
- *Sewage from sewage treatment works* - This can be treated using AD to produce biogas, (or sewage gas) as described above for animal manure.
- *Municipal Solid Waste (MSW) and Commercial and Industrial (C&I) waste* - Rather than going to landfill, any residual waste that is left after re-use, recycling and composting or AD, can go for other forms of secondary treatment.

  This can consist of some form of thermal treatment, where the waste is combusted to raise steam to drive a steam turbine, which can generate electricity, and also heat if in CHP mode. This could consist of either mass burn incineration, or some form of "advanced thermal treatment" using pyrolysis or gasification or both and is commonly referred to as Energy from Waste (EfW). Or it can go through some form of Mechanical Biological Treatment (MBT), which produces Solid Recovered Fuel (SRF) pellets. These pellets can then themselves be combusted for energy production, again using a variety of approaches.

  Only the biodegradable fraction of this resource is classed as renewable, under the definitions of the EU Renewables Directive.
- *Landfill gas.* Over time, the organic fraction of waste buried in landfill breaks down, through anaerobic digestion, to release methane gas. This gas can be captured, via underground pipes, and the gas then burnt in a gas engine to generate electricity. All of the output from landfill gas is classed as renewable.

Waste wood is not covered in this section, but is covered under the biomass resource section in the previous section 5.12.

5.13.2 Existing energy from waste capacity

AD of wet organic waste (food/animal waste)

There are currently no operational generators in the region. However, there are three food waste facilities currently under construction, and due to become operational in 2011. The first is GWE Biogas, in Kirkburn, East Riding, which will be a $2MW_e$ facility, taking, initially, commercial food waste. The second is also a $2MW_e$ facility in Doncaster, to be operated by ReFood UK, which is a joint venture involving Prosper De Mulder (PDM), and will take retail food waste. Each plant will process about 50,000 tonnes of food waste each year. The third is a $0.3MW_e$ facility at Clayton Hall farm in Emley, Kirklees, which will also take commercial food waste as the feedstock.

Dry organic waste (poultry litter)

The $14MW_e$ Glanford Power Station in North Lincolnshire is the only facility identified that can process poultry litter. This facility is believed to currently process meat and bone meal.

Sewage gas

Sewage treatment for the region is provided predominantly by Yorkshire Water, although Anglian Water are responsible for sewage treatment in North East Lincolnshire (at Pyewipe WWTW in Grimsby), and Severn Trent Water are responsible for North Lincolnshire (at Yaddlethorpe WWTW near Scunthrope).

From discussion with Yorkshire Water, they process about 150,000 tonnes (dry weight) of sewage per year, at about 20 sites. Currently, the majority of this (about 60%) is processed using AD at the larger sites to produce biogas which is then used for electricity generation in gas engines. This gives a current installed capacity for electricity generation of $7.3MW_e$ in the region. All of the heat from the gas engines is used as part of drying the sludge. The remaining sewage sludge is currently incinerated. In addition, the Anglian water and Severn Trent Water schemes in North and North East Lincolnshire have an installed capacity of 1.3MWe. This gives a total installed sewage gas capacity for the region of 8.6MW_e.

Energy from MSW and C&I waste

Currently, there are three energy from waste facilities generating electricity in the region, with a total installed capacity of about 33MW_e. These are the Sheffield Energy Recovery facility (20MW_e), the Huddersfield facility in Kirklees (10MW_e), and the Newlincs facility in Grimsby, North East Lincolnshire (3MW_e). These facilities are predominantly taking MSW waste, and they involve PFI type contracts between waste management companies and the local authorities.

Only the biodegradable fraction of the waste stream is regarded as being renewable. Nominally, this is currently about 50%, giving an installed renewable capacity of 16.5MW_e for the region.

The Sheffield scheme also provides up to 39 MW_{th} of heat into the city's district heating network, and the Newlincs scheme supplies up to 3 MW_{th} of heat to a neighbouring industrial customer.

Landfill gas

There are a number of landfills in the region where energy is recovered from methane gas. These represent nearly 76MW_e of electricity generation capacity. However, most of these facilities will have reached the end of their operational lives by 2025, due to a combination of the quantity of gas tailing off and the life of the generation plant.

5.13.3 Potential for energy from waste

AD of wet organic (food/animal) waste

Based on data from the Food and Drink Federation and DEFRA (for 2008), the amount of food waste available in the region from the food and drink industry is about 47,000 tonnes per annum. Assuming only 50% of this could be used for energy generation, due to competing uses, then this could support an installed AD generation capacity of about 0.7MWe, which is a very limited resource.

However, there is a much greater potential if the amount of food waste available from more general commercial and retail businesses is considered, as well as domestic food waste. Discussions with stakeholders has suggested that up to 500,000 tonnes of food waste could be available for energy generation in the region from these sources, by 2020. This could support up to 16MW_e of installed capacity. As mentioned above, about 4.3MW_e of this resource is being harnessed by operational or near operational facilities. There is also a scheme currently in planning for a 0.7MW_e facility in Thirsk, Hambleton, which would take commercial food waste as the feedstock.

This leaves the potential for an additional 11MW_e of capacity to come forward over the next few years, which could amount to 5-10 or more schemes.

In terms of slurry from cattle and pigs, there is the potential for nearly 30 MW_e of installed capacity, with the majority of this (20MW_e) in North Yorkshire, due to its predominantly rural nature. However, the likelihood of this waste being harnessed for energy production appears to be low. There are no current schemes in operation in the region that take wet animal waste as the feedstock and there are none in planning.

This is because the economic viability of AD plants appears to be driven by the value to operators of being paid gate fees by food waste producers, in order to meet the requirement to pasteurise such waste under the EU Animal Byproducts Directive.

Dry organic (poultry litter)

The assessment found that there is the potential for around 35 MW_e of poultry litter, based on the number of poultry broiler birds in each local authority area. The greatest concentration of this (about 13MW_e) is in North Lincolnshire, which already has the 14MW_e Glanford facility. Therefore, the potential for additional new capacity is up to 21MW_e, which could consist of one or two facilities.

Sewage gas

Yorkshire Water indicated that the current AD capacity is unlikely to decrease by 2020. There is a possibility that it may increase, if they look to digest rather than incinerate some of the remaining sludge. However, at the time of writing there were no definite plans for this. Therefore, we have assumed that by 2020-25 the installed capacity of AD from sewage sludge in the region remains at the current level of 7MW_e.

Energy from MSW

There are 15 local government authorities in the Yorkshire and Humber region which act as Waste Disposal Authorities (WDAs) for MSW. Some of these have joined together, resulting in 10 separate partnerships, as shown in appendix E.4. Several proposals are now in development for energy from waste plants, both thermal treatment and AD. However, WDAs in the region have reached very different stages in the preparation of waste DPDs. The procurement of the necessary new treatment facilities and contractual arrangements are also at varying stages of progress and often linked to DPD progress.

The MSW resource for 2020 has been assessed using the waste projections developed by Enviros for the RSS. The projections have been adjusted by including the actual MSW figures for 2007/8, as reported in the Annual Monitoring report for the region for that year. The data for North Yorkshire County has been broken down to district level by assigning the waste on a pro-rata basis according to the number of households.

The Waste Strategy for England [32] sets out a target that 75% of all MSW should be recovered (i.e. not sent to landfill) by 2020 and 50% should be re-used, recycled or composted. Therefore, to avoid any conflict with the waste hierarchy, and in line with the targets, we have assumed that 25% of MSW (i.e. the balance of the 75%) would be available for energy recovery by 2020. This amounts to about 810,000 tonnes of residual waste which could support up to $81MW_e$ of generation capacity. We have assumed that by 2020-25 only 35% of this residual waste would be biodegradable (due to higher recycling rates), therefore the potential renewable capacity would be 28MWe.

About 420,000 tonnes of MSW is already being utilised in the three operational EfW schemes mentioned above. This leaves the potential for an additional 390,000 tonnes to be treated. A number of local authorities in the region have plans for new energy recovery facilities to treat their residual MSW waste. The proposed Allerton Waste recovery centre in Harrogate would recover energy from about 200,000 tonnes per annum, for the York and North Yorkshire authorities.

Leeds City Council is also currently going through a tendering process to procure an energy from waste facility to process a similar amount of MSW. Other WDAs in the region are also considering energy recovery options for residual MSW. There is also the Saltend energy recovery facility in Hull, which was to treat the MSW for Hull and East Riding Councils and which has been granted planning consent, but that we understand is no longer going to proceed.

[32] Waste Strategy for England 2007, DEFRA, May 2007

Therefore, this suggests that the potential of $81MW_e$ of energy recovery from MSW by 2020-25 (of which $28MW_e$ would be renewable) is likely to be delivered, as long as projects can secure planning consent.

Energy from C&I

Assessing the C&I waste resource for the region is more complex than for MSW. This is due in part to uncertainty over the level of C&I activity in the region by 2020. It is also due to the fact that a lot of industrial waste is “inert”, such as combustion residues and metallic wastes, and therefore would not be suitable as a feedstock for an EfW facility.

We have taken data on the total levels of C&I waste projected for the region by 2020 from the report prepared for CO2 Sense Yorkshire by Urban Mines. This provided a projection for C&I waste for each local authority in the region, based on employment projections from the Regional Econometric Model and waste arisings data from surveys in other regions to estimate arisings for different employment sectors.

A related report by Urban Mines provided a breakdown of the waste stream for each major sector. Using this data, we estimated the C&I waste that could be available for energy recovery by identifying only the waste that fell into the following categories:

- Animal and vegetable waste
- Mixed ordinary wastes
- Non-metallic wastes

We then assumed that all of the waste in the first category would be recovered preferentially via composting or anaerobic digestion, i.e. not for EfW. We assumed that for the two other categories, about 50% could be recycled, from an estimate given for mixed waste in the Environment Agency mass balance study for the region, leaving the other 50% as available for energy recovery. This gave a total of 1.5 million tonnes by 2020. This could give a potential energy generation capacity of 150MWe. Again, as with MSW, assuming that only 35% of this is biodegradable would yield a renewable capacity of 53MWe.

There are two energy from waste facilities that have planning consent in the region that would process C&I waste. These are schemes that are not underpinned by an MSW contract from a local authority, but rather are “merchant” facilities that would charge a gate fee to take commercial waste from waste management. They are the two Energos gasification facilities, one in Bradford, and one in Doncaster (Kirk Sandhall energy recovery facility), which would process about 280,000 tonnes, and have an installed capacity of about 26MWe

In addition, there are proposals in planning for several other energy recovery facilities that could take up to 1 million tonnes per annum of C&I waste, namely:

- Skelton Grange energy recovery facility, on the site of a former power station, Leeds (300,000 tonnes per annum);
- Doncaster energy from waste project, next to Hatfield colliery (up to 400,000 tonnes per annum);
- Ferrybridge multi-fuel proposal, on the site of Ferrybridge power station (300,000 tonnes per annum).

This suggests that the potential for 150MWe (53MWe renewable) of energy from waste capacity from C&I waste could be deliverable by 2020, assuming that planning consent can be obtained for projects.

Figure 36 Huddersfield energy from waste plant in Kirklees (Source: © Copyright David Ward and licensed for reuse under this Creative Commons Licence, website accessed January 2011 www.geograph.org.uk/photo/489160)

5.13.4 Conclusions from energy from waste assessment

With a current installed capacity of 75MW$_e$ in the region, energy from landfill gas represents the largest operational source of energy from waste and second only to wind power in terms of overall capacity. However, much of this plant is over 10 years old and the output is decreasing over time as the production of methane from the landfill sites tails off. Therefore, this technology is expected to make little if any contribution to any renewable energy targets by 2025.

Another well developed technology in the region is electricity generation from sewage gas, produced at sewage and waste water treatment works across the region. This current level of capacity is expected to remain through to 2025, and may increase slightly.

Energy production from the AD of food waste is a growing technology in the region. There are several facilities due to come on-line in the near future, taking commercial food waste as feedstock. There is the potential for developing several further facilities in the region. There is a role for local authorities to support this opportunity through the way they procure solutions to manage their biodegradable municipal waste. There is also a potential role for stakeholders in the region to provide support with extracting food waste from the general M&I waste stream. If the UK Government decides that C&I waste should fall under the Landfill Allowance Trading Scheme (LATS) this could provide a major boost for such AD facilities.

Although there are significant quantities of animal slurry available in the rural areas of the region, from pigs and cattle, most of the animal slurry, from livestock, is being spread back on the land in the region, and as such is displacing the use of inorganic fertiliser. It is not a problem waste that farmers are looking to get rid of. As a feedstock it does have the advantage of being homogenous, but has lower biogas yield than food waste and also does not attract gate fees as it does not fall under the animal byproducts directive (ABD). Therefore there do not appear to be strong enough drivers in place for this resource to be used for energy production at any significant scale.

Disposal of MSW is a statutory responsibility of local authorities and generally tied into long term management contracts. For residual MSW, only three out of the 15 WDAs in the region have the long term infrastructure in place to divert enough waste from landfill to meet their obligations. Some authorities, such as Kirklees, North East Lincolnshire and Sheffield, have modern waste infrastructure up and running, centred on recycling with energy recovery from residual waste. Kirklees, with its Energy from Waste incinerator in Huddersfield, which has been in operation since 2000, is considered to be a beacon authority in its waste management and energy practices. [33]

[33] State of the nation briefing: waste and resource management, ICE

The Sheffield energy recovery facility provides a (national) good example of how the overall efficiency and carbons savings from an energy recovery scheme can be maximised through supplying heat into a district heating network. The Newlincs energy recovery facility in North east Lincolnshire is a good example of a smaller scale recovery facility where the facility is co-located with an industrial heat user who can take heat from the facility as well as electricity being supplied into the grid.

For the remainder of the local authorities in the region, slow but steady progress is being made in securing new infrastructure for MSW, with authorities having to overcome procurement and planning issues. Two have contracts and are in the infrastructure planning/development stage, and 10 authorities are in procurement for their new residual waste infrastructure contracts.

It may be too late for to influence Waste Strategies which are at an advanced stage of preparation. However, a number of actions could be considered for those DPDs which are not yet complete:

- There is potential to use heat from energy from waste plants in the existing building stock and for industrial loads. A number of waste disposal contracts are due to be re-tendered in the short to medium term, such as the East Riding and Hull contract in 2013. The co-location of energy from waste facilities with major heat loads, and the opportunity to use district heating networks to make use of waste heat should be a key consideration within these contracts.
- The opportunity to partner with organisations that may have similar waste management and/or energy needs should also be considered.

In terms of C&I waste, no coherent strategy exists for commercial waste management in the region but the rising landfill tax escalator is pushing up the cost of landfill disposal and creating an incentive for investment in new privately funded infrastructure. This means that there may be several new energy recovery facilities coming on-line over the next few years taking C&I waste as their feedstock. A key opportunity for stakeholders in the region is to work to try to maximise the energy and carbon benefit of these schemes by having them “CHP enabled” so that they can supply low carbon heat into local heating networks as well as providing electricity into the grid.

The graph in below summarises the existing capacity for energy generation from waste in the region as well as the maximum potential resource by 2025. The capacity shown for MSW and C&I waste is for the biodegradable fraction only, and not the total installed generation capacity. This fraction is assumed to be 50% for currently operational facilities, and 35% for consented schemes and future potential by 2025. The landfill gas resource is assumed be zero by 2025.

Capabilities on project:
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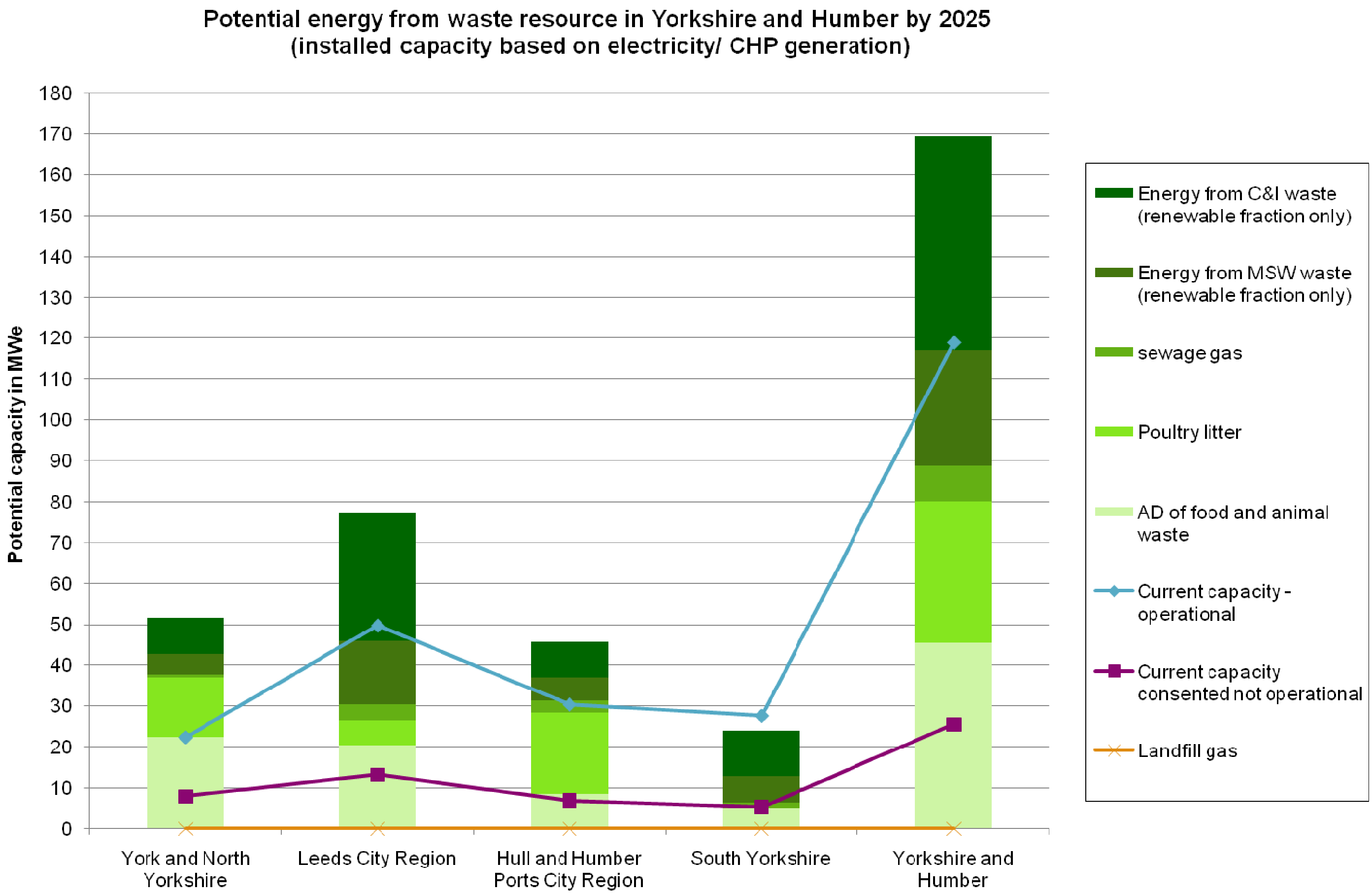

Figure 37 Energy from waste resource in Yorkshire and Humber, by sub region, in terms of potential installed electricity generation capacity in MW. The stacked columns illustrate the potential resource by 2025, whilst the lines show the current operational and consented capacity.

5.14 Microgeneration uptake

5.14.1 Introduction

The potential for energy generation from the solar resource, air source and ground source heat pumps and small scale wind turbines is presented in this section.

There are two main technologies that can directly exploit the solar resource. Solar photovoltaic panels (PV) use semi-conducting cells to convert sunlight into electricity. Solar water heating panels convert solar energy into stored heat and are used primarily to provide hot water. Solar water heating supplements and does not replace existing heating systems.

Air source heat pumps use the refrigeration cycle to extract low grade heat from the outside air and deliver it as higher grade heat to a building.

Ground source heat pump systems operate in a similar way by taking low grade heat from the ground and delivering it as higher grade heat to a building.

Small scale wind energy schemes have different characteristics to commercial scale wind farms. They can be freestanding or integrated into the design of buildings and are viable at lower wind speeds. They are typically installed as part of development and supply the on-site demand. Consequently, their viability is usually dependent on the number of buildings or sites rather than the amount of land available.

5.14.2 Existing microgeneration capacity

Most microgeneration schemes do not require planning permission and therefore there is no consistent way to monitor installations. This study has found, based on analysis of data from the Low Carbon Building programme (Energy Saving Trust), the feed-in-tariff (Ofgem) and consultation with stakeholders, that there was around 12 MW of microgeneration capacity (i.e. small scale wind, solar PV, solar thermal, heat pumps and biomass boilers) installed in the Yorkshire and Humber region as of 2010. About 60% of this is comprised of solar PV, installed in the last year presumably as a direct result of the recent introduction of the feed in tariff.

It is acknowledged that it has not been possible to capture details of every microgeneration installation in the region for this study. However, the level of installed capacity is so low that installations that have been missed will make a negligible difference to the overall resource identified.

5.14.3 Financial implications of microgeneration

There are two standard types of solar water heating collectors: flat plate and evacuated tube collectors. Generally, evacuated tubes are more expensive to manufacture and therefore purchase, but achieve higher efficiencies and are more flexible in terms of the locations they can be used. Recent advances in evacuated tube collector design have achieved near parity in terms of cost per unit of energy generated. Solar PV is eligible for the feed in tariff and solar water heating systems are eligible for the Renewable Heat Incentive.

There is a wide variation in costs for ground source heat pumps at the 20-100kW scale, principally due to differences in the cost of the ground works. The cost of the heat pumps themselves is also dependent on size as commercial systems are usually made up of multiple smaller units rather than a single heat pump. Due to these variations, heat pumps in the 20-100kW range are shown with an indicative cost of £1,000 per kW installed. A borehole ground source heat pump system is more costly due to a high drilling cost of £30 per metre. A typical 70m borehole provides 3-5kW of heat output, giving a drilling cost of £4200 for an 8kW system[34]

Air source heat pumps are around half the installed cost of ground source, albeit with a lower efficiency. For air source heat pumps, retrofit costs are slightly higher than new build to allow for increases in plumbing and electrical work.

Costs for a selection of small scale wind turbines are shown in Table 13. These are in the region of £1,267,000 per MW installed. These costs are based on an installed cost of £51,000 for one 15 kW turbine and include civil works for an average site.

Figure 38 Building mounted wind turbine at Dalby Visitor centre in Ryedale (Source: Green design at Dalby visitor centre case study, Forestry Commission, 2010)

[34] The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR, June 2008)

Technology	Solar water heating	Solar PV
Approximate size required	~4 m^2 per dwelling	~8 m^2 per dwelling
Total cost of system	£2,500 for new build homes (2 kW system) £5,000 for existing homes (2.8 kW system) £1,000/kW for new build non-domestic £1,600/kW for existing non-domestic	£5,500 for new build homes (1 kWp system) £6,000 for existing homes (1 kWp system) £4,500/kW for new build non-domestic £5,000/kW for existing non-domestic

Table 10 indicative costs for solar energy technologies. Costs are approximate and represent prices in 2009. (Source: AECOM modelling)

Technology	Air Source Heat Pump	Ground Source Heat Pump
Approximate size required	5 kW	5kW trench system for new build 11kW trench system for existing
Total cost of system	£5,000 for new build £7,000 for existing £500/kW for non domestic	£8,000 for new build £12,000 for existing £1,000/kW for non domestic

Table 11 Indicative costs of heat pumps (2007 costs). (Source: The Growth Potential for Microgeneration in England, Wales and Scotland, Element Energy for BERR, 2008)

Technology	Small scale biomass boiler
Approximate size required	8.8 kW for homes
Capital cost of system	£9,000 for new build homes £11,000 for existing homes

Table 12 indicative costs for biomass technologies. Costs are approximate and represent prices in 2009. (Source: AECOM modelling)

Turbine model	Rating (kW)	Cost
Proven 11	6 kW	£19,647
Proven 35-2	15 kW	£44,886
Proven 35	15 kW	£50,886
Sirocco Eoltec	6 kW	£18, 880

Table 13 Indicative prices of small wind turbines. Exchange rate of £1=1.18 EUR applied, based on exchange rates in November 2010. (Source: Proven Energy website http://www.provenenergy.co.uk/our_products.php and All Small Wind turbines website, http://www.allsmallwindturbines.com/, both accessed November 2010)

5.14.4 Potential microgeneration resource

The assessment of the likely uptake in microgeneration technologies has been driven by AECOM modelling as described in Appendix A.3. This study has found that there is the potential to exploit a range of microgeneration technologies across the region. The economically viable capacity for microgeneration technologies in Yorkshire and Humber is around 1,705 MW, equivalent to around 1,136 GWh annual energy generation, or the energy use of 75,700 homes. In most cases the potential is not spatially determined but is instead constrained by the size of the existing and future building stock. Urban centres such as Leeds, where there are numerous roofs to install solar arrays, have a particularly large resource.

The expected uptake of microgeneration technologies in the existing and new build stock is shown in Figure 40. The high take-up of renewable heat technologies depends heavily on the introduction of renewable heat incentive (RHI) (section 4.6.3). The modelling assumes that RHI is introduced in 2011, with the tariffs as published in the 2010 consultation.

Solar water heating

The economically viable capacity for solar water heating in the region is around 353 MW, equivalent to around 217 GWh annual energy generation, or the energy use of around 14,500 homes.

The RHI is specifically designed to provide lower rates of return for solar water heating than for other renewable heating technologies. But the model projects large numbers of solar water heating installations under these circumstances, more than installations of other technologies. This is because the choice model reflects consumer preferences for low capital costs independent of all but the fastest paybacks (very high discount rates), and for low maintenance. A slightly lower rate of return for solar water heating (the RHI consultation was based on 6% compared to 9% for other technologies) is less significant than the cost differences and low annual maintenance cost assumed.

Biomass

The economically viable capacity for biomass heating in the region is around 389MW, equivalent to around 1,021GWh annual energy generation, or the energy use of around 68,000 homes.

Woodchip boiler take-up is driven by the numbers of rural homes and non-domestic buildings and pellet boilers by urban homes. Districts with more rural homes and non-residential buildings will have proportionately higher forecasts for woodchip boiler take-up. Very large numbers of urban homes are needed before the model forecasts any take-up of pellet boilers. This is because pellet boilers have longer paybacks than wood chip boilers because of the higher fuel price for pellets.

Solar PV

The economically viable capacity for solar PV in the region is around 235MW, equivalent to around 206GWh annual energy generation, or the energy use of 13,700 homes.

The model assumes that solar PV is applicable to all buildings except flats. However, forecast uptake (numbers of installations) is typically much lower than the uptake of solar water heating. This difference in uptake reflects the aversion of private homeowners to high up-front costs: while long term returns are higher for PV, a PV system typically costs thousands of pounds more than fitting a solar hot water system to the same building.

Small scale wind

The economically viable capacity for small scale wind turbines in the region is around 26MW, equivalent to around 34 GWh annual energy generation, or the energy use of 2,200 homes.

Small scale wind turbine take-up is driven by the numbers of rural homes and buildings. Districts with more rural homes will have higher forecasts for micro-wind take-up. Districts with more rural non-residential buildings will have higher forecasts for small wind take-up.

Heat pumps

The economically viable capacity for heat pumps in the region is around 408MW, equivalent to around 679GWh annual energy generation, or the energy use of 45,000 homes. Only the renewable proportion of energy use of the heat pump has been accounted for in this resource assessment.

In deciding the applicability of technologies to each type of building, AECOM judged that heat pumps should not be considered generally applicable to pre-1980 homes. This is because older homes built to previous Building Regulations standards have higher heat demands, which would tend to make the installation of heat pump equipment impractical. As such, potential uptake is limited to the typically ~20% of post-1980 homes. Air source heat pump take up is initially very low because there are few post-1980 homes with primary heating systems more than 16 years old and being considered for replacement. Ground source heat pump uptake is even lower and is essentially zero because of the cost and disruption associated with digging up a garden to install heat exchange pipework.

Ground source heat pump uptake in new build development is comparatively high due to the potential for meeting carbon targets in new development.

5.14.5 Conclusions from microgeneration resource assessment

The potential for microgeneration technologies is very large, and is only limited in technical terms by the size of the existing building stock.

For the existing stock, the variation in forecast renewables take-up between districts depends entirely on the number and profile of homes and non-domestic buildings.

Figure 39 A PV installation at Sackville Street, Ravensthorpe, in Kirklees. (Source: Renewable Energy Initiatives In Kirklees, Kirklees Metropolitan Council, September 2005)

Our modelling predicts that a proportion of homeowners will fit microgeneration technologies either to replace primary heating systems or as discretionary installations. The number opting for renewable microgenerators increases as the financial case improves, e.g. as a result of feed in tariffs and the prospective renewable heat incentive. However, owner-occupiers and private landlords dislike making up-front investments to achieve future savings (i.e. their discount rate is high). Furthermore they prefer cheap options (low capital cost) to expensive options independent of rates of return over the long term. And finally, they are less likely to fit unfamiliar technologies that cause disruption and have ongoing maintenance costs. Social landlords and businesses are more willing to invest against future savings (their discount rate is lower than private homeowners).

The increased uptake of certain technologies in the existing stock may conflict with the desire to maintain the character of certain landscapes within the region, for example, conservation areas. Roof mounted technologies are likely to be the most concerning from a conservation perspective, though it should be noted that other roof-mounted objects such as TV aerials are allowable in conservation areas. Roof mounted microgeneration technologies that may be of concern include solar PV, solar thermal, flues associated with wood-burning stoves/boilers and CHP and building mounted wind turbines.

Planning should ensure that the volume of delivery and the positioning of technologies does not adversely affect the value of the conservation area as a whole. Where possible, roof mounted technologies should be placed so that they are not viewable from public realm. Solar panels and wind turbines can be installed in private gardens out of view of the public realm. Solar PV panels have now been developed that look similar to roof tiles and may be more attractive in areas of the region where aesthetics are important. At present these are up to £2,000/kW more expensive than conventional PV. [35]

In the new build stock, the main driver for increased contribution from microgeneration technologies is likely to be the progressive tightening of the Building Regulations, up to and including the introduction of the zero carbon requirement for homes in 2016 and for other buildings in 2019 (section 4.3). The role of regional, sub-regional and local bodies is therefore limited beyond specifying more stringent policy to achieve this. Setting planning policy targets for carbon reduction or for a minimum contribution from renewable or low carbon technologies would add to the complexity of the planning and development control process, with potentially little impact on generating capacity. Furthermore, planning policy targets of this nature would only have a short term impact, as they would effectively be superseded by the Building Regulations zero carbon requirement.

Post 2016, allowable solutions will place emphasis on local authorities to identify and support delivery of community scale solutions. It may therefore be more productive for regional and sub-regional bodies to begin to focus on identifying and

[35] The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR, June 2008)