Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2011

Background

Combined Heat and Power (CHP) is the simultaneous generation of usable heat and power (usually electricity) in a single process. CHP data for the UK as a whole are updated annually and published in the Digest of United Kingdom Energy Statistics (DUKES), the latest edition of which was published on 26 July 2012. This article updates statistics published in the September 2011 edition of Energy Trends, which provided a breakdown of CHP in the Devolved Administrations and English regions[1] in 2010. This update is based upon data for 2011. Since the last article was published, the Good Quality CHP capacity in the UK has increased from 6,053 MWe (revised 2010 figure) to 6,111 MWe in 2011.

The data presented in this paper originates from a CHP database maintained by AEA on behalf of DECC. Data relating to the overwhelming majority of CHP electrical capacity (over 99 per cent of total capacity) is received annually from the Combined Heat and Power Quality Assurance (CHPQA) programme, the Iron and Steel Statistics Bureau (ISSB) and from Ofgem's Renewable Obligations Certificates (ROCs) returns. A small number of anaerobic digestion sites, obtained via a targeted survey, were added in 2010. The 2011 data also includes small schemes reported by suppliers but not registered under CHPQA. Data from CHP schemes not covered by the above are extrapolated from historic data.

During 2011, 140 new CHP schemes came into operation and registered with CHPQA while 31 CHP schemes, which were operating in 2010, subsequently closed and did not operate in 2011. The data also includes an additional 194 small scale schemes (ranging from 30 to 600 kWe) reported by suppliers but not registered under CHPQA, a net increase of 303 schemes. During 2011 there was a net increase in capacity of 58 MWe, made up of 108 MWe of new capacity (either through new schemes or an increase in capacity of existing schemes) and a loss of 50 MWe (either through schemes closing or a reduction of capacity due to a reduction in heat supplier loads at schemes that remained operational).

Table 1: Overview of CHP schemes in 2011

	Number of schemes	Electrical capacity∗ MWe	Heat capacity MWth	Fuel used∗ GWh	Electricity generated∗ GWh	Heat generated GWh	Load Factor ** (%)
England	**1,586**	**5,323**	**7,187**	**92,815**	**23,208**	**38,773**	54.6%
East Midlands	98	234	348	4,544	1,247	1,819	57.0%
Eastern	130	285	344	4,218	1,233	1,864	49.9%
London	212	126	249	2,139	409	1,074	38.8%
North East	101	910	1,169	16,073	3,121	6,312	37.5%
North West	257	739	1,609	17,951	3,631	9,508	55.8%
South East	322	889	1,615	17,934	4,221	8,526	54.6%
South West	129	80	68	1,394	321	608	48.2%
West Midlands	161	104	101	1,795	408	719	37.2%
Yorkshire/Humberside	176	1,956	1,684	26,767	8,617	8,342	71.5%
Scotland	116	529	2,827	13,902	2,864	6,813	59.1%
Wales	119	210	299	5,278	962	2,585	49.3%
Northern Ireland	59	49	92	863	157	456	39.9%
UK Total	**1,880**	**6,111**	**10,405**	**112,858**	**27,191**	**48,627**	**54.6%**

∗This represents Good Quality CHP capacity, Good Quality CHP power output and the fuel associated with the Good Quality CHP outputs.

** These load factors are based on the total power output (TPO) and total power capacity (TPC) of the CHP (for partially and fully qualified schemes) and are not derived from the Electrical Capacity and Electricity Generated in this table. This gives the true utilization of the power generating plant.

[1] Similar articles on CHP have appeared in previous Energy Trends publications. However, the figures within any one article are a snapshot of the position as seen at the time and therefore figures between articles do not constitute a time series.

Regional Trends[2]

Table 1 shows an overview of CHP plant data broken down between the English regions and Devolved Administrations. The degree to which the CHP capacity installed in the regions is utilised can be expressed by the Load Factor (LF). The LF is the actual generation as a proportion of the theoretical maximum power that can be generated for a given total installed capacity (TPC). The power output that is actually generated is the total power output (TPO). For example, a CHP with a TPC of 10 MWe has a maximum TPO of 87,600 MWh, i.e. if it ran for all hours in the year (8,760 hours). However, if the TPO was actually 52,560 MWh, it would have a LF of 60 per cent.

Higher LF values tend to be found in industrial uses where the demand for heat extends over a greater proportion of the year than for space heating applications (where the heat demanded from the CHP is mostly confined to the heating season). In 2011, the overall LF value (54.6 per cent) was the same as in 2010, attributed to the fact that the LF in England (the location of 87 per cent of UK CHP capacity), remained relatively constant between 2010 and 2011. The small reduction in LF in Wales and Northern Ireland was balanced by an increase in LF in Scotland. The region with the highest LF in 2011 was Yorkshire/Humberside, followed by Scotland and then the East Midlands. Yorkshire and Humberside has a much higher LF than the other regions because many of its plants are heavy industry plants with 24 hour operation. In 2011, several of these plants operated at LF above 70%, with a few operating at LF above 80%. Some regions (e.g. West Midlands and North East) have low load factors because many schemes in these regions did not operate in 2011, thus reducing the average load factor for the region.

Table 2 shows a comparison of the number of schemes and electrical capacity in the regions for the period 2009 to 2011. During this time, the total number of schemes increased from 1,485 to 1,880, while capacity increased from 5,573 MWe to 6,111 MWe. In England, Wales and Northern Ireland both the number of schemes and electrical capacity have increased between 2009 and 2011. In Scotland, however, while the number of schemes has increased, the total capacity between 2009 and 2011 has decreased. The biggest increase in capacity between 2009 and 2011 was in Yorkshire and Humberside.

Table 2: Number and electrical capacity of CHP schemes, 2009 to 2011

	Number of schemes			Electrical capacity (MWe)		
	2009	**2010**	**2011**	**2009**	**2010**	**2011**
England	**1,263**	**1,333**	**1,586**	**4,870**	**5,266**	**5,323**
East Midlands	76	78	98	223	228	234
Eastern	103	119	130	261	275	285
London	152	158	212	141	122	126
North East	78	80	101	898	905	910
North West	205	216	257	778	783	739
South East	283	294	322	890	884	889
South West	102	112	129	55	68	80
West Midlands	122	131	161	93	99	104
Yorkshire/Humberside	142	145	176	1,531	1,902	1,956
Scotland	85	93	116	536	527	529
Wales	88	97	119	136	213	210
Northern Ireland	49	54	59	31	48	49
UK Total	**1,485**	**1,577**	**1,880**	**5,573**	**6,053**	**6,111**

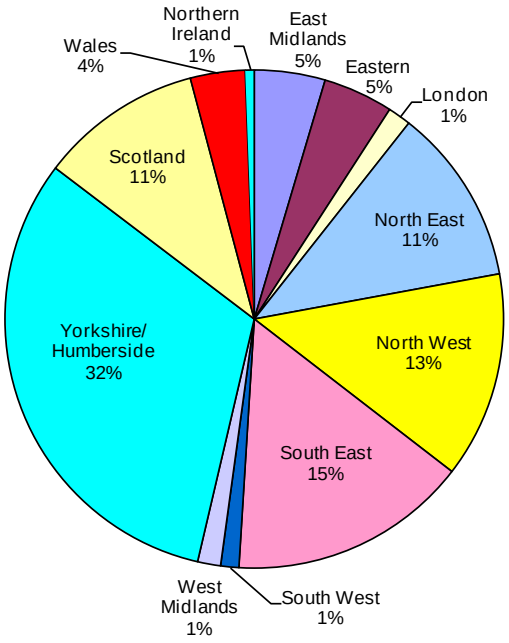
[2] Note: The figures for previous years are revised on an annual basis to account for late information submitted after the publication date of the article. This is to ensure that the true trends are captured in the data. The figures herein therefore supersede the previous articles published.

Special feature - CHP

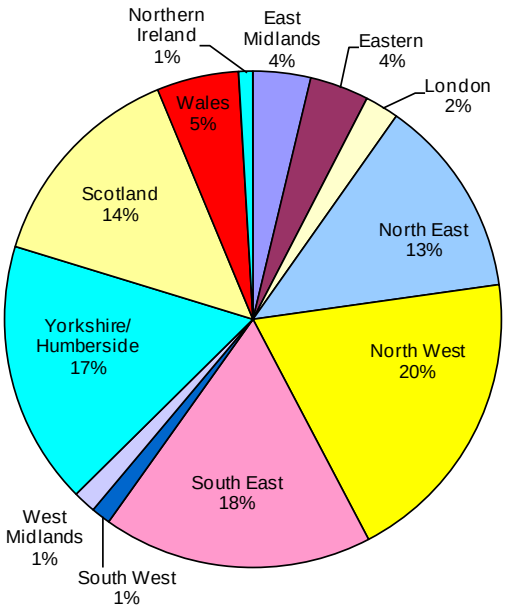
In 2011, as in the previous two years, most of the UK's installed CHP electrical capacity was in England. The region with the highest proportion of the UK's capacity was the Yorkshire and Humberside region with a 32 per cent share. The fact that only 9.3 per cent of the total number of schemes in 2011 came from the Yorkshire and Humberside region is an indication of the large capacities of schemes in this region, particularly in the refineries sector.

Chart 1 shows the distribution of electricity and heat generation from CHP in 2011 across the English regions and the Devolved Administrations. The largest contribution to electricity generation remains that of the Yorkshire and the Humber region (32 per cent), followed by the South East (15 per cent), the North West (13 per cent) and the North East (11 per cent). This ranking is the same as in 2010.

Chart 1: CHP generation by area in 2011



By Electricity Generation



By Heat Generation

The region with the greatest share of heat generation in 2011 was the North West (20 per cent), followed by the South East (18 per cent), Yorkshire and Humberside (17 per cent) and then Scotland (14 per cent). The North West has had the single largest regional share of overall CHP heat generated since at least 2007.

Importance of CHP in the Regional Economies

Chart 1 portrays only a limited picture as it does not account for the varying size of each region. To allow for this, CHP heat capacity and electrical capacity have been compared with the level of economic activity in each region as measured by Gross Value Added (in £ million) in Table 3 and in Charts 2 and 3.

The North East and Scotland have the highest heat capacity density by a large margin followed by Yorkshire and the Humber and the North West. In these regions, industries using CHP play an important part of the economy as represented by the high heat capacity to GVA ratio. The high value of heat capacity per unit of GVA in Scotland, compared to electrical capacity per unit GVA, is a reflection of the high average heat to power ratio of the CHP schemes in Scotland, which in turn is driven by a large Back Pressure Steam Turbine (BPST) capacity in this region[3]. The relatively

[3] Most of this BPST capacity is contained within schemes classified as Gas Turbines in this paper, on account of the fact that the schemes also include gas turbines and operate in CCGT mode.

high values per unit GVA for both heat and electrical capacity in the North East and Yorkshire and the Humber are a reflection of the relative prominence of CHP in the economies of those regions, in particular the use of CHP in refinery and chemical processing activities. In both of these regions, about 90 per cent of the CHP capacity is within the chemical and refineries industry.

Table 3: Density of CHP in different areas, ordered by heat capacity

	Heat capacity kWt/GVA (£million)*	Electrical capacity kWe/GVA (£million)*
North East	28.48	22.17
Scotland	26.77	5.01
Yorkshire/Humberside	18.78	21.81
North West	13.35	6.15
South East	8.64	4.76
Wales	6.56	4.61
East Midlands	4.29	2.89
Northern Ireland	3.27	1.75
Eastern	3.11	2.57
London	1.16	0.51
West Midlands	1.08	1.17
South West	0.69	0.82
UK total	28.48	22.17

*GVA is provisional gross value added in 2010 (workplace based)[4]

The distribution of CHP capacity across the regions and economic sectors is summarised in Table 4, which shows the proportion of total CHP capacity in a particular economic sector that resides in each region. Sixty per cent of all CHP capacity in the oil refineries and oil and gas terminals sector can be found in the Yorkshire and Humber region. Other notable concentrations of CHP capacity are in the North East, North West and Yorkshire and Humberside regions for the chemicals sector, in the South East for the paper and printing sector and in the East region for the food and beverages sector.

[4] www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--income-approach-/december-2010/stb-regional-gva-dec-2011.html. (Regional, sub-regional and local Gross Value Added 2010, Office of National Statistics, Statistical Bulletin, December 2011)

Table 4: Distribution of CHP capacity across the regions and economic sectors										
Region	Sector									
	Iron and Steel and Non-ferrous Metals	Chemicals	Oil Refineries and Oil and Gas Terminals	Paper, Publishing and Printing	Food, Beverages and Tobacco	Metal Products, Machinery and Equipment	Mineral Products	Other Industrial Branches	Transport, Commerce and Administration	Other
England	**80.7%**	**91.2%**	**84.5%**	**80.1%**	**92.0%**	**83.2%**	**100.0%**	**78.2%**	**84.0%**	**94.2%**
East Midlands	*0.0%*	*5.1%*	*0.0%*	*0.0%*	*7.4%*	*45.1%*	*6.1%*	*2.9%*	*6.4%*	*13.1%*
East	*7.0%*	*0.4%*	*0.0%*	*0.0%*	*48.8%*	*0.0%*	*0.0%*	*9.5%*	*5.9%*	*8.5%*
London	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*4.7%*	*0.0%*	*0.0%*	*7.8%*	*14.9%*	*11.2%*
North East	*49.2%*	*38.0%*	*4.2%*	*0.0%*	*0.0%*	*0.0%*	*27.9%*	*7.5%*	*4.8%*	*2.7%*
North West	*0.0%*	*20.5%*	*4.8%*	*16.5%*	*19.4%*	*1.1%*	*43.7%*	*10.1%*	*9.9%*	*4.0%*
South East	*6.1%*	*4.6%*	*15.2%*	*58.4%*	*5.4%*	*5.5%*	*0.0%*	*17.4%*	*16.7%*	*24.8%*
South West	*0.0%*	*0.4%*	*0.0%*	*1.4%*	*2.0%*	*4.4%*	*12.8%*	*5.5%*	*4.9%*	*5.7%*
West Midlands	*0.0%*	*0.0%*	*0.0%*	*2.1%*	*0.7%*	*27.3%*	*0.0%*	*14.5%*	*9.6%*	*2.9%*
Yorkshire and Humber	*18.4%*	*22.1%*	*60.3%*	*1.7%*	*3.6%*	*0.0%*	*9.6%*	*3.0%*	*10.9%*	*21.2%*
Scotland	**0.0%**	**6.5%**	**12.4%**	**11.2%**	**2.3%**	**1.5%**	**0.0%**	**10.5%**	**8.8%**	**2.9%**
Wales	**17.6%**	**1.7%**	**3.1%**	**8.7%**	**1.4%**	**9.0%**	**0.0%**	**11.1%**	**4.9%**	**1.3%**
Northern Ireland	**1.7%**	**0.6%**	**0.0%**	**0.0%**	**4.3%**	**6.2%**	**0.0%**	**0.1%**	**2.3%**	**1.6%**
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Chart 2: Map of CHP density in terms of electrical capacity and gross value added

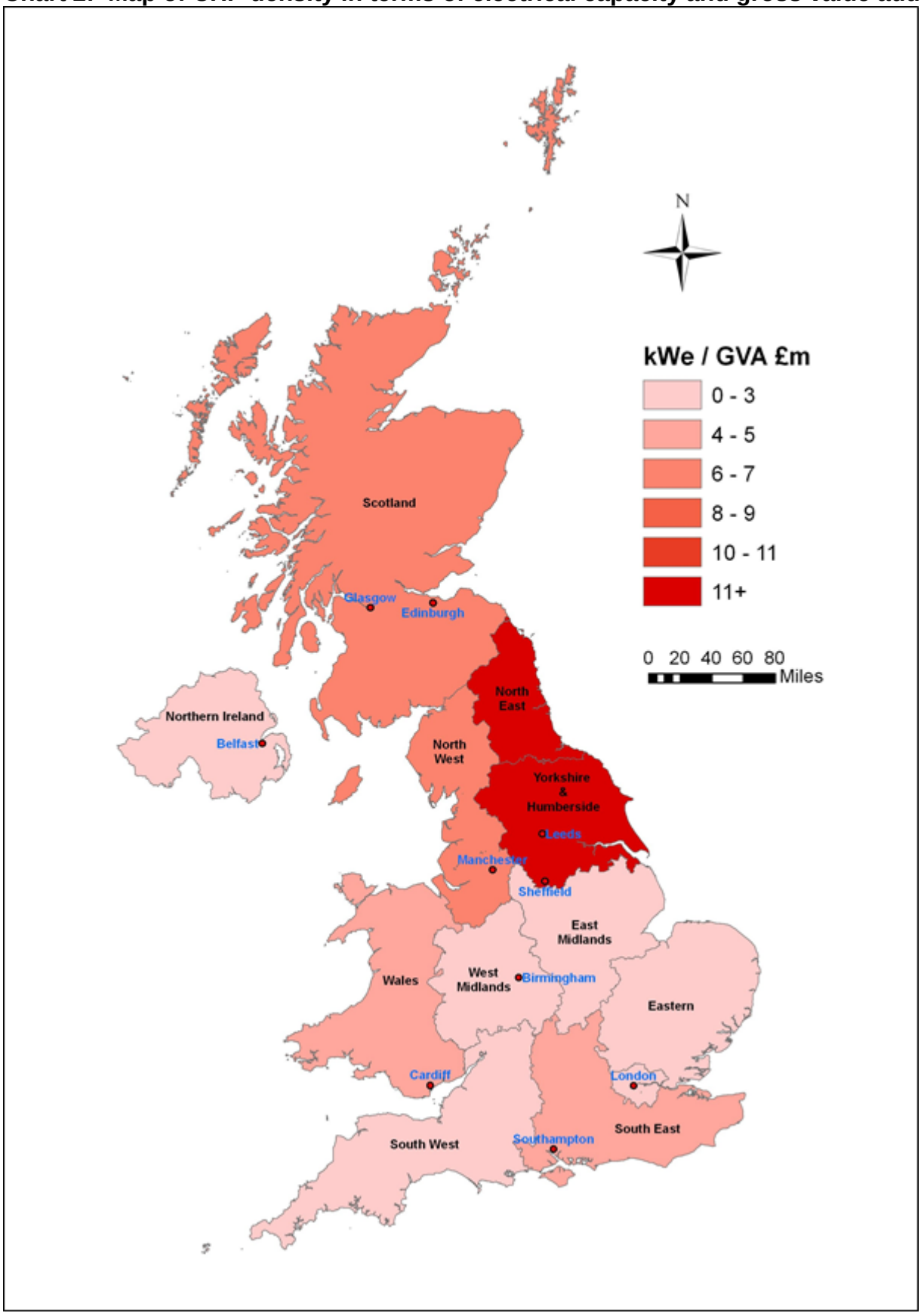
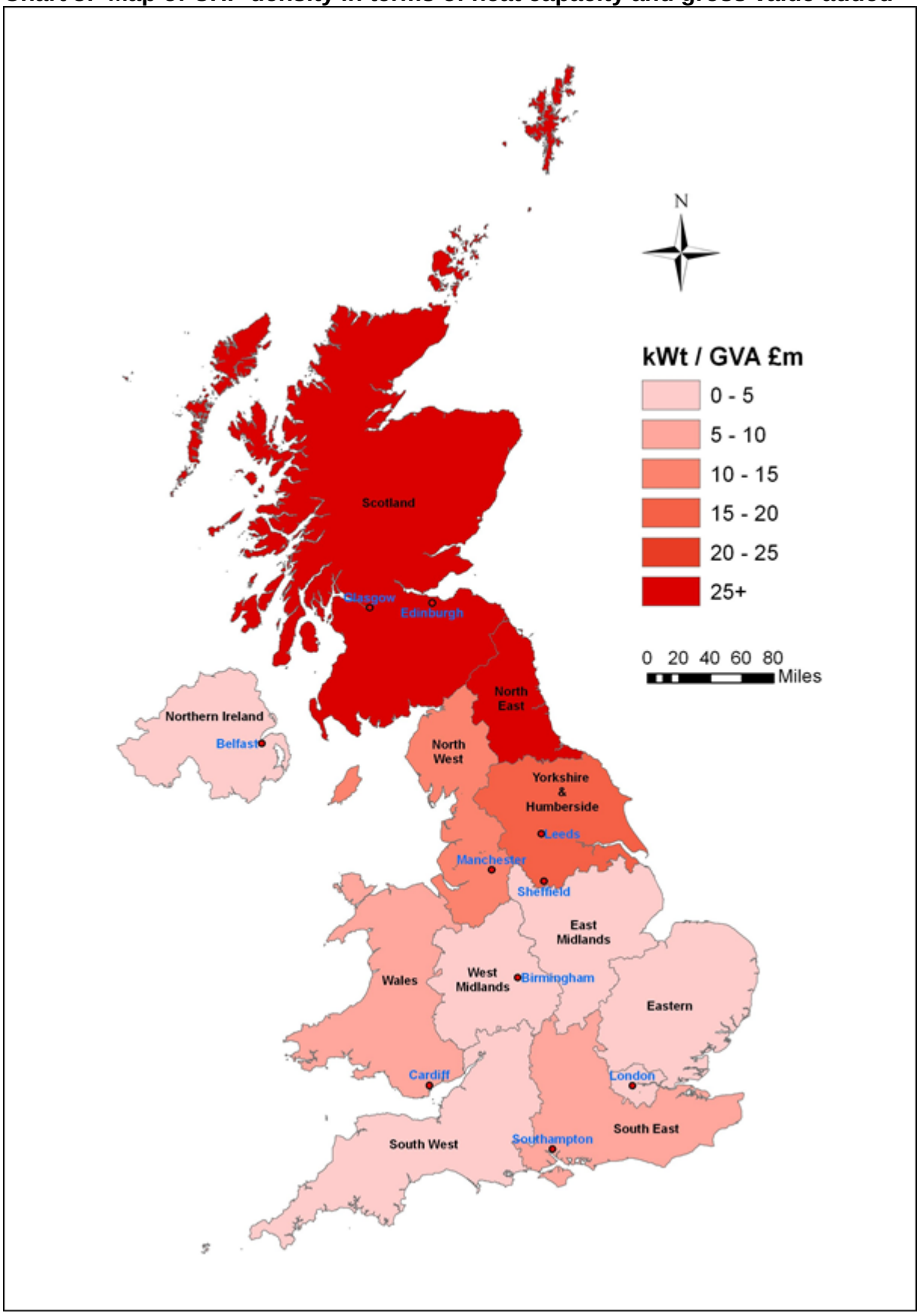


Chart 3: Map of CHP density in terms of heat capacity and gross value added



Technology type and size

Tables 5 and 6 show the regional split of installed electrical capacity (that qualifies as Good Quality CHP capacity) by prime mover type and by size range, respectively. In a number of regions, disaggregation of the data by prime mover type or size category could result in the disclosure of confidential information and so, for these areas, only totals are shown. The following conclusions can be drawn from the tables:

- Gas turbines, whether on their own or as part of Combined Cycle Gas Turbines (CCGT), continue to dominate the CHP market. In 2011, CCGT accounted for around two-thirds of total CHP capacity while accounting for just 2.1 per cent of the total number of CHP schemes (40 CCGT schemes out of a total of 1,880 CHP schemes).

- Only in the North East and North West regions is there a significant presence of steam turbine-based CHP plant, which helps to explain the relatively high ratio of heat to power generated observed for the North West region (H:P = 2.62).

- As CCGT CHP plant has the lowest heat to power ratios of all the CHP technologies, the large amount of CCGT capacity in the Yorkshire and Humber region helps to explain why this region generated 31 per cent of all CHP electricity but only 16 per cent of all CHP heat in 2011. The heat to power ratio in the Yorkshire and Humber region fell from 1.01 in 2010 to 0.97 in 2011, due to reduced heat output from the large schemes in the region.

Table 5: CHP electrical capacity (MWe) by area and prime mover in 2011

	Gas Turbines*	Steam Turbines	Reciprocating Engines	Total
England	**4,060**	**495**	**768**	**5,323**
East Midlands	146	46	42	234
Eastern		285		285
London		125		126
North East	588	255	66	910
North West	513	128	98	739
South East		889		889
South West		80		80
West Midlands		104		104
Yorkshire/Humberside	1,829	41	85	1,956
Scotland	440	44	45	529
Wales		210		210
Northern Ireland		49		49
Grand Total	**4,632**	**589**	**889**	**6,111**

*Includes Combined Cycle Gas Turbines (CCGT)

While the CHP market in total is dominated by large-scale (>10MWe) plant, with 81.8 per cent of installed capacity being in this size range, two regions in 2011 have no capacity above 10MWe (West Midlands and the South West), as shown in Table 6.

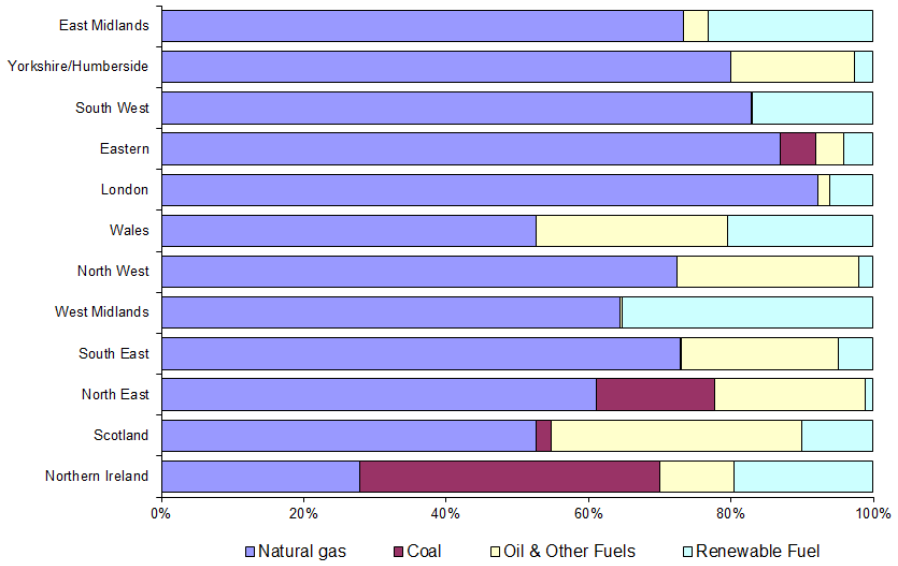
Table 6: CHP electrical capacity (MWe) by area and size in 2011

	Less than 100 kWe	100 kWe but less than 1 MWe	1 MWe but less than 10 MWe	10 MWe and greater	Total
England	**28**	**213**	**695**	**4,387**	**5,323**
East Midlands	2	13	31	189	234
Eastern	2	20	64	198	285
London	4	29	93		126
North East	2	8	51	849	910
North West	5	34	102	598	739
South East	5	47	837		889
South West	2	20	58	0	80
West Midlands	3	20	81	0	104
Yorkshire/Humberside	4	21	76	1,855	1,956
Scotland	1	15	61	452	529
Wales	3	14	194		210
Northern Ireland	1	8	40		49
UK Total	**33**	**250**	**828**	**5,000**	**6,111**

The fuel mix

The proportion of coal, gas, renewable fuels and 'oil and other fuels' (comprising oil products, refinery gases, blast furnace gas and other industrial wastes) in the fuel mix for each region is shown in Chart 4.

Chart 4: Proportion of different fuels in the fuel mix for CHP in 2011 for each region



Natural gas represents at least half of all fuel burned in CHP in all regions except Northern Ireland, where the relatively limited extent of the gas grid continues to suppresses gas use. Northern Ireland is unique in that coal represents the single largest fuel used in CHP (about 47 per cent).

Coal plays a relatively minor role in all other regions (except North East where it accounts for about 17 per cent) and is not used at all in CHP in six regions (East Midlands, South West, London, Wales, North West and West Midlands).

In 2011, the region where renewable fuels constituted the largest share for total CHP fuel input was the West Midlands where renewables accounted for 34 per cent of total fuel used in the region. This was followed by the East Midlands (23 per cent), Wales (24 per cent), Northern Ireland (20 per cent) and the South West (17 per cent). The use of renewable fuel in Northern Ireland fell from 26 per cent in 2010 to 20 per cent in 2011, mainly due to an increase in the use of natural gas. Renewable fuels' relatively large proportion of total fuel consumption in the West Midlands and South West is principally due to the use of sewage gas. Renewable fuels' share of total fuel use in CHP plant rose from 5.8 per cent in 2010 (revised) to 6.2 per cent in 2011.

Summary

After taking into account the installation of new schemes, the decommissioning of old schemes and a fall in capacity at some schemes that remain operational, there was a 9.7 per cent increase in UK CHP capacity over the three year period 2009 to 2011. However, capacity was broadly unchanged between 2010 and 2011.

The Yorkshire and the Humberside region continues to be the region of the UK with the greatest level of installed capacity and electricity generation. Other regions with high levels of CHP capacity (North East, South East and North West) are those with significant presence of heat intensive industry, such as oil refining, chemicals production and paper and printing. About 88 per cent of all refinery CHP capacity is located in the regions of Yorkshire and the Humber, the South East and Scotland, while about 81 per cent of CHP capacity at chemical works is located in the three regions of the North East, the North West and Yorkshire and Humber. About 58 per cent of the paper and printing CHP capacity, on the other hand, is located in the South East.

The region with the highest heat capacity density is the North East, followed by Scotland, Yorkshire and Humberside and the North West. The North East also has the highest electrical capacity density, followed by Yorkshire and Humber. This is a reflection of the relative prominence of CHP in the economies of these regions, in particular the use of CHP in the refinery and chemical sectors. The low electrical capacity per unit GVA for Scotland in comparison to the high heat capacity per unit GVA is a reflection of the high heat-to-power ratio of CHP schemes in Scotland due to a large capacity of Back Pressure Steam Turbines in the region.

The region with the highest proportion of renewable fuel use is the West Midlands, followed by East Midlands and then Wales.

For further information on UK CHP statistics, please contact:

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