

## Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2016

### 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 in July 2017. This article updates statistics published in the September 2016 edition of Energy Trends and provides a breakdown of CHP in the Devolved Administrations and English regions in 2016<sup>1</sup>. In compiling the data for this article, it became apparent that a revision was required to the quantities of renewable and “other” fuels, which were published in DUKES 2017 for year of operation 2015 and 2016. These revisions have been made to DUKES and the figures presented in this article reflect the revised figures.

The data presented originates from a CHP database maintained by Ricardo Energy & Environment on behalf of The Department of Business Energy and Industrial Strategy (BEIS). Data relating to the overwhelming majority of CHP electrical capacity (>98 per cent of total capacity) is received annually from the reliable sources of 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. Another source of data is the sales databases of the Association for Decentralised Energy (ADE). Data from CHP schemes not covered by the above sources are extrapolated from historic data. There is an ongoing data quality assurance exercise in respect of these schemes.

Between 2015 and 2016 there was a net increase of 43 CHP schemes in the database (62 new schemes and the removal of 19 schemes), but a net decrease of 159 MWe in capacity. Good Quality CHP<sup>2</sup> capacity in the UK fell from 5,730 MWe (revised 2015 figure) to 5,571 MWe in 2016.

### Regional Trends<sup>3</sup>

Tables 1 and 1B show a comparison of the number of schemes, electrical capacity, electricity generated and heat generated in the regions<sup>4</sup> for the period 2014 to 2016. During this time, the total number of schemes increased from 2,076 to 2,182, however the capacity decreased from 5,892 MWe to 5,571 MWe. With the exception of Wales, the number of schemes increased in all regions over the period 2014 to 2016. Over this period, the electrical capacity decreased in the North East, North West, South East, Scotland and Wales, with capacity increasing in all other regions. The fall in capacity in the North East was substantial and occurred mainly between 2014 and 2015. The reasons for this were discussed in the Energy Trends 2016 edition; capacity serving an oil terminal ceased to operate as a CHP plant and a chemical plant significantly downgraded its capacity. Since then the capacity in the North East has fallen further due to the final closure of the power plant at what was the integrated steel works at Redcar. Between 2015 and 2016 about 10 per cent of the capacity was lost in the South East region, due to the closure of a large paper site and its CHP plant. There were further losses in capacity in the Chemicals sector in the North West region.

<sup>1</sup> Similar articles on CHP have appeared in previous Energy Trends publications from 2001 to 2016. 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. For example, there have been revisions down to the installed capacity for 2014 and 2015 shown in this article compared to the installed capacity shown for those years in last year’s edition of this article.

<sup>2</sup> Good Quality CHP denotes schemes that have been certified as being highly efficient through the UK’s CHP Quality Assurance (CHPQA) programme.

<sup>3</sup> 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.

<sup>4</sup> These regions are the Government Office Regions of England and Devolved Administrations of Scotland, Wales and Northern Ireland.

**Table 1: Trend in number of CHP schemes and their electrical capacity over the period 2014-2016**

	Number of Schemes			Electrical Capacity (MWe)		
	2014	2015	2016	2014	2015	2016
<b>England</b>	<b>1,749</b>	<b>1,808</b>	<b>1,849</b>	<b>5,075</b>	<b>4,940</b>	<b>4,778</b>
East Midlands	109	116	116	111	132	132
Eastern	166	169	174	304	321	323
London	290	305	319	199	232	247
North East	110	112	112	538	374	333
North West	279	291	292	780	741	695
South East	292	301	309	948	896	808
South West	140	144	149	81	116	120
West Midlands	175	177	181	112	112	114
Yorkshire/Humberside	188	193	197	2,004	2,016	2,007
<b>Scotland</b>	135	137	140	546	525	528
<b>Wales</b>	118	117	117	208	184	184
<b>Northern Ireland</b>	74	77	76	62	82	81
<b>UK Total</b>	<b>2,076</b>	<b>2,139</b>	<b>2,182</b>	<b>5,892</b>	<b>5,730</b>	<b>5,571</b>

**Table 1B: Trend in CHP electricity and heat generated 2014-2016**

	Electricity Generated (GWh)			Heat Generated (GWh)		
	2014	2015	2016	2014	2015	2016
<b>England</b>	<b>16,230</b>	<b>16,252</b>	<b>16,824</b>	<b>33,188</b>	<b>32,047</b>	<b>31,892</b>
East Midlands	579	629	623	1,323	1,358	1,310
Eastern	1,327	1,381	1,314	1,984	1,994	1,789
London	584	593	627	1,220	1,211	1,262
North East	1,223	1,078	1,080	4,690	4,095	3,580
North West	2,771	2,527	2,527	8,025	7,678	7,588
South East	3,200	2,729	2,826	6,704	6,395	6,483
South West	376	407	403	468	503	498
West Midlands	443	484	474	764	766	838
Yorkshire/Humberside	5,726	6,424	6,949	8,010	8,048	8,544
<b>Scotland</b>	2,503	2,435	2,298	5,893	5,760	6,104
<b>Wales</b>	738	613	615	2,361	1,931	1,918
<b>Northern Ireland</b>	224	258	332	515	524	509
<b>UK Total</b>	<b>19,695</b>	<b>19,558</b>	<b>20,070</b>	<b>41,957</b>	<b>40,261</b>	<b>40,423</b>

The region with the highest proportion of the UK's electrical capacity is still the Yorkshire and Humberside region with a 36 per cent share, followed by the South East (15 per cent) the North West (12 per cent) and Scotland (9 per cent). The Yorkshire and Humberside region hosts the largest CHP scheme in the UK. If this particular scheme were disregarded, the Yorkshire and Humberside region would host the second largest share of capacity in the UK.

The four largest regions in terms of installed capacity were also the four largest regions in terms of electricity generation, and were ranked in the same order. In 2016, the Yorkshire and Humberside region accounted for over one third of all Good Quality electricity generated in the UK. Two of the top five largest generators of Good Quality power in the UK are located in this region.

The Yorkshire and Humber region also accounted for the largest share of heat generated from CHP in 2016. However, its position was less dominant for heat generation than for power generation, and this is reflection of significantly lower than average heat to power ratios registered at some of the very large power generating schemes in this region.

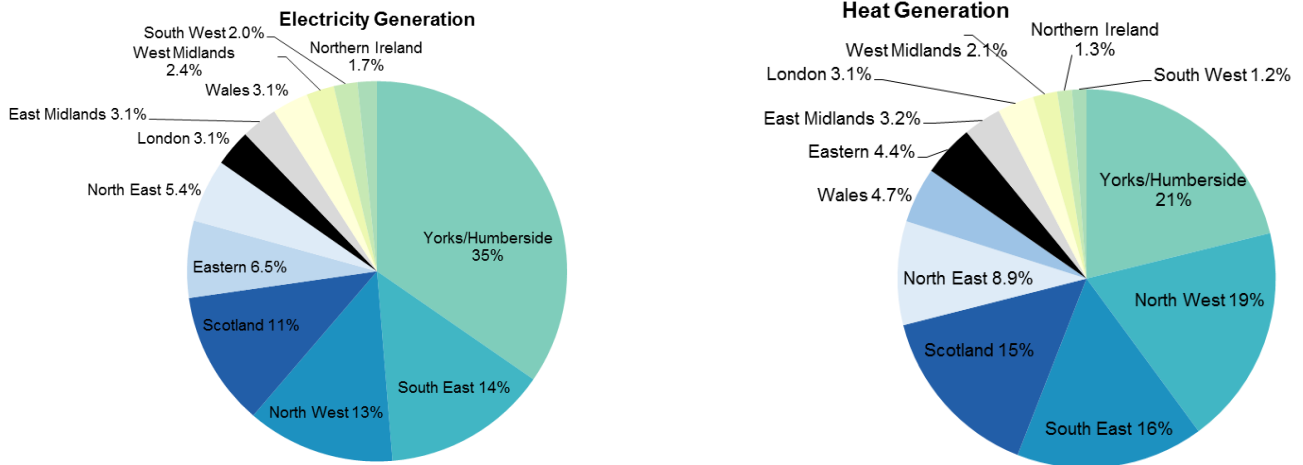
**Chart 1: CHP generation by area in 2016**

Table 2 shows an overview of CHP plant data broken down between the English regions and devolved administrations. CHP capacity utilisation can be expressed by the Load Factor (LF). 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 2016, the TPC was 8,324 MWe<sup>5</sup> and the TPO was 43,761 GWh, giving a LF of 60.1 per cent. This is a significant increase on the revised value for 2015 (50.9 per cent), and this is substantially due to a notable increase in the LF at a number of large power generating sites in the Yorkshire and Humber and South East regions.

Higher LF values tend to be found in industrial uses where the demand for heat extends over a greater proportion of the year than is the case for space heating applications, where the heat demanded from the CHP is mostly confined to the heating season. This is especially well illustrated by the fact that the region with the highest ratio of industrial to non-industrial installed capacity (Yorkshire and the Humber) has the highest LF (68 per cent) while the region with the lowest ratio of industrial to non-industrial installed capacity (London) has the lowest LF (39 per cent).

The downward trend in LF in industry, seen until 2015, came to an end in 2016. The increase in LF between 2015 and 2016 can be substantially explained by an increase in LF at some very large industrial sites. It remains to be seen whether these higher industrial LF values will be sustained over time.

<sup>5</sup> The Total Power Capacity (TPC) is the registered maximum power generating capacity of a CHP scheme. It should be distinguished from Qualifying Power Capacity (QPC). QPC is defined under the CHPQA Standard and is also known as Good Quality capacity. QPC is the registered power generation capacity that achieves a QI of 100 or more under conditions of Maximum Heat Output under Normal Operating Conditions, as defined in the CHPQA Standard. Where a CHP scheme does achieve a QI of 100 or more under these conditions, its TPC and QPC are the same. Where it does not, then the capacity considered Good Quality is scaled- back and under these circumstances TPC>QPC. Unless otherwise stated, QPC is the basis of all power capacities quoted in this article.

**Table 2: Overview of CHP schemes in 2016**

	Number of Schemes	Electrical Capacity (QPC)* MWe	Electrical Capacity (TPC) MWe	Heat Capacity MWth	Fuel Used* GWh	Electricity Generated (QPO)* GWh	Electricity Generated (TPO) GWh	Heat Generated GWh	Load Factor** (%)
<b>England</b>	<b>1,849</b>	<b>4,778</b>	<b>7,286</b>	<b>16,123</b>	<b>67,013</b>	<b>16,824</b>	<b>38,486</b>	<b>31,892</b>	60.3%
East Midlands	116	132	174	607	2,817	623	1,023	1,310	67.0%
Eastern	174	323	323	890	4,258	1,314	1,365	1,789	48.2%
London	319	247	281	1,046	2,588	627	960	1,262	38.9%
North East	112	333	360	877	6,204	1,080	1,565	3,580	49.7%
North West	292	695	837	4,172	13,101	2,527	3,949	7,588	53.9%
South East	309	808	2,011	3,092	12,957	2,826	10,369	6,483	58.9%
South West	149	120	120	285	1,489	403	497	498	47.4%
West Midlands	181	114	129	510	2,153	474	632	838	55.9%
Yorkshire/Humberside	197	2,007	3,050	4,643	21,445	6,949	18,126	8,544	67.8%
<b>Scotland</b>	<b>140</b>	<b>528</b>	<b>682</b>	<b>2,534</b>	<b>11,742</b>	<b>2,298</b>	<b>3,447</b>	<b>6,104</b>	57.7%
<b>Wales</b>	<b>117</b>	<b>184</b>	<b>275</b>	<b>827</b>	<b>3,920</b>	<b>615</b>	<b>1,472</b>	<b>1,918</b>	61.1%
<b>Northern Ireland</b>	<b>76</b>	<b>81</b>	<b>81</b>	<b>189</b>	<b>1,450</b>	<b>332</b>	<b>356</b>	<b>509</b>	50.2%
<b>UK Total</b>	<b>2,182</b>	<b>5,571</b>	<b>8,324</b>	<b>19,673</b>	<b>84,125</b>	<b>20,070</b>	<b>43,761</b>	<b>40,423</b>	<b>60.0%</b>

\*This represents Good Quality CHP capacity (QPC), Good Quality CHP power output (QPO) and the fuel associated with the Good Quality CHP outputs. For further details on how these are defined, see Dukes 2016 Chapter 7 and the Combined Heat and Power Quality Assurance (CHPQA) Standard Issue 5):

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/335471/CHPQAStandardIssue5.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335471/CHPQAStandardIssue5.pdf)

\*\* 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). This gives the true utilisation of the power generating plant.

### Importance of CHP in the Regional Economies

Chart 1 shows the CHP outputs of each region and is derived from the data contained in Table 1B. It portrays only a limited picture as it does not account for the varying size of each region's economy. 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. Chart 2 maps the heat capacity per unit of GVA for the different regions.

CHP continues to be a very important part of the economies of the Yorkshire/Humber, North West, and North East regions, as evidenced by the large heat capacities per unit of GVA in these regions. This is due to the prominence of the chemicals and oil refining industries in these regions, which are heat intensive sectors. With the exception of London and the South West, the fall in overall capacity (discussed above) has led to CHP playing a less important role in the economies of all regions. The largest falls were in the North East and South East regions. The most important instances of loss in capacity, leading to these falls in capacity per unit GVA, were discussed above.

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

	Heat capacity per unit GVA kWth/ (£million)*	Electrical capacity per unit GVA kWe/ (£million)*
Yorkshire/Humberside	42.32	18.29
North West	26.59	4.43
<b>Scotland</b>	19.91	4.15
North East	<b>17.66</b>	<b>6.71</b>
<b>Wales</b>	14.83	3.29
South East	<b>12.41</b>	<b>3.24</b>
<b>England</b>	<b>11.25</b>	<b>3.33</b>
Eastern	6.11	2.22
East Midlands	6.21	1.35
<b>Northern Ireland</b>	5.49	2.35
West Midlands	<b>4.26</b>	<b>0.95</b>
London	2.76	0.65
South West	2.26	0.95
<b>UK total</b>	<b>11.81</b>	<b>3.34</b>

\*GVA is provisional gross value added in 2015 (workplace based)<sup>6</sup>

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 in each region. The well established patterns of CHP deployment by economic sector, which are defined by long term investments in industrial CHP capacity, remain. Over 84 per cent of all capacity installed in the Chemicals sector is to be found in just three regions of the UK: Yorkshire and Humber, North West and North East. Sixty-two per cent of capacity in the oil refineries and oil and gas terminals

<sup>6</sup> [www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedincomeapproach/december2015](http://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedincomeapproach/december2015)

### *Special feature - CHP*

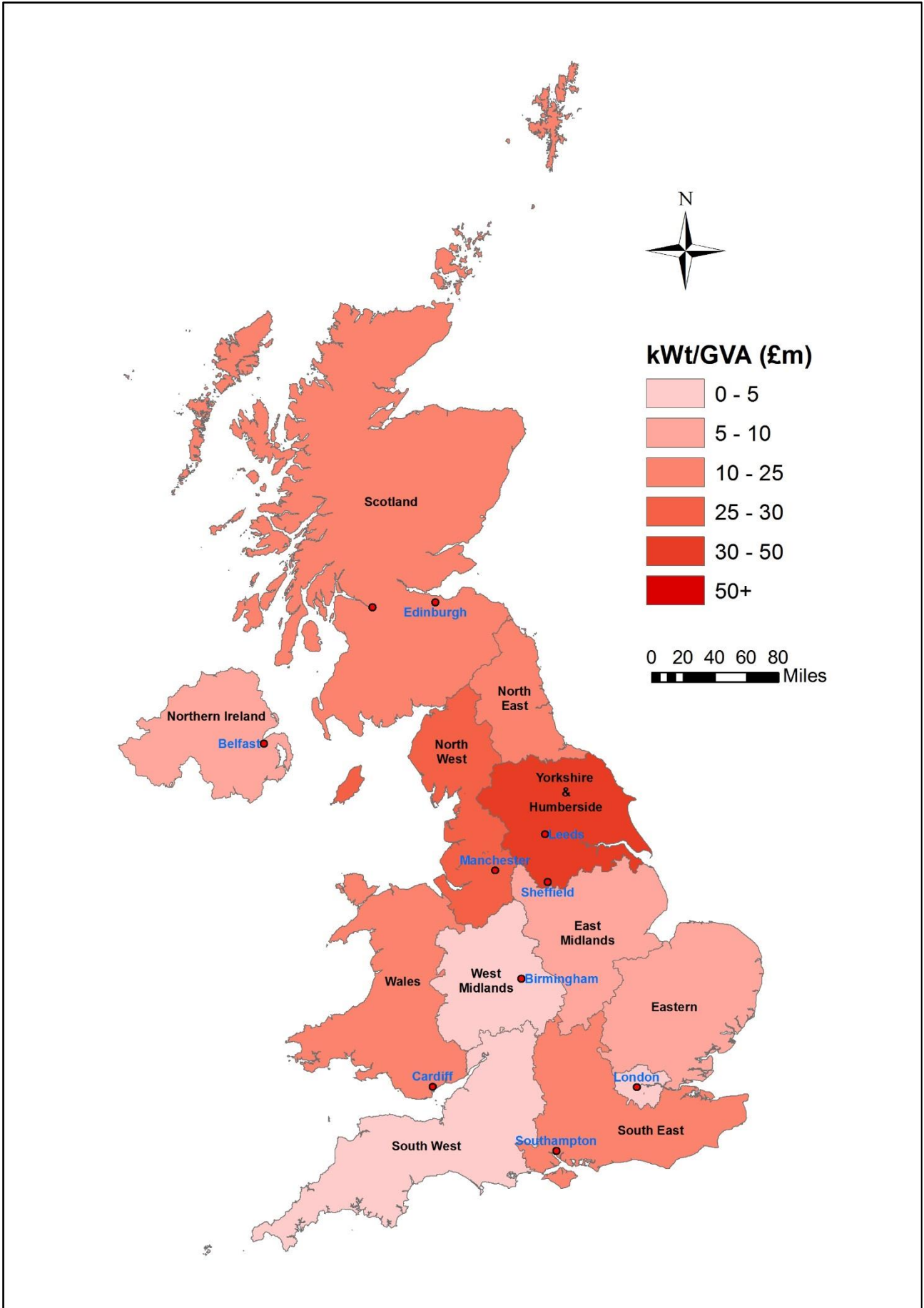
sector can be found in the Yorkshire and Humber region. The most notable changes to the geographic distribution of CHP capacity by economic sector over the past year are within the Iron and Steel and Paper sectors. In 2015 over half of the capacity in the Iron and Steel sector was located in the North East region. With the closure of the integrated steel works at Redcar there is now no capacity in this region in the Iron and Steel sector. The share of capacity installed in the paper sector in the South East has fallen from over half to 38 per cent, mainly due to the closure of one large newsprint works in that region.

The large proportion of capacity installed in the Food and Drink sector in the Eastern region (44 per cent), is substantially due to that region's sugar from sugar beet refining operations. The predominance of services in London and the South East is reflected by these two regions having the highest and second highest shares, respectively, of capacity installed within the Transport Commerce and Administration sector.

**Table 4: Distribution of CHP capacity across the regions and economic sectors in 2016**

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
<b>England</b>	60.1%	88.9%	85.9%	72.4%	89.2%	80.7%	100.0%	76.6%	84.7%	92.8%
East Midlands	0.0%	1.2%	0.0%	0.0%	6.5%	0.0%	6.7%	7.1%	6.0%	7.4%
Eastern	14.6%	1.4%	0.0%	0.0%	44.4%	0.0%	0.0%	11.3%	4.9%	7.9%
London	7.3%	1.1%	0.0%	0.0%	6.0%	14.3%	0.0%	15.9%	15.4%	16.4%
North East	0.0%	23.1%	0.0%	0.0%	0.0%	0.0%	24.6%	3.9%	7.6%	1.9%
North West	0.0%	23.9%	4.9%	31.0%	17.3%	5.6%	48.1%	7.5%	10.3%	4.4%
South East	0.0%	0.2%	19.3%	36.8%	4.8%	6.5%	0.0%	12.1%	13.0%	25.9%
South West	0.0%	0.7%	0.0%	0.0%	1.8%	6.5%	20.5%	5.1%	9.5%	6.2%
West Midlands	0.0%	0.2%	0.0%	2.6%	0.1%	47.7%	0.0%	8.5%	8.2%	3.3%
Yorkshire and Humber	38.1%	37.1%	61.7%	1.9%	8.4%	0.0%	0.0%	5.1%	9.8%	19.4%
<b>Scotland</b>	0.0%	6.9%	12.0%	19.2%	4.6%	0.8%	0.0%	9.1%	9.1%	4.3%
<b>Wales</b>	36.4%	3.1%	2.1%	8.4%	1.0%	9.2%	0.0%	8.2%	3.6%	1.0%
<b>Northern Ireland</b>	3.5%	1.0%	0.0%	0.0%	5.2%	9.4%	0.0%	6.1%	2.6%	1.8%
<b>UK Total</b>	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 heat capacity and gross value added





## Technology type and size

Tables 5 and 6 show the regional split of installed electrical capacity (which qualifies as Good Quality CHP capacity) by prime mover (table 5) and by size range (table 6). In a number of regions, disaggregation of the data by prime mover or size 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 2016, gas turbine based schemes accounted for 69 per cent of total CHP capacity but only 6 per cent of the total number of CHP schemes.
- The North West remains the region with the largest steam turbine based capacity. All of this capacity is at industrial sites. Scotland is the region with the second largest steam turbine based capacity, followed by the Yorkshire and the Humber.
- Reciprocating Engines constitute the vast majority of all CHP schemes (92 per cent). The region with the largest number of reciprocating engine schemes is London, followed by the South East and the North West. This is explained by the high number of leisure centres, hotels and retail outlets to be found in these regions, for which reciprocating engines are suited.

**Table 5: CHP electrical capacity (MWe) by area and prime mover in 2016**

	Gas Turbines*	Steam Turbines	Gas and Steam Turbines Subtotal	Reciprocating Engines	Total
<b>England</b>	<b>3,361</b>	<b>335</b>	<b>3,696</b>	<b>1,082</b>	<b>4,778</b>
East Midlands	-	-	59	72	132
East of England	-	-	197	127	323
London	-	-	53	194	247
North East	-	-	270	63	333
North West	-	-	567	128	695
South East	592	3	594	213	808
South West	18	26	43	76	120
West Midlands	-	-	16	98	114
Yorkshire and The Humber	1,838	58	1,896	111	2,007
<b>Scotland</b>	<b>382</b>	<b>81</b>	<b>463</b>	<b>65</b>	<b>528</b>
<b>Wales</b>	<b>-</b>	<b>-</b>	<b>141</b>	<b>43</b>	<b>184</b>
<b>Northern Ireland</b>	<b>-</b>	<b>-</b>	<b>33</b>	<b>48</b>	<b>81</b>
<b>Grand Total</b>	<b>3,848</b>	<b>485</b>	<b>4,333</b>	<b>1,238</b>	<b>5,571</b>

\*Includes Combined Cycle Gas Turbines (CCGT)

The CHP market continues to be dominated by large-scale (>10MWe) plant, with 75 per cent of all installed capacity being in this size range. However, this proportion is lower than in previous years and is a continuation of a longer term trend for a decreasing share of capacity to fall above 10 MWe. This is explained by the closure, over time, of a number of larger industrial based CHP.

The regional distribution of CHP by capacity tranche is given in Table 6. Over 45 per cent of all capacity greater than 10 MWe is to be found in the Yorkshire and Humber region. The region with the second largest share of CHP capacity greater than 10 MWe is the South East (14 per cent), followed by the North West (12 per cent) and Scotland (10 per cent). Again, this is a reflection of the tendency for sites in the industrial sectors of oil refineries, chemicals and paper, which have large demands for heat, to be found in these locations.

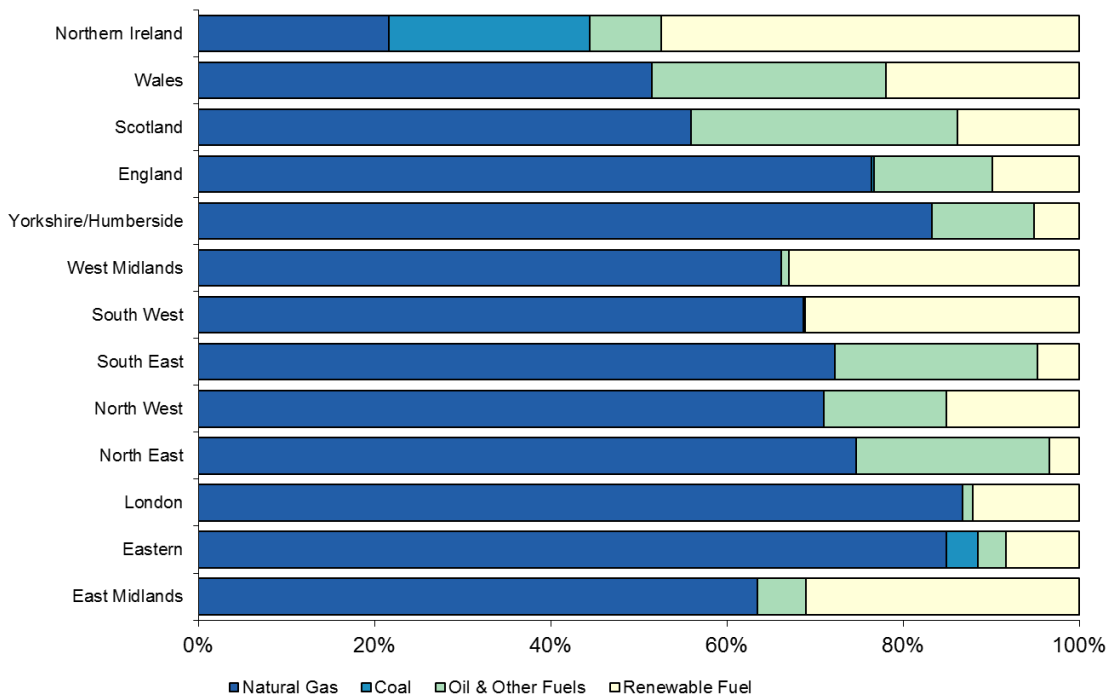
**Table 6: CHP electrical capacity (MWe) by area and size in 2016**

	<= 100 kWe	> 100 kWe to 1 MWe	>1 MWe to 2 MWe	> 2 MWe to 10 MWe	> 10 MWe +	Total
<b>England</b>	<b>35</b>	<b>255</b>	<b>192</b>	<b>705</b>	<b>3,591</b>	<b>4,778</b>
East Midlands	2	15	22	-	-	132
East of England	3	25	20	-	-	323
London	6	46	19	-	-	247
North East	3	9	8	49	264	333
North West	5	42	32	101	514	695
South East	5	43	34	135	590	808
South West	3	24	15	-	-	120
West Midlands	3	26	18	-	-	114
Yorkshire and The Humber	4	26	24	77	1,876	2,007
<b>Scotland</b>	<b>2</b>	<b>16</b>	<b>20</b>	<b>65</b>	<b>426</b>	<b>528</b>
<b>Wales</b>	<b>3</b>	<b>15</b>	<b>-</b>	<b>-</b>	<b>123</b>	<b>184</b>
<b>Northern Ireland</b>	<b>1</b>	<b>16</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>81</b>
<b>Grand Total</b>	<b>40</b>	<b>303</b>	<b>218</b>	<b>824</b>	<b>4,185</b>	<b>5,571</b>

### 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 3.

**Chart 3: Proportion of different fuels in the fuel mix for CHP in 2016 for each region**



Natural gas represented 71 per cent of all fuel burned in CHP in 2016, which is slightly higher than in 2015 when the share was 70 per cent (revised). Natural gas makes up more than half of the overall fuel consumption in every region except Northern Ireland. The low levels of natural gas consumption in Northern Ireland are a reflection of the under-developed nature of the gas distribution network in that region. Over the last five years the proportion of total CHP fuel consumption in Northern Ireland that is natural gas has not exceeded 36 per cent and was only 22 per cent in 2016.

In 2016 coal was only burned in Northern Ireland and the Eastern region and was confined to a very small number of schemes. The proportion of fuel that was renewable was higher in 2016 (12 per cent) than in 2015 (11 per cent, revised). The region with the largest share of fuel inputs to CHP that are renewable is Northern Ireland (48 per cent), followed by the West Midlands (33 per cent) and then the South West and East Midlands regions (both on 31 per cent) The North East had the lowest share of renewable fuel input to CHP. In 2016, biogas and biomass constituted roughly equal quantities of total renewable fuel consumed (39 and 38 per cent respectively), with the majority of the remainder being in the form of renewable waste fuels.

## **Summary**

The well established patterns concerning the regional distribution of CHP in the UK remain. Nevertheless, these patterns have been undergoing subtle changes over time. In the main these changes are caused by the closure of industrial CHP which, because they are usually large, produce noticeable effects in the patterns of the data.

Over the period 2014 to 2016, the number of CHP schemes has increased in all regions of the UK, apart from Wales. However, over the same period, the installed capacity decreased in five of the twelve separate regions and devolved administrations observed in this article. This is invariably caused by closures in industrial CHP capacity and there have been notable losses of capacity in the chemicals and paper sectors in recent years, affecting the regions in which these industries tend to cluster. The CHP capacity in the Iron and Steel sector has also fallen by an appreciable amount, due to the closure of the integrated steelworks at Redcar, leading to a further fall in the installed capacity in the North East.

The use of renewable fuels in CHP has increased again and renewable fuels make up large proportions of the total CHP fuel consumed in Northern Ireland, West Midlands and East Midlands. Natural gas continues to be main fuel used in CHP, and makes up more than half of all CHP fuel consumed in all but one of the twelve regions, the exception being Northern Ireland. Overall 71 per cent of all CHP fuel was natural gas.

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