Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2018

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 2019. This article updates statistics published in the September 2018 edition of Energy Trends and provides a breakdown of CHP in the Devolved Administrations and English regions in 2018[1].

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 (>99 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 historical data. There is an ongoing data quality assurance exercise in respect of these schemes.

Between 2017 and 2018 there was a net increase in Good Quality CHP[2] capacity of 66 MWe and a net increase of 64 in the number of CHP schemes in the database (68 new schemes and the removal of 4 schemes). Good Quality CHP capacity in the UK increased from 5,919 MWe (revised 2017 figure) to 5,985 MWe in 2018. In 2018, 22.9 TWh of Good Quality CHP electricity was generated, which is 5.0 per cent higher than in 2017. This Good Quality CHP electricity constitutes 6.9 per cent of all electricity supplied in the UK.

Regional Trends[3]

Tables 1 and 1B show a comparison of the number of schemes, electrical capacity, electricity generated and heat generated in the regions[4] for the period 2016 to 2018. During this time, the total number of schemes increased from 2,224 to 2,473 and the capacity increased from 5,625 MWe to 5,985 MWe. Over this period, every region saw an increase in the number of CHP schemes and the capacity increased in all regions.

[1] Similar articles on CHP have appeared in previous Energy Trends publications from 2001 to 2018. 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.

[2] Good Quality CHP denotes schemes that have been certified as being highly efficient through the UK's CHP Quality Assurance (CHPQA) programme.

[3] 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.

[4] 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 2016-2018

	Number of Schemes			Electrical Capacity (MWe)		
	2016	**2017**	**2018**	**2016**	**2017**	**2018**
England	**1,879**	**2,016**	**2,066**	**4,773**	**5,026**	**5,096**
East Midlands	117	133	136	131	151	152
Eastern	183	196	200	313	347	353
London	324	337	344	244	253	258
North East	114	126	130	333	360	391
North West	295	311	318	696	747	760
South East	315	328	334	818	860	871
South West	153	169	173	120	137	143
West Midlands	181	204	215	111	147	151
Yorkshire/Humberside	197	212	216	2,006	2,024	2,018
Scotland	149	171	178	551	561	563
Wales	120	137	138	220	236	228
Northern Ireland	76	85	91	81	96	99
UK Total	**2,224**	**2,409**	**2,473**	**5,625**	**5,919**	**5,985**

Table 1B: Trend in CHP electricity and heat generated over the period 2016-2018

	Electricity Generated (GWh)			Heat Generated (GWh)		
	2016	**2017**	**2018**	**2016**	**2017**	**2018**
England	**17,031**	**18,010**	**18,987**	**32,110**	**33,766**	**33,592**
East Midlands	637	732	720	1,336	1,383	1,369
Eastern	1,341	1,488	1,559	1,820	1,971	2,217
London	650	783	866	1,300	1,350	1,469
North East	1,080	1,342	1,184	3,580	4,019	3,497
North West	2,538	2,739	2,761	7,621	8,014	7,931
South East	2,742	3,016	3,712	6,498	6,845	6,991
South West	603	677	707	555	626	665
West Midlands	475	600	613	845	883	924
Yorkshire/Humberside	6,966	6,633	6,866	8,555	8,676	8,528
Scotland	2,326	2,607	2,593	6,119	6,247	6,155
Wales	712	785	859	1,934	2,004	2,123
Northern Ireland	337	383	428	507	503	546
UK Total	**20,406**	**21,785**	**22,867**	**40,671**	**42,521**	**42,416**

The region with the highest proportion of the UK's Good Quality electrical capacity is still the Yorkshire and Humber region with a 34 per cent share, followed by the South East (15 per cent) the North West (13 per cent) and Scotland (9 per cent). The Yorkshire and Humber region has constituted the largest share since 2003 and hosts the single largest CHP scheme in the UK. In all, just 6.2 per cent of sites account for 80 per cent of the electricity capacity shown in Table 1.

The four largest regions in terms of installed capacity were also the four largest regions in terms of electricity generation. In 2018, the Yorkshire and Humberside region accounted for 30 per cent of all Good Quality electricity generated in the UK, which is about the same as it was in 2017, but a decrease from 34 per cent in 2016. As with capacity, a very large proportion of Good Quality electricity generated is taken up by a very small number of schemes.

With 20 per cent of the total CHP heat delivered, the Yorkshire and Humber region provided the largest share of CHP heat in 2018, followed by the North West (19 per cent), South East (16 per cent) and Scotland (15 per cent). The fact that the Yorkshire and Humber region is not as dominant in terms of heat generation as it is for power generation is a reflection of the very large proportion of

capacity in this region being Combined Cycle Gas Turbine (CCGT) technology, where the heat to power rations is lower than for any other CHP technology.

Chart 1: CHP generation by area in 2018

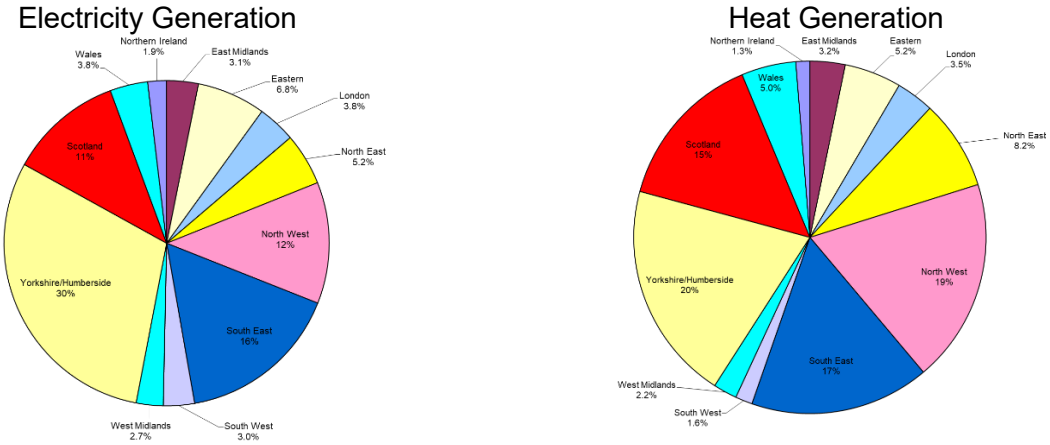


Table 2 shows an overview of CHP plant data broken down between the English regions and devolved administrations. The extent to which CHP capacity is utilised can be expressed by the Load Factor (LF). LF is the actual power generation as a proportion of the theoretical maximum power that can be generated for a given total installed capacity (TPC). The power output that is actually generated is the total power output (TPO). For 2018, the TPC was 8,825 MWe[5] and the TPO was 44,219 GWh, giving a LF of 57.2 per cent. This is 0.8 percentage points higher than in 2017. The highest LF over the last ten years was 60.0 per cent in 2016 and the lowest 51.0 per cent in 2013. The average LF over the last ten years has been 55.3 per cent.

Higher LF values tend to be found when CHP is deployed to satisfy industrial heat loads. This is because the demand for heat extends over a greater proportion of the year at industrial sites than at sites where CHP is deployed to satisfy space heating, where demand is seasonal. For example, in 2018 Yorkshire and Humber had the highest proportion of capacity that is industrial (94 per cent) and the highest LF (65 per cent) while London has the lowest proportion of capacity that is industrial (28 per cent) and the second lowest LF (50 per cent).

[5] 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 2018

	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** (%)
England	**2,066**	**5,096**	**7,683**	**16,872**	**74,007**	**18,987**	**38,268**	**33,592**	56.9%
East Midlands	136	152	194	633	2,965	720	941	1,369	55.3%
Eastern	200	353	353	951	5,124	1,559	1,642	2,217	53.1%
London	344	258	292	1,033	3,200	866	1,271	1,469	49.7%
North East	130	391	417	1,001	6,340	1,184	2,096	3,497	57.3%
North West	318	760	902	4,307	14,249	2,761	3,952	7,931	50.0%
South East	334	871	2,076	3,222	14,932	3,712	8,991	6,991	49.5%
South West	173	143	143	332	2,512	707	743	665	59.4%
West Midlands	215	151	189	630	2,767	613	1,012	924	61.3%
Yorkshire/Humberside	216	2,018	3,118	4,763	21,919	6,866	17,620	8,528	64.5%
Scotland	178	563	717	2,687	12,376	2,593	3,830	6,155	61.0%
Wales	138	228	327	924	4,468	859	1,677	2,123	58.6%
Northern Ireland	91	99	99	238	1,673	428	443	546	51.3%
UK Total	**2,473**	**5,985**	**8,825**	**20,722**	**92,523**	**22,867**	**44,219**	**42,416**	**57.2%**

∗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 2019 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

** 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 can be 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.

The importance of the chemicals and oil refining industries in Yorkshire/Humber, the North West and Scotland - industrial sectors particularly suitable for CHP – explains the large heat capacities per unit of GVA in these regions.

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

	Heat capacity per unit GVA kWt/ (£million)*	Electrical capacity per unit GVA kWe/ (£million)*
Yorkshire/Humberside	40.18	17.02
North West	25.18	4.44
Scotland	**19.29**	**4.04**
North East	18.82	7.34
Wales	**15.00**	**3.70**
South East	12.24	3.31
England	**10.85**	**3.28**
Eastern	6.11	2.27
East Midlands	6.04	1.45
Northern Ireland	**5.99**	**2.48**
West Midlands	4.71	1.13
London	2.45	0.61
South West	2.49	1.07
UK total	**11.54**	**3.33**

*GVA is provisional gross value added in 2017 (income approach) at current prices[6]

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 most striking feature of Table 4 is the very large proportion (62 per cent) of CHP capacity serving the oil refineries and oil and gas terminals sector being located in the Yorkshire and Humber region. Over 85 per cent of CHP capacity in the Chemicals sector is to be found in just three regions (Yorkshire and Humber, North West and North East), which is consistent with the importance of the Chemical industry to the economies of these parts of the country. A large proportion (nearly 83 per cent) of CHP capacity serving the paper sector is installed in just three regions (South East, North West and Scotland), attesting to the concentration of this industry in these regions. The dominance

[6] www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach

of the South East region for CHP serving the paper sector has reduced in recent years due to some significant site closures. In 2010, 51 per cent of all CHP capacity operating in the paper sector was located in the South East. By 2018 this had fallen to 35 percent.

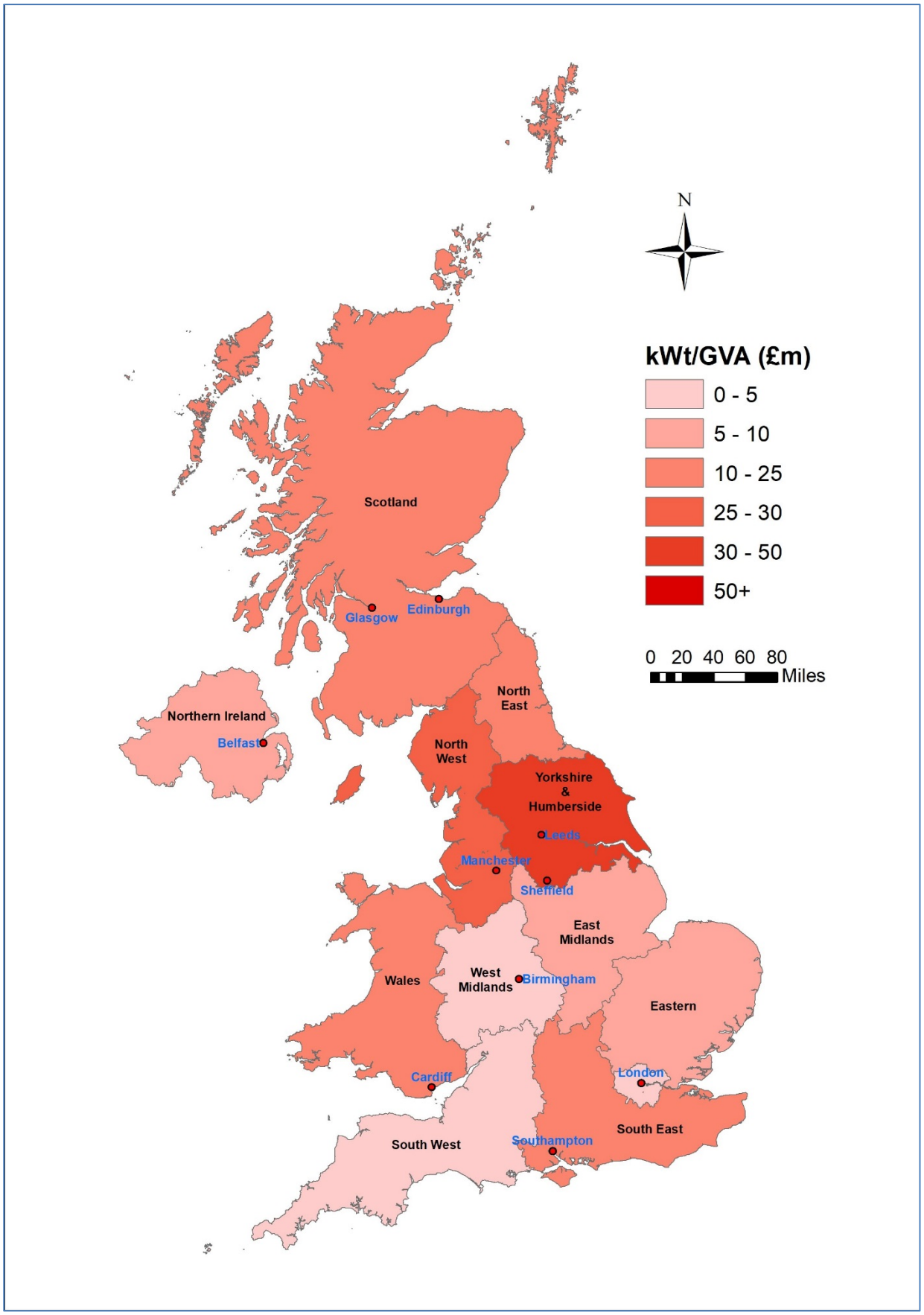
The production of primary steel and the availability of by-product gases for fuelling CHP is responsible for the large shares of capacity in the Iron and Steel and Non-ferrous sectors in Wales and Yorkshire/Humber.

The large proportion of capacity installed in the Food and Drink sector in the Eastern region (42 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 2018

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	65.9%	88.9%	86.6%	72.8%	85.0%	84.2%	100.0%	68.5%	84.0%	89.1%
East Midlands	0.0%	1.2%	0.0%	0.0%	6.1%	3.5%	7.7%	6.9%	5.4%	6.5%
Eastern	28.4%	1.4%	0.0%	0.0%	41.9%	0.0%	0.0%	8.1%	6.6%	7.6%
London	14.2%	0.0%	0.0%	0.0%	5.6%	11.7%	0.0%	12.6%	15.7%	12.2%
North East	0.0%	25.9%	0.0%	0.0%	0.0%	0.0%	14.0%	3.7%	6.7%	5.6%
North West	0.0%	24.0%	5.0%	29.4%	16.1%	4.6%	54.9%	8.3%	9.8%	10.1%
South East	0.0%	0.2%	19.5%	34.9%	5.2%	20.9%	0.0%	11.2%	12.1%	21.5%
South West	0.0%	0.7%	0.0%	0.0%	1.6%	5.3%	23.4%	5.4%	9.2%	5.7%
West Midlands	0.0%	0.2%	0.0%	2.5%	0.9%	38.1%	0.0%	7.4%	9.6%	4.8%
Yorkshire and Humber	23.4%	35.3%	62.2%	5.9%	7.7%	0.0%	0.0%	5.0%	8.8%	15.0%
Scotland	0.0%	6.9%	11.2%	18.2%	7.7%	0.6%	0.0%	8.6%	10.0%	5.7%
Wales	27.2%	3.1%	2.2%	9.0%	1.9%	7.5%	0.0%	17.1%	3.3%	2.5%
Northern Ireland	6.8%	1.0%	0.0%	0.0%	5.4%	7.7%	0.0%	5.8%	2.6%	2.8%
UK 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 heat capacity per unit 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 2018, just 137 schemes of the CCGT and Open Cycle Gas Turbine (OCGT) technologies accounted for 63 per cent of total Good Quality CHP capacity. This proportion of capacity taken up by these technologies has been much higher in the past and was 81 per cent in 2010. Most of this loss in share of capacity has been taken up by the reciprocating engine technology, as there has been a shift towards smaller capacity schemes of the types most conveniently served by reciprocating engines.
- 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 (91 per cent of all schemes). The region with the largest number of reciprocating engine schemes is London, followed by the South East and the North West. These high population areas have a large number of sites which are well suited to the capacity range and grade of heat offered by reciprocating engines, namely leisure centres, hotels and retail outlets.

Table 5: CHP electrical capacity (MWe) by area and prime mover in 2018

	Gas Turbines*	Steam Turbines	Organic Rankine Cycle	Gas, Steam Turbine and ORC Subtotal	Reciprocating Engines	Total
England	**3,323**	**412**	**10**	**3,745**	**1,350**	**5,096**
East Midlands	-	-	-	60	92	152
East of England	-	-	-	203	149	353
London	-	-	-	42	215	258
North East	-	-	-	300	90	391
North West	388	202	1	590	170	760
South East	595	4	-	599	272	871
South West	18	26	-	46	97	143
West Midlands	-	-	2.9	24	127	151
Yorkshire and The Humber	1,815	65	-	1,880	138	2,018
Scotland	361	95	3	460	103	**563**
Wales	-	-	4	141	87	**228**
Northern Ireland	-	-	-	33	66	**99**
Grand Total	**-**	**-**	**-**	**4,379**	**1,606**	**5,985**

*Includes Combined Cycle Gas Turbines (CCGT)

The CHP market continues to be dominated by large-scale (>10MWe) plant, with 70 per cent of all installed capacity being in this size range. However, this proportion has been in steady decline over the years as larger (usually) industrial based CHP has closed and smaller (often) non-industrial based schemes have opened. For example in 2010, the proportion of installed capacity that was taken up by schemes > 10 MWe capacity was 83 per cent. Since 2010, the proportion of total capacity provided by schemes in the 2 MWe to 10 MWe range has increased from 11 per cent to 18 per cent

The regional distribution of CHP by capacity tranche is given in Table 6. Over 44 per cent of all capacity greater than 10 MWe is to be found in the Yorkshire and Humber region, followed by the South East (14 per cent), the North West (13 per cent) and Scotland (10 per cent). This is consistent with the tendency for heat intensive industries such as oil refineries, chemicals and paper, for which large CHP schemes are needed, to be located in these regions.

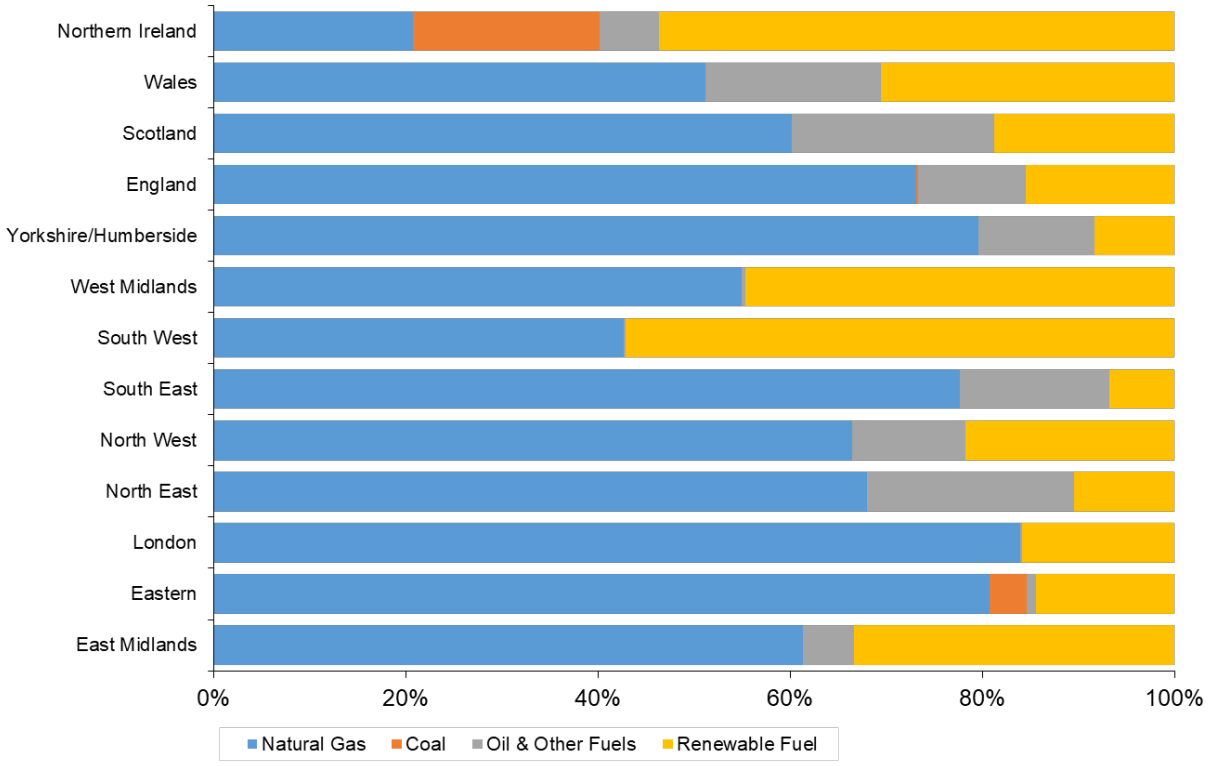
Table 6: CHP electrical capacity (MWe) by area and size in 2018

	<= 100 kWe	> 100 kWe to 1 MWe	>1 MWe to 2 MWe	> 2 MWe to 10 MWe	> 10 MWe +	Total
England	**37**	**289**	**245**	**928**	**3,596**	**5,096**
East Midlands	3	18	27	-	-	152
East of England	3	27	25	-	-	353
London	7	50	27	-	-	258
North East	3	11	11	83	282	391
North West	5	45	49	123	537	760
South East	5	47	35	182	602	871
South West	3	31	18	-	-	143
West Midlands	4	32	26	-	-	151
Yorkshire and The Humber	4	28	28	106	1,852	2,018
Scotland	3	20	33	86	421	563
Wales	3	19	11	53	142	228
Northern Ireland	1	22	6	-	-	99
Grand Total	**44**	**351**	**295**	**1,091**	**4,204**	**5,985**

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 2018 for each region



Natural gas represented 69 per cent of all fuel burned in CHP in 2018, which is 0.8 per centage points higher than in 2017 (revised). Over the last ten years, the share of all fuel burned that was natural gas has been within the range 69-73 per cent. With the exception of Northern Ireland and the South West, natural gas accounts for more than half of all fuel burned.

The South West had the highest proportion of fuel burned that was renewable (57 per cent) followed by Northern Ireland (54 per cent) and then the West Midlands (45 per cent). The South West also had the highest proportion of heat from CHP that was renewable (35 per cent of all CHP heat generated in the South West), but Northern Ireland had the highest proportion of Good Quality electricity generated that was renewable (58 per cent of all Good Quality CHP electricity generated in Northern Ireland).

In 2018 coal was again burned in only two regions (Northern Ireland and Eastern) and was confined to a very small number of schemes.

Summary

Between 2016 and 2018 the number of CHP schemes increased in all regions of the UK and all regions also saw an increase in the installed capacity.

CHP continues to play an important role in the economies of Yorkshire/Humber, the North West, Scotland and the North East. This reflects the importance of the oil refining and chemicals industries in these regions, which are well suited to the deployment of CHP. Other long established regional patterns endure, such as the importance of CHP in the food and drink and paper industries of the Eastern and South East regions, respectively, and the fact that the South East and London have the highest and second highest shares on non-industrial installed capacity.

In 2018 renewable fuels accounted for 17 per cent of CHP fuel consumption, 0.7 percentage points higher than in 2017 (revised). In 2008 the proportion of CHP fuel that was renewable was just 3.9 per cent. In 2018 the South West had the largest proportion of renewable fuel consumption in CHP followed by Northern Ireland and then the West Midlands.

For further information on UK CHP statistics, please contact:

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