

Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2019

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 2020. This article updates statistics published in the September 2019 edition of Energy Trends and provides a breakdown of CHP in the Devolved Administrations and English regions in 2019¹.

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 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 2018 and 2019 there was a net decrease in Good Quality CHP² capacity of 13 MWe but a net increase of 50 in the number of CHP schemes in the database (63 new schemes and the removal of 13 schemes). Good Quality CHP capacity in the UK decreased from 6,063 MWe (revised 2018 figure) to 6,050 MWe in 2019. In 2019, 23.5 TWh of Good Quality CHP electricity was generated, which is 2.2 per cent higher than in 2018. This Good Quality CHP electricity constitutes 7.1 per cent of all electricity supplied in the UK.

Regional trends³

Tables 1 and 1B show a comparison of the number of schemes, electrical capacity, electricity generated and heat generated in the regions⁴ for the period 2017 to 2019. During this time, the total number of schemes increased from 2,406 to 2,547 and the capacity increased from 5,919 MWe to 6,050 MWe. Over this period, every region saw an increase in the number of CHP schemes. However, over the period there was an appreciable fall in capacity in Wales and very slight falls in London and Yorkshire and the Humber. The fall in Wales is substantially due to the closure of one significant industrial scheme.

¹ Similar articles on CHP have appeared in previous Energy Trends publications from 2001 to 2019. 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 2017-2019

	Number of Schemes			Electrical Capacity (MWe)		
	2017	2018	2019	2017	2018	2019
England	2,013	2,075	2,109	5,026	5,170	5,190
East Midlands	133	136	140	151	166	165
Eastern	198	204	207	348	389	374
London	340	348	352	254	250	252
North East	126	131	134	360	391	393
North West	308	317	322	747	760	764
South East	323	334	338	859	904	906
South West	169	173	178	137	143	146
West Midlands	204	218	221	147	151	167
Yorkshire/Humberside	212	214	217	2,024	2,016	2,023
Scotland	171	184	193	561	564	577
Wales	137	147	146	236	230	183
Northern Ireland	85	91	99	96	99	100
UK Total	2,406	2,497	2,547	5,919	6,063	6,050

Table 1B: Trend in CHP electricity and heat generated over the period 2017-2019

	Electricity Generated (GWh)			Heat Generated (GWh)		
	2017	2018	2019	2017	2018	2019
England	17,996	19,071	19,888	33,745	33,992	33,677
East Midlands	732	740	762	1,383	1,483	1,505
Eastern	1,489	1,708	1,736	1,973	2,450	2,391
London	786	857	992	1,353	1,482	1,555
North East	1,342	1,184	1,218	4,019	3,496	3,171
North West	2,725	2,770	2,898	7,993	7,926	8,139
South East	3,013	3,730	4,964	6,840	7,011	7,220
South West	677	712	748	626	673	675
West Midlands	600	607	627	883	948	991
Yorkshire/Humbe	6,633	6,763	5,942	8,676	8,523	8,029
Scotland	2,607	2,583	2,304	6,247	6,152	5,374
Wales	785	864	839	2,004	2,147	2,093
Northern Ireland	383	427	431	503	545	553
UK Total	21,771	22,945	23,461	42,500	42,836	41,697

The region with the highest proportion of the UK's Good Quality electrical capacity is still the Yorkshire and Humber region with a 33 per cent share, followed by the South East (15 per cent) the North West (13 per cent) and Scotland (10 per cent). The Yorkshire and Humber region has constituted the largest share since 2003 and hosts the single largest CHP scheme in the UK.

The four largest regions in terms of installed capacity were also the four largest regions in terms of electricity generation. In 2019, the Yorkshire and Humberside region accounted for 25 per cent of all Good Quality electricity generated in the UK. The share of power generation taken up by the Yorkshire and Humberside region has fallen appreciably over recent years and was as high as 34% in 2016. This change is due to two factors: (1) A large increase in the Good Quality electricity generated in the South East, and (2) A fall in the Good Quality generation in the Yorkshire/Humber region. The latter factor is not due to a fall in the absolute quantity of all power generated in this region, but a fall in the electricity generated which is deemed Good Quality, in turn due to a significant decrease in the heat recovered from power generation at one large Chemicals site.

Special feature - CHP

The aforementioned fall in CHP heat generated in the Yorkshire/Humber region in 2019 means that this region no longer has the largest share of CHP heat generated. In 2019, the North West region accounted for the largest share of CHP heat generated (20 per cent), with the Yorkshire/Humber region ranked second (19 per cent), followed by the South East (17 per cent) and then Scotland (13 per cent).

Chart 1: CHP generation by area in 2019

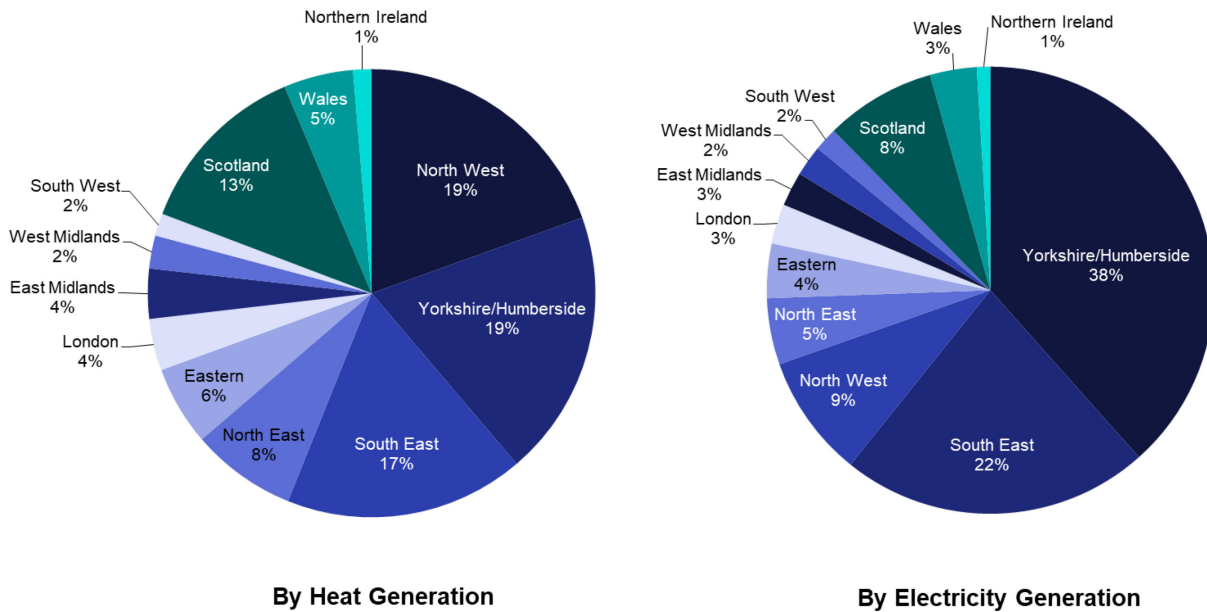


Table 2 shows an overview of CHP plant data broken down between the English regions and devolved administrations. The extent to which CHP capacity is utilised can be expressed by the Load Factor (LF). LF is the actual power generation as a proportion of the theoretical maximum power that can be generated for a given total installed capacity (TPC). The power output that is actually generated is the total power output (TPO). For 2019, the TPC was 8,894 MWe⁵ and the TPO was 46,028 GWh, giving a LF of 59.1 per cent. This is 2.0 percentage points higher than in 2018. The LF was higher in 2019 than in 2018 in all regions, with the exceptions of Scotland, Northern Ireland and the West Midlands. The greatest increase in LF between 2018 and 2019 was seen in the South East and this was substantially due to a large increase in the LF of one very large industrial CHP plant. The highest LF over the last ten years was 60.0 per cent in 2016 and the lowest 51.0 per cent in 2013.

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. Consequently, higher LF tend to be seen in regions with larger shares of capacity serving industrial installations.

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 2019

	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	2,109	5,190	7,781	16,940	75,665	19,888	40,341	33,677	59.2%
East Midlands	140	165	209	636	3,346	762	1,141	1,505	62.3%
Eastern	207	374	374	1,077	5,625	1,736	1,811	2,391	55.3%
London	352	252	285	1,012	3,563	992	1,324	1,555	53.0%
North East	134	393	420	984	5,843	1,218	2,212	3,171	60.1%
North West	322	764	907	4,268	14,487	2,898	4,082	8,139	51.4%
South East	338	906	2,109	3,236	17,458	4,964	10,280	7,220	55.6%
South West	178	146	146	312	2,580	748	781	675	61.0%
West Midlands	221	167	206	655	2,898	627	1,024	991	56.9%
Yorkshire/Humberside	217	2,023	3,126	4,760	19,866	5,942	17,685	8,029	64.6%
Scotland	193	577	731	2,709	10,892	2,304	3,688	5,374	57.6%
Wales	146	183	282	822	4,347	839	1,553	2,093	62.9%
Northern Ireland	99	100	100	219	1,687	431	447	553	50.9%
UK Total	2,547	6,050	8,894	20,690	92,591	23,461	46,028	41,697	59.1%

*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 2020 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 kWel/ (£million)*
Yorkshire/Humberside	40.16	17.07
North West	24.96	4.47
Scotland	19.44	4.14
North East	18.48	7.39
Wales	13.35	2.97
South East	12.29	3.44
England	10.90	3.34
Eastern	6.92	2.40
East Midlands	6.06	1.57
Northern Ireland	5.52	2.52
West Midlands	4.90	1.25
London	2.40	0.60
South West	2.34	1.10
UK total	11.53	3.37

*GVA is provisional gross value added in 2017 (income approach) at current prices⁶

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. These data reflect higher level regional patterns seen in the UK economy. For example, 55 per cent of the Iron and Steel and Non-ferrous Metals capacity is located in Yorkshire/Humber and Wales. This is driven by the large capacity CHP plant operated at integrated steel works, which have at their disposal by-product gases which are used as CHP fuel. The last two integrated steel works in the UK are located in these two regions. The high demands for steam in chemical manufacturing make the Chemicals sector ideal for CHP. The historical concentration of chemicals manufacture in the North West, North East and Yorkshire/Humber (specifically Humber) regions of England explain the fact that nearly 83 per cent of Chemicals CHP capacity is located in these three regions. Similarly,

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

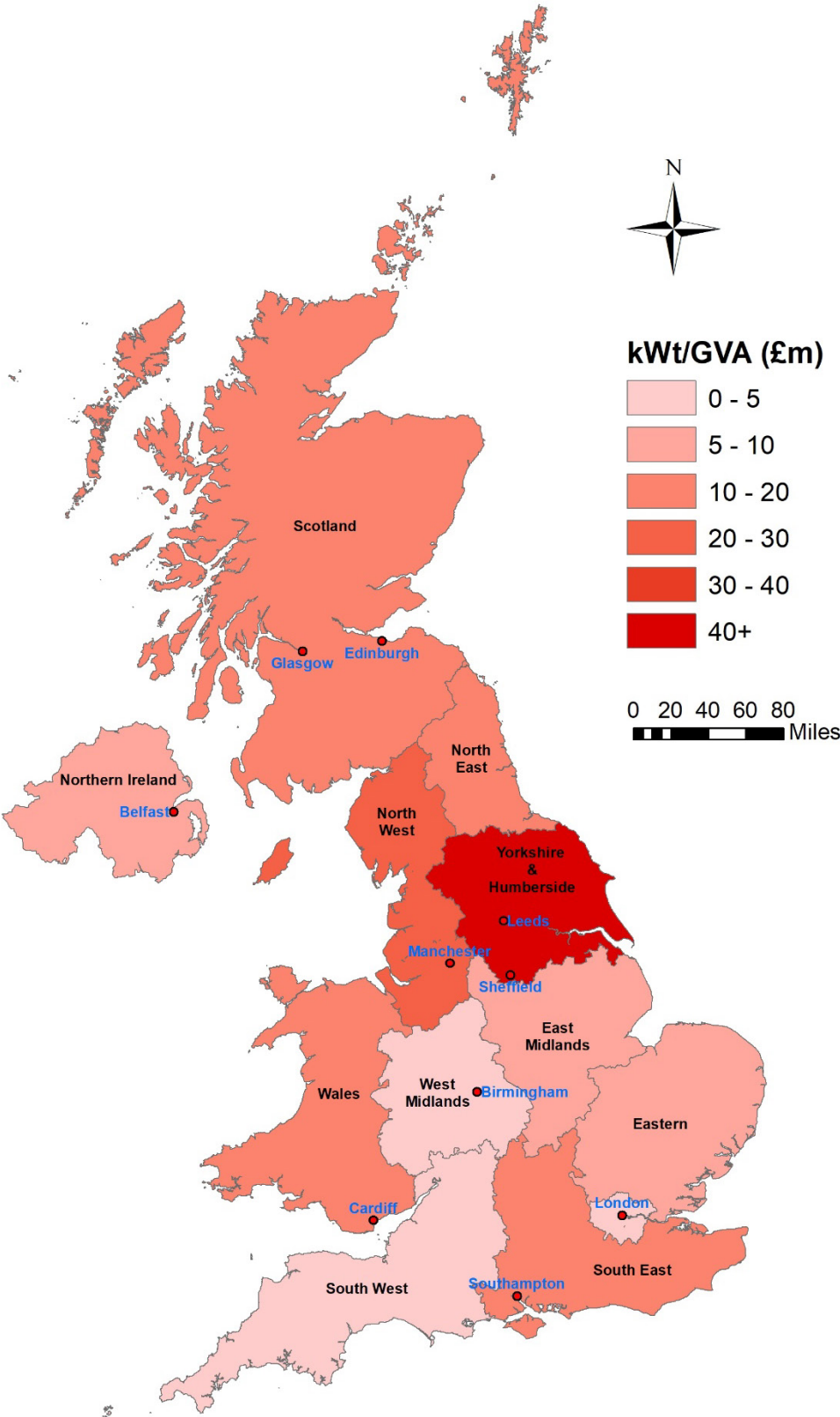
of the six oil refineries now operating in the UK, two are situated in Humber area, explaining the large share of capacity in the Oil Refineries and Gas Terminals sector in the Yorkshire/Humber region. The heat intensive nature of sugar production and the concentration of sugar beet processing in East Anglia explains the fact that over one third of the Food and Drink sector's capacity is located in the Eastern region.

In the non-industrial sectors, the highest shares of the Transport, Commerce and Administration sector's capacity is found in London and the South East and this reflects the importance of the services sector to these regions' economies.

Table 4: Distribution of CHP capacity across the regions and economic sectors in 2019

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	62.7%	89.1%	88.5%	75.6%	85.5%	84.2%	100.0%	67.0%	82.9%	88.3%
East Midlands	0.0%	1.2%	0.0%	0.0%	8.8%	3.5%	7.7%	7.2%	5.3%	6.1%
Eastern	21.6%	1.4%	0.0%	10.3%	37.4%	0.0%	0.0%	8.1%	6.2%	7.0%
London	15.5%	0.0%	0.0%	0.0%	5.7%	11.7%	0.0%	10.1%	15.5%	11.7%
North East	0.0%	25.4%	0.0%	0.0%	0.0%	0.0%	14.0%	3.8%	6.9%	5.3%
North West	0.0%	23.5%	5.1%	26.4%	15.6%	4.6%	54.9%	7.7%	10.2%	10.1%
South East	0.0%	2.9%	19.9%	31.3%	5.5%	20.9%	0.0%	11.7%	11.9%	20.7%
South West	0.0%	0.7%	0.0%	0.0%	1.6%	5.3%	23.4%	5.3%	9.3%	5.8%
West Midlands	0.0%	0.2%	0.0%	2.2%	2.6%	38.1%	0.0%	7.7%	9.1%	5.6%
Yorkshire and Humber	25.6%	33.8%	63.5%	5.3%	8.4%	0.0%	0.0%	5.2%	8.4%	15.9%
Scotland	0.0%	6.8%	11.5%	16.4%	7.4%	0.6%	0.0%	9.1%	11.0%	6.3%
Wales	29.8%	3.1%	0.0%	8.0%	1.8%	7.5%	0.0%	17.8%	3.4%	2.5%
Northern Ireland	7.5%	1.0%	0.0%	0.0%	5.2%	7.7%	0.0%	6.1%	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 2019, just 140 schemes of the CCGT and Open Cycle Gas Turbine (OCGT) technologies accounted for 62 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. The large majority of this capacity is situated 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 (90 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 2019

	Gas Turbines*	Steam Turbines	Organic Rankine Cycle	Gas, Steam Turbine and ORC Subtotal	Reciprocating Engines	Total
England	3,327	457	10	3,794	1,395	5,190
East Midlands	-	-	-	74	91	165
East of England	-	-	-	231	143	374
London	-	-	-	42	209	252
North East	-	-	-	300	93	393
North West	388	202	1	590	174	764
South East	597	35	-	633	273	906
South West	18	26	-	46	100	146
West Midlands	-	-	3.0	24	142	167
Yorkshire and The Humber	1,789	65	-	1,854	169	2,023
Scotland	361	95	4	460	117	577
Wales	-	-	6	95	88	183
Northern Ireland	-	-	-	33	67	100
Grand Total	3,747	615	20	4,382	1,668	6,050

*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. While this proportion is almost the same as last year, it has seen 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 19 per cent

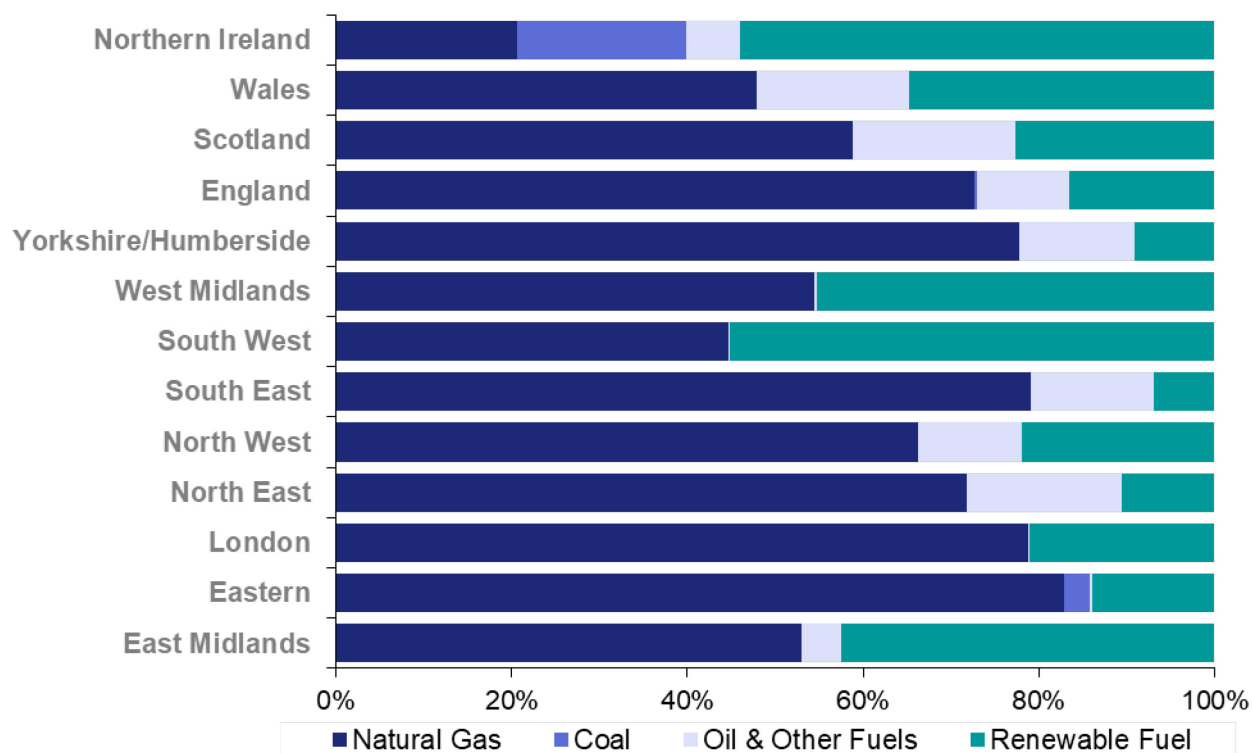
The regional distribution of CHP by capacity tranche is given in Table 6. Nearly 44 per cent of all capacity greater than 10 MWe is to be found in the Yorkshire and Humber region, followed by the South East (15 per cent), the North West (13 per cent) and Scotland (10 per cent). This is consistent with 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 2019

	<= 100 kWe	> 100 kWe to 1 MWe	>1 MWe to 2 MWe	> 2 MWe to 10 MWe	> 10 MWe +	Total
England	38	292	250	955	3,656	5,190
East Midlands	3	19	25	-	-	165
East of England	3	28	26	-	-	374
London	7	51	29	-	-	252
North East	3	12	13	83	282	393
North West	6	45	46	130	537	764
South East	5	46	39	181	635	906
South West	3	32	20	-	-	146
West Midlands	4	32	24	-	-	167
Yorkshire and The Humbe	4	27	28	127	1,837	2,023
Scotland	3	23	36	94	421	577
Wales	3	20	12	-	-	183
Northern Ireland	1	22	7	-	-	100
Grand Total	45	358	306	1,126	4,216	6,050

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 2019 for each region

Special feature - CHP

Natural gas represented 70 per cent of all fuel burned in CHP in 2019, and this is virtually unchanged from 2018 (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, Wales and the South West, natural gas accounts for more than half of all fuel burned in CHP plant.

In 2019 17,382 GWh of renewable fuels were consumed by CHP across the UK. This is a 4.4 per cent increase on 2018. The North West had the highest absolute consumption of renewable fuel in 2019 (3,169 GWh, 18 per cent of the total across all regions), followed by Scotland (2,468 GWh, 14 per cent of the total) and Yorkshire/Humber (1,803 GWh, 10 per cent of the total). In terms of the share of total CHP fuel input that was renewable, in 2019 that was highest in the South West, where 55 per cent of CHP fuel consumed in that region was renewable, followed by Northern Ireland (54 per cent) and the West Midlands (45 per cent). Between 2018 and 2019, CHP renewable fuel consumption increased in absolute terms in all regions except the North East and Yorkshire/Humber. Over the same period, the share of total CHP fuel that was renewable increased in all regions except the South East, South West and West Midlands.

In 2019 coal was again burned in only two regions (Northern Ireland and Eastern) and was confined to a very small number of schemes.

Summary

Between 2017 and 2019 the number of CHP schemes increased in all regions of the UK. Over the same period, the installed capacity increased in all regions with the exception of the South East and Yorkshire/Humber, which saw very slight falls, and Wales where the closure of one large scheme produced a more noticeable fall.

The deployment of CHP across the UK regions continues to reflect established, regional economic patterns, with CHP deployment in the Chemicals sector being very significant in the Yorkshire/Humber (specifically Humber) region, the North East and North West. The deployment of reciprocating engines in the non-industrial sectors is significant in London, South East and North West, consistent with these high population areas having a large number of non-industrial sites which are well suited to the capacity range and grade of heat offered by reciprocating engines, namely leisure centres, hotels and retail outlets. Oil refineries are well suited to the deployment of large CHP plant, and all but one of the six UK oil refineries use CHP. Consequently, there is significant oil refinery CHP capacity in the North East, Scotland, South East and Yorkshire/Humber.

In 2019 renewable fuels accounted for 19 per cent of CHP fuel consumption, 1.0 percentage points higher than in 2018 (revised). In 2008 the proportion of CHP fuel that was renewable was 3.9 per cent.

In 2019 the region with the greatest consumption of renewable fuels for CHP was the North West, followed by Scotland and Yorkshire/Humber. In relative terms, the region with the highest share of CHP fuel that as renewable was the South West, followed by Northern Ireland and the West Midlands.

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